

# COURSE STRUCTURE AND SYLLABI

## B.Tech in Aerospace Engineering

2024-25 Batch



**Centurion**  
**UNIVERSITY**

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*Empowering Communities...*

**SCHOOL OF ENGINEERING AND TECHNOLOGY**  
**CENTURION UNIVERSITY OF TECHNOLOGY & MANAGEMENT**  
**Odisha-761211, India**

Web Site: - [www.cutm.ac.in](http://www.cutm.ac.in)



**CENTURION UNIVERSITY OF TECHNOLOGY AND MANAGEMENT,  
ODISHA**

**CERTIFICATE**



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**This is to certify that the syllabus of the Programme B.Tech in Aerospace Engineering of the School of Engineering and Technology is approved in the 14<sup>th</sup> Academic Council Meeting held on 22<sup>nd</sup> November 2024.**

**Dean**  
**School of Engineering and Technology,**  
**CUTM, Odisha**











# **Centurion University of Technology and Management Odisha**

**B.Tech. in Aerospace Engineering**

**CHOICE BASED CREDIT SYSTEM**

**COURSE STRUCTURE & SYLLABUS**

**BASKET – I, II, III, IV & V**



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**School of Engineering & Technology**

**2024**



**Index**  
**Basket - I**

<b>Course Code</b>	<b>Course Title</b>	<b>Page No</b>
CUTM1001	Differential Equations and Linear Algebra	2
CUTM1002	Laplace & Fourier Transforms	4
CUTM1003	Complex Analysis & Numerical Methods	6
CUTM1004	Discrete Mathematics	8
CUTM1005	Probability & Statistics	11
CUTM1925	Calculus	13
CUTM1006	Mechanics for Engineers	15
CUTM1007	Optics and Optical Fibres	18
CUTM1008	Applied Analytical Chemistry	21
CUTM1009	Applied Engineering Materials	24
CUTM1674	Environmental Science	27

**Basket - II**

<b>Course Code</b>	<b>Course Title</b>	<b>Page No</b>
CUTM1011	Optimisation Techniques	32
CUTM1012	Engineering Economics and Costing	34
CUTM1013	Project Management	36
CUTM1014	Gender, Human Rights and Ethics	40
CUTM1015	Climate Change, Sustainability and Organisation	42
CUTM1016	Job Readiness	44



### Basket - III

Course Code	Course Title	Page No
CUTM1017	Industrial IOT and Automation	48
CUTM1018	Data Analysis and Visualisation using Python	51
CUTM1019	Machine Learning using Python	53
CUTM1020	Robotic automation with ROS and C++	56
CUTM1021	Basics of Design Thinking	59
CUTM1022	System Integration with DYMOLA	61
CUTM1023	Smart Engineering Project (G2M)	66

### Basket - IV

Course Code	Course Title	Page No
CUTM1094	Introduction to Aerospace Engineering	72
CUTM1095	Rotary-wing Flight Dynamics	75
CUTM1096	Aerodynamics	78
CUTM1097	Flight Mechanics	82
CUTM1098	Aircraft Structure	86
CUTM1099	Aerospace Structural Analysis	90
CUTM1100	Jet Propulsion	94
CUTM1101	Advanced Propulsion	98
CUTM1102	Experimental Aerodynamics	102
CUTM1103	Space Dynamics	105
CUTM1104	Introduction to Avionics	108
CUTM1088	Thermodynamics	111



CUTM1089	Fluid Mechanics with Finite Volume Method	115
CUTM1062	Theories of Failure Using Finite Element Analysis	119
CUTM1058	Programming in Java(Same as Java Technologies)	123
CUTM1059	Database Management Systems	135
CUAS1001	Introduction To Aircraft Documents And Logbook	144

### **Basket – V (Domain)**

Sr. No.	Domain Title	Page No
1	Full-Stack Development with MERN	151
2	Generative AI	172
3	Data Analytics and Machine Learning	187
4	Cloud Technology	204
5	Drone Imaging and Spectral Analysis	221
6	Software Technology	237
7	Mobile App Development	253
8	Gaming and Immersive Learning-AR/VR	268
9	Blockchain Development	304
10	Cyber Security	322
11	CONSTRUCTION PLANNING, MONITORING AND PROJECT MANAGEMENT	338
12	Aerial Surveying and Remote Sensing Applications	360
13	Go To Market	377
14	Automobile Engineering	385
15	Manufacturing (Conventional, CNC and Additive)	394
16	Computational Fluid Dynamics	407
17	Composite Design and Manufacturing	414
18	Electronics Hardware Design and Automation	425







## **Programme Objectives; Job/Higher studies/Entrepreneurship**

### **POs: Engineering Graduates will be able to;**

- 1. PO1:** Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- 2. PO2:** Problem Analysis: Identify, formulate, review research literature, and analyze complex engineering problems to reach substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- 3. PO3:** Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.
- 4. PO4:** Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including the design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
- 5. PO5:** Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
- 6. PO6:** The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to professional engineering practice.
- 7. PO7:** Environment and Sustainability: Understand the impact of professional engineering solutions in societal and environmental contexts, and demonstrate knowledge of, and need for, sustainable development.
- 8. PO8:** Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- 9. PO9:** Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- 10. PO10:** Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- 11. PO11:** Project Management and Finance: Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- 12. PO12:** Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.



## PEOs/PSOs

1. **PEO1:** Prepare students to build competency in current technology and its application to meet the industry need for skilled Engineer
2. **PEO2:** Provide students with strong foundational concepts and also domain knowledge to pursue research to build solutions or systems of varying complexity to solve the problems identified
3. **PEO3:** Enable graduates to innovate, bring new idea and become an entrepreneur
4. **PSO1:** Graduates will be able to understand the governing principles and apply them in the fundamental disciplines of Aerospace Engineering (aerodynamics, guidance & control, propulsion and structures) and work on high-end technology of aviation and aerospace services industries.
5. **PSO2:** Graduates can acquire industry certified level of competency and work on real time aerospace and aviation application projects like Drone/Helicopter/UAVs/Fixed wing aircraft/Missiles/Rocket/ Satellites etc.
6. **PSO3:** Graduates can start their own start up, small scale or micro scale industries, service enterprise and to work with multi-disciplinary team in the entrepreneurial ecosystem.

Course Outcomes	Attributes
CO1	Knowledge
CO2	Analytical skill and Critical Thinking
CO3	Problem Solving and Decision taking ability
CO4	Use of Tool, Design and Development (Hands-on/Technical skill)
CO5	Research
CO6	Environment and Sustainability
CO7	Ethics & Team work
CO8	Soft skill



## Course Structure

### Basket - I

Course Code	Course Title	Credits	Course Type T+P+PJ
CUTM1001	Differential Equations and Linear Algebra	3	2+0+1
CUTM1002	Laplace & Fourier Transforms	3	2+0+1
CUTM1003	Complex Analysis & Numerical Methods	3	2+0+1
CUTM1004	Discrete Mathematics	3	2+0+1
CUTM1005	Probability & Statistics	3	2+0+1
CUTM1925	Calculus	3	2+0+1
CUTM1006	Mechanics for Engineers	3	2+1+0
CUTM1007	Optics and Optical Fibres	3	2+1+0
CUTM1008	Applied Analytical Chemistry	3	2+1+0
CUTM1009	Applied Engineering Materials	3	2+0+1
CUTM1674	Environmental Science	4	3+0+1



## Differential Equations and Linear Algebra

Code	Course Title	Credit	T-P-PJ
CUTM1001	Differential Equations and Linear Algebra	3	2-0-1

### Course Objectives:

- To introduce first and second order differential equations.
- To solve the system of linear equations appearing in the problems of electrical engineering, mechanical engineering etc.
- To use Eigen values and Eigen vectors in Control theory, vibration analysis, electric circuits, advanced dynamics problems.

### Course Outcomes:

After the completion of the course students will be able to:

- **CO1:** Solve systems of linear equations using Gauss- elimination to reduce to echelon form.
- **CO2:** Describe and discuss the importance of linear functions in mathematics.
- **CO3:** Apply Gauss- elimination procedure to solve systems of linear equations reducing to echelon form.
- **CO4:** Analyse and test fundamental concepts of ODE theories and where and how such equations arise in applications to scientific and engineering problems.
- **CO5:** Formulate and competent in solving linear/non-linear 1st & higher order ODEs using analytical methods to obtain their exact

### Course Outcome to Program Outcome Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	3					1				1	2		1
CO2	2	3	2	2			2	2					2	2	1
CO3	2	3	2	2		2				2			2	3	
CO4	3	2	3	2	2						2		3	3	2
CO5	3	2	3	2	2			1					2		1

\*High-3, Medium-2, Low-1

## Course content

### Module-I

First order linear differential equations and its applications ( Kirchhoff's law)

**Project-1:** Some applications of differential equations in RL electrical circuit problems

### Module-II:

Second order linear homogeneous differential equations (Real roots, Real equal roots, Complex conjugate roots) and its applications.

**Project-2:** RLC Circuit, Pendulum

### Module-III:

Second order linear non-homogeneous differential equations, Finding particular integral consisting of exponential, trigonometric functions (Sine, cosine) using inverse operator method

**Project-3:** Simple mass-spring system, Damped vibration system

### Module IV:

Basic concepts of a matrices, solution of linear system of equations by Gauss elimination method, linearly independent and dependent of a vectors, rank of a matrix.

### Project-4

Report on finding the traffic flow in the net of one-way streets

### Module V:

Determinants and Cramer's Rule, Fundamental theorem of linear system of equations.

### Module VI:

Eigenvalues and Eigen vectors of a matrix

### Project-5

(i) Find the limit states of the Markov process model.

(ii) Find the growth rate in the Leslie model

### Module VII:

Symmetric, Skew-Symmetric , Orthogonal Matrices and Properties

### Project-6

To make a report to show that the product of two orthogonal matrices is orthogonal, and so is the inverse of an orthogonal matrix. What does this mean in terms of rotations?

### Text Books:

1. Advanced engineering mathematics by Erwin Kreyszig, 8<sup>th</sup> edition  
Chapter-6 (6.1-6.6), Chapter-7 (7.1,7.2)
2. Higher Engineering by B.V. Ramana  
Chapter-8(8.1,8.2,8.21), Chapter-9 (9.2,9.3,9.5)

### Reference Books:

1. J. Sinha Roy and S. Padhy, A Course of Ordinary and Partial Differential Equations, Kalyani Publishers, New Delhi.
2. G.B. Thomas, M.D. Weir, J.R. Hass, Thomas' Calculus, Pearson Publication.
3. R.G. Bartle, D.R. Sherbert, Introduction to Real Analysis, Wiley Publication

## Laplace and Fourier Transform

Code	Course Title	Credit	T-P-PJ
CUTM1002	Laplace and Fourier Transform	3	2-0-1

### Objective

- To describe the ideas of Fourier and Laplace Transforms and indicate their applications in the fields such as application of PDE, Digital Signal Processing, Image Processing, Theory of wave equations, Differential Equations and many others.
- To use Fourier series for solving boundary value problems appearing in scientific & engineering problems.
- Introduce students about solution of Differential Equations with the help of Laplace Transform.

### Course Outcomes:

After the completion of the course students will be able to:

- **CO1:** solve initial value problem and boundary value problem using Laplace transfer.
- **CO2:** describe and discuss properties, applications to the solution of ordinary and partial differential equations having constant co-efficient.
- **CO3:** apply the expansion of simple functions in Fourier series and half range series.
- **CO4:** analyze and test fundamental concepts of Fourier sine and cosine transform and their inversion.
- **CO5:** formulate and apply the Fourier Transform to solution of partial differential

### Course Outcome to Program Outcome Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1				1				1	2		2
CO2	2	3	2	2			2	2					3	2	1
CO3	3	3	2	2		1				3			2	3	
CO4	2	3	3	2	2		2				2		2	3	2
CO5	3	2	2	2	2			1					2		1

\*High-3, Medium-2, Low-1

## Course content

### Module-I (T-3-Pj-2)

Laplace Transforms, Properties of Laplace transforms, Unit step function.

#### Project-1

Make a short draft of properties of Laplace transform from memory. Then compare your notes with the text and write a report of 2-3 pages on these operations and their significance in applications.

### Module-II (T-2-Pj-2)

Second shifting theorem, Laplace transforms of Derivatives and Integrals

#### Project-2

Find the Laplace transform of the following functions

### Module-III (T-3-Pj-2)

Derivatives and Integrals of Transforms, Inverse Laplace transform.

#### Project 3:

Application of Unit step function (RC- Circuit to a single square wave).

### Module- IV (T-2-Pj-2)

Solution of Differential Equation by using Laplace Transform.

**Project 4:** Find the solution of differential equation by using Laplace Transform.

### Module-V (T-4-Pj-2)

Periodic function, Fourier series, Fourier series expansion of an arbitrary period, Half range expansions.

#### Project-5

Find the Fourier series expansion of a  $2\pi$  periodic function.

### Module-VI(T-3-Pj-2)

Complex form of Fourier series, Fourier Integrals, Different forms of Fourier Integral.

#### Project-6

Find the Fourier sine and cosine integral of the following functions.

### Module-VII(T-3)

Fourier Transforms, Fourier sine and cosine Transforms.

#### **Text Books:**

E. Kreyszig , Advanced Engineering Mathematics, Johnwiley& Sons Inc-8th Edition.Chapters:5(5.1 to 5.4(without Dirac's delta function ) ),10(10.1,10.4 and 10.7-10.9(definitions only , no proofs))

Higher Engineering Mathematics by B.V.Ramana, Tata McGraw-Hill Education India, Inc-8th Edition.

#### **Reference Books:**

- 1) Advanced Engineering Mathematics by P.V.O'Neil Publisher: Thomson
- 2) Mathematical Methods by Potter & Goldberg ; Publisher : PHI

## Complex Analysis and Numerical Methods

Code	Course Title	Credit	T-P-PJ
CUTM1003	Complex Analysis and Numerical Methods	3	2-0-1

### Course Objectives:

- To understand about Complex variables and complex functions.
- To acquire the skill of evaluating contour integrals using Cauchy's integral formula and Cauchy's integral theorem.
- To understand the limitations of analytical methods and the need for numerical methods and the ability to apply these numerical methods to obtain the approximate solutions to engineering and mathematical problems.

### Course Outcomes:

After the completion of the course students will be able to:

- **CO1:** Solve the problems related to analytic functions using the Cauchy-Riemann equations.
- **CO2:** Describe and discuss the importance of harmonic functions and analytical functions.
- **CO3:** Apply Cauchy integral theorem and Cauchy integral formula for evaluating complex contour integrals.
- **CO4:** Analyse and test the fundamental concepts numerical methods for finding out solutions of various mathematical problems arising in roots of linear and non-linear equations, solving differential equations with initial conditions and evaluating real definite integrals.
- **CO5:** Formulate and competent in solving numerical problems by using Runge-Kutta 2nd

### Course Outcome to Program Outcome Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2					2				2	2		1
CO2	3	2	2	3			2	3					2	2	2
CO3	3	3	2	2		3				3			2	2	
CO4	2	3	2	2	2						2		3	3	3
CO5	2	2	3	3	2			1					2		1

\*High-3, Medium-2, Low-1

## Course Outline

### Module I (T-3 hrs-P-0-hrs-P-0 hrs)

Functions of a complex variable, Analytic functions, Cauchy-Riemann equations (Without Proof), Harmonic and Conjugate harmonic functions, Cauchy's Integral Theorem (Without Proof).

**Project-1** : Verification of Cauchy-Riemann equations for complex functions in Cartesian form and Polar form

### Module II (T-3 hrs-P-0 hrs-P-2 hrs)

Cauchy's Integral Formula (Without Proof), Cauchy's Integral Formula for higher order derivatives (Without Proof), Taylor series.

**Project-2** : Evaluation of contour integrals using Cauchy's Integral Formula

### Module III (T-4 hrs-P-0 hrs-P-2 hrs)

Laurent series (Without Proof), Pole, Residue, Residue Theorem (Without Proof), Evaluation of Real integral Type-I.

### Module – IV (T-2 hrs-P-0 hrs-P-2 hrs)

Interpolation, Lagrange interpolation polynomial.

**Project-3** : Finding out the value of a given function at an interior point on an unequal interval using Lagrange interpolation polynomial

### Module – V (T-3 hrs-P-0 hrs-P-2 hrs)

Forward and backward difference operators, Newton's forward and backward difference Interpolation formulae.

**Project-4** : Finding out the value of a given function at an interior point on an equal interval using Newton's forward and backward difference interpolation formulae

### Module – VI (T-2 hrs-P-0 hrs-P 2 hrs)

Numerical Integration, Trapezoidal rule, Simpson's one third rule.

**Project-5** : Evaluation of real definite integrals using Trapezoidal rule and Simpson's one third rule

### Module – VII (T-3 hrs-P-0 hrs-P-2 hrs)

Runge-Kutta 2nd & 4th order methods.

**Project-6** : Finding out Numerical solutions of differential equations using Runge-Kutta 2<sup>nd</sup> & 4<sup>th</sup> order methods

#### Text Book:

1) Advanced Engineering Mathematics by E. Kreyszig Publisher: Johnwiley& Sons Inc-8th Edition Chapters : 12 (12.3, 12.4), 13 (13.2 to 13.4), 14.4, 15 (15.1 to 15.4 Only Type-I integral), 17 (17.3, 17.5), 19 (19.1).

#### Reference Books:

- 1) Advanced Engineering Mathematics by P.V. O'Neil Publisher: Thomson
- 2) Fundamentals of Complex Analysis (with Applications to Engineering and Science) by E.B. Saff& A.D. Snider Publisher: Pearson
- 3) Numerical Methods for Scientific and Engineering Computation by M. K. Jain, S. R. K. Iyengar& R.K. Jain; New Age International Publishers.
- 4) Introductory Methods of Numerical Analysis by S.S. Sastry; Third Edition, Prentice Hall India.

## Discrete Mathematics

Code	Course Title	Credit	T-P-PJ
CUTM1004	Discrete Mathematics	3	2-0-1

### Course Objective

- To understand mathematical reasoning in order to read, comprehend and construct Mathematical arguments as well as to solve problems, occurred in the development of programming languages.
- To understand different types of relations.
- To work with discrete structures such as graphs to study the structure of the world wide web, to model a computer network and to find the shortest path between two places in a transportation network

### Course Outcomes

After the completion of the course students will be able to:

- **CO1:** Apply the logical structure of proofs and work symbolically with connective and quantifiers to produce logically valid, correct and clear arguments.
- **CO2:** Evaluate elementary mathematical arguments and identify fallacious reasoning
- **CO3:** Reformulate statements from common language to formal logic
- **CO4:** Apply truth tables and the rules of propositional and predicate calculus
- **CO5:** Model and solve real world problems using graphs ,both quantitatively and

### Course Outcome to Program Outcome Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	3					2				1	2		1
CO2	2	3	2	2		2			1				2	2	1
CO3	2	3	2	2		2				2			3	3	
CO4	3	3	3	2		2					3		2	3	
CO5	3	2	3	2	2			2					2		1

\*High-3, Medium-2, Low-1

## Course Outline

### Module -I

(3Hours)

Propositional Logic, Connectives, Truth tables of compound propositions, Propositional Equivalence.

**Project 1:** Given the truth values of the propositions  $p$  and  $q$ , find the truth values of the conjunction, disjunction, implication, bi-implication, converse, contrapositive and inverse.

### Module -II

(2Hours)

Theory of inference, Predicates and Quantifiers, Rules of Inference.

**Project 2:** Build valid arguments of a given set of propositional logics and quantified statements using rules of inferences.

### Module -III

(3 Hours)

Relations and its properties, Partial Ordering, POSET, Totally Ordered Set.

**Project 3:** Define the properties of a relation on a set using the matrix representation of that relation with examples.

### Module -IV

(3Hours)

Hasse Diagram, Maximal & Minimal Elements of a Poset, Greatest & Least Elements of a Poset, Supremum & Infimum of a Poset, Lattice.

**Project 4:** Find a Topological Sort of a Poset.

### Module -V

(3 Hours)

Introduction to Graph Theory, Graph Terminology and Special types of Graphs, Representation of Graphs.

**Project 5:** Describe how some special types of graphs such as bipartite, complete bipartite graphs are used in Job Assignment, Model, Local Area Networks and Parallel Processing.

### Module -VI

(3 Hours)

Graph Isomorphism, Connectivity, Euler and Hamiltonian Graphs, Planar Graphs, Graph Coloring.

**Project 6(i):** Describe the scheduling of semester examination at a University and Frequency Assignments using Graph Colouring with examples. Find also their Chromatic numbers.

**Project 6(ii):** List out 10 pairs of Non-isomorphic graphs and explain the reason behind it.

**Project 6(iii):** List out all features of Euler and Hamiltonian Graphs. Justify whether the given set of graphs are Euler and Hamiltonian. Construct a Gray Code where the code words are bit strings of length three.

### Module -VII

(3 Hours)

Trees and their Properties, Spanning Trees, Minimum Spanning Trees, Kruskal's Algorithm.

**Project 7:** Find a minimum spanning tree in a given weighted graph using Kruskal's Algorithm.

**Text Books:**

1. Discrete Mathematics and its Applications by K.H.Rosen, Publisher: TMH, Sixth Edition, 2009.

Chapters: 1(1.1 ,1.2,1.3, 1.5); 7(7.1,7.6); 8(8.1 to8.5, 8.7, 8.8);9(9.1,9.4,9.5).

**Reference Books:**

1. Discrete Mathematical Structures with Applications to Computer Science, J. P. Trembkay, R. Manohar, Tata MC Graw – Hill Edition 38<sup>th</sup> reprint, 2010.

2. Discrete and Combinatorial Mathematics by R.P.Grimaldi Publisher: Pearson, 5<sup>th</sup> Edition, 2003.

3. Discrete Mathematics and Applications by Thomas Koshy Publisher: Elsevier, 2004.

4. Discrete Mathematical Structures by B. Kolman, R.C. Busby & S. Ross Publisher: PHI, 5<sup>th</sup> Edition, 2003

## Probability and Statistics

Code	Course Title	Credit	T-P-PJ
CUTM1005	Probability and Statistics	3	2-0-1

### Objective

- To translate real-world problems into probability models.
- To recognize the role and application of probability theory, descriptive and inferential statistics in many different fields of science and engineering.
- To apply probability and statistics in engineering and science like disease modeling, climate prediction and computer networks etc.

### Learning outcome

After the completion of the course students will be able to:

- **CO1:** explain the concepts of sample space, events and compute the probability of different events.
- **CO2:** describe discrete and continuous random variables.
- **CO3:** implement the concept of expectation, variance and covariance of random variables.
- **CO4:** solve problems related to correlation and regression.
- **CO5:** compare Binomial, Poisson and Normal distributions.

### Course Outcome to Program Outcome Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
<b>CO1</b>	3.00		2.0	1			2.0	2.0				3.0	3.0	3.0	3.0
<b>CO2</b>	2.00	2.0	3.0	2.0	1.0		1.0	2.0				1.0	2.0	1.0	3.0
<b>CO3</b>	2.00	1.0	3.0	1.0			2.0	2.0				3.0	3.0	2.0	2.0
<b>CO4</b>			2.0	1.0	3.0		3.0	2.0				3.0	1.0	2.0	2.0
<b>CO5</b>		1.0	2.0	1.0			2.0	2.0				3.0	3.0	1.0	2.0

\*High-3, Medium-2, Low-1

## Course content

### **Module I :( 3 hrs+2 hrs)**

Sample spaces and events; axiomatic definition of probability; Axioms of Probabilities

#### **Project-1**

A Report on Application of probability to control the flow of traffic through a highway system, a telephone interchange, or a computer processor

### **Module II :( 2 hrs +2 hrs)**

Mutually Exclusive Events, Dependent and Independent Events. Conditional Probability

#### **Project-2**

A Report on Dependent and Independent Events with Examples

### **Module III:(3 hrs +2 hrs)**

Discrete random variables and probability distributions, Continuous random variables and probability

distributions , Mean ,Variance and Moment Generating Function of Distributions

#### **Project-3**

Application of random variables in Engineering Field

### **Module IV:(3 hrs +2 hrs)**

Uniform Distribution, Binomial Distribution, Poisson Distribution

#### **Project-4**

Applications of Poisson distribution

### **Module V:(3 hrs +2 hrs)**

Normal Distribution, Working with Normal Tables, Normal Approximation to the Binomial Distributions

#### **Project-5**

Normal Distribution utilized in statistics, business settings, and government entities.

### **Module VI:(3 hrs)**

Statistics: Random Sampling, Population and Sample, Sample Mean and Variances, Point and Interval Estimations, Confidence Intervals

### **Module VII:(3 hrs +2 hrs)**

Regression and Correlation Analysis: Correlation Coefficient, Co-variance independent random variables, linear regression of two variables

#### **Project-6**

Uses of Regression and Correlation Analysis in Business

#### **Text Books:**

1. Name of Author, Title, Publication, Edition

Advanced Engineering Mathematics by E. Kreyszig Publisher: John Willey & Sons Inc-8th Edition

#### **Reference Books:**

1.Statistical Methods by S.P. Gupta (31st Edition); Publisher: Sultan Chand & Sons.

2. Mathematical Statistics by S.C. Gupta & V.K. Kapur (10th Edition); Publisher: Sultan Chand & Sons.

## Calculus

Code	Course Title	T-P-PJ	Prerequisite
CUTM1925	Calculus	2-0-1	

### Objective

- To apply the concepts of derivative to find curvature and radius of curvature of a curve.
- To apply concepts of Vector Calculus to the problems related to models in work, circulation and flux Problems, hydrodynamics and fluid dynamics etc.
- To introduce line, surface and volume integrals and their applications.

### Learning Outcome

- **CO1:** calculate curvature and radius of curvature for a given curve.
- **CO2:** determine the important quantities associated with scalar and vector fields.
- **CO3:** find gradient of a scalar point function, divergence and curl of a vector point function.
- **CO4:** implement the concept of line, double, and triple integrals to find out work done by a force, volume of regions in space, centre of gravity of a mass etc.
- **CO5:** transform double integral to line integrals, triple integrals to surface integrals, surface integrals to line integrals and vice versa.

### Course Outcome to Program Outcome Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
<b>CO1</b>	3.00	2.0		1.0	2.0							3.0	3.0	3.0	2.0
<b>CO2</b>	3.00	1.0		3.0	1.0		2.0					3.0	3.0	2.0	2.0
<b>CO3</b>	3.00	2.0		2.0	2.0		2.0					2.0	2.0	1.0	1.0
<b>CO4</b>	3.00			2.0			2.0					2.0	1.0	2.0	2.0
<b>CO5</b>	2.00	1.0		3.0	2.0		1.0					3.0	2.0	2.0	3.0

\*High-3, Medium-2, Low-1

## Course Outline

### Module-I(3hr+0hr+2hr)

Curvature and Radius of curvature in Cartesian form.

**Project 1:** To find radius of curvature (Parametric form)

### Module-II(2hr+0hr+4hr)

Vector algebra: Algebraic operations, Scalar product, Inner product, Vector product, Scalar and vector triple product.

**Project 2:** Problems based on inner product, scalar and vector triple products.

**Project 3:** To find angle between two vectors, area of triangle and parallelogram, volume of parallelepiped and tetrahedron using vector algebra.

### Module III(2hr+0hr+4hr)

Gradient of scalar point function, Directional derivatives, Divergence and curl of vector point functions, second order differential operator: the Laplacian operator.

**Project 4:** To prove the identities with regards to Gradient, Divergence and Curl.

**Project 5:** To find normal vector to a plane using Gradient of scalar point function.

### Module-IV: (3hr+0hr+0hr)

Line Integrals (path dependence and path independence), double integrals.

### Module-V: (3hr+0hr+0hr)

Surface Integrals, Triple Integrals

### Module-VI: (4hr+0hr+2hr)

Green's and Gauss's Theorems (without proof) and their applications to evaluate the integrals.

**Project 6:** To find center of gravity and moments of inertia of a mass density

### Module-VII: (3hr+0hr+0hr)

Stokes' Theorem (without proof) and its applications to evaluate the integrals.

### Text Books:

1. A Text book of Calculus Part – II by Shanti Narayan, Publisher: S. Chand & Company Ltd. Chapters: 8 (Art. 24, 25 (only for Cartesian and parametric curves)).
2. Advanced Engineering Mathematics by E. Kreyszig, Publisher: John Willey & Sons Inc.- 8th Edition  
Chapters: 8 (8.1 to 8.3, 8.9 to 8.11), 9 (9.1 to 9.7, 9.9).

### Mechanics for Engineers (40 hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUTM1006	Mechanics for Engineers	3	2+1+0

#### Course Objectives:

- To develop a fundamental understanding of the principles of statics and dynamics.
- To enhance problem-solving skills in engineering mechanics.
- To foster the application of engineering mechanics principles in real-world scenarios.

#### Course Outcomes:

After the completion of the course, students will be able to:

- **CO1:** Understand the basic principles of statics and dynamics in engineering mechanics.
- **CO2:** Analyze and solve problems involving forces, moments, and equilibrium conditions in mechanical systems.
- **CO3:** Apply the principles of kinematics and kinetics to analyze the motion of particles and rigid bodies.
- **CO4:** Utilize energy and momentum methods to solve engineering problems involving impact, work, and energy principles.
- **CO5:** Demonstrate the ability to use modern engineering tools and software for modeling and solving engineering mechanics problems.

#### Course Outcome to Program Outcome Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2			1		1						1	
CO2	3	3	2	1		1		1						1	
CO3	3	3	2	1	1	1	1	1						1	
CO4	3	3	3	1	1	1	1	1						1	
CO5	3	3	3	2	2	1	1	1	2	1		1		1	

**\*High-3, Medium-2, Low-1**

## **Course Syllabus:**

### **Module 1: Force and Moment (6 hours)**

#### **Theory**

- Law of Transmissibility of a Force, Composition, and Resolution of Forces, Resultant and Equilibrant, Resultant of Two and Several Forces, Moment of a Force and a Couple, Varignon's Principle of Moment

#### **Practice**

- Experiment 1.1: Verification of laws of parallelogram law of forces.

### **Module 2: Equilibrium (6 hours)**

#### **Theory**

- System Isolation and Free Body Diagram, Particle Equilibrium, Lami's theorem, General Conditions of Equilibrium, Types of Supports and Support Reactions, Rigid Body Equilibrium.

#### **Practice**

- Experiment 2.1: To verify the condition of equilibrium by finding reactions at the support of a beam.

### **Module 3: Friction (6 hours)**

#### **Theory**

- Basic Terms used in Dry Friction, Laws of Coulomb Friction, Equilibrium of Bodies on an Inclined Plane, Ladder Friction, Belt Friction

#### **Practice**

- Experiment 3.1: Determination of Angle of Repose.

### **Module 4: Centroid (4 hours)**

#### **Theory**

- Axis of Symmetry, Centroid of Lines, Areas, and Volumes, Centroid of Composite Section

## **Module 5: Moment of Inertia (6 hours)**

### **Theory**

Rectangular and Polar Moment of Inertia, Radius of Gyration, Parallel Axis Theorem and Perpendicular Axis Theorem, Moment of Inertia of Composite Section

### **Practice**

- Experiment 5.1: Determination of the Moment of Inertia of a flywheel.

## **Module 6: Kinematics of Linear Motion (4 hours)**

### **Theory**

- Kinematics of a Particle, Uniform and Variable Acceleration, Motion under Gravity.

## **Module 7: Kinetics of Linear Motion (8 hours)**

### **Theory**

- Principles of Dynamics such as Newton's Second Law, Work-Energy Principle, Impulse-Momentum Principle, Law of Conservation of Momentum, and Energy

### **Practice**

- Experiment 7.1: Verification of Newton's second law of motion.
- Experiment 7.2: Verification of conservation of momentum in a collision.

### **Text Books:**

1. Engineering Mechanics; Statics and Dynamics by A. K. Tayal, Umesh Publications.

### **Reference Books:**

1. Engineering Mechanics by S. Timoshenko, D.H. Young and J.V. Rao, Tata McGraw Hill.
2. A textbook of Engineering Mechanics by R. S. Khurmi, S. Chand Publications

### Optics and Optical Fibres (33 hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUTM1007	Optics and Optical Fibres	3	2+1+0

#### Course Objectives:

- To train the students for the applications of the solar cell, laser and optical Fibre in the field of engineering and technology.
- To learn and practice the techniques used by optical phenomena so that these can be applied to actual field studies.

#### Course Outcomes:

After the completion of the course students will be able to:

- **CO1:** Understand optical phenomena.
- **CO2:** Different light sources and their use.
- **CO3:** To understand the basic knowledge of solar cell, laser and optical fiber.
- **CO4:** To understand optical fiber principle, operations and its applications.
- **CO5:** To handle different tools and instruments used in optical experiments.

#### Course Outcome to Program Outcome Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	3				2				1	2	2	1	
CO2	3	1	2	3		3		1			1	1	2	2	
CO3	1	3	2	3		2			2				1	2	
CO4	3	2	2	3		3					3		2	3	
CO5	2	2	3	3		2		3			3	1	2		3

**\*High-3, Medium-2, Low-1**

#### Course Syllabus:

##### Module I: Reflection and Refraction (Derivation is not required) (3 hours + 2 hours)

Reflection at plane surface, reflection at spherical mirrors, Paraxial rays and approximation Sign convention, Location of the image formation, Spherical mirror equation, Refraction, Total internal reflection, Dispersion by a prism, Refraction through a prism.

**Practice: 1**

To determine the refractive index of glass slab using travelling microscope

**Module II: Lenses (Derivation is not required) (2 hours +2 hours)**

Definition, Types of Lenses, Terminology associated with the Lens, Sign Convention

Location of the image formation by graphical method for Lenses, Lens formula.

**Practice: 2**

To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.

**Module III: Interference (Derivation is not required) (2 hours +2 hours)**

Superposition principle, definition of Interference, Coherence, Young's double slit experiment, Newton's rings theory- Determination of wave length of light.

**Practice: 3**

Newton's Rings-Refractive index of liquid

**Module IV: Diffraction and Polarization (Derivation is not required (3 hours +2 hours)**

Types of diffraction, Fraunhofer diffraction at a single slit, Diffraction at N-parallel slits (plane diffraction grating) Polarisation, Types of polarized light and their representation, Brewster Law .Malus Law, polarization by double refraction, polarimeter, Applications of polarized light.

**Practice: 4**

To find grating element of a plan transmission diffraction grating.

**Module V: Optical Properties and Laser (3 hours +2 hours)**

Scattering, refraction, reflection, absorption & transmission, Introduction to optoelectronics, Concept of Light Emitting Diode, Stimulated and spontaneous emission, Basic principle of Lasers, Population inversion, Laser Pumping, Different levels of laser system, Ruby Laser, Applications of Lasers (Medicine, Metrology, Defenses, Nuclear energy, in communication, in consumer electronics industry)

**Practice: 5**

Wave length of LASER source by diffraction grating method

**Module VI : Optical Fibers (4 hours +1 hours)**

Introduction to fiber optics, structure of optical fibers, classification of optical fibers on the variation of refractive index, Classification of optical fibers on the variation of mode of transmission/core diameter, Numerical Aperture, Acceptance angle. Principle of optical fibers communication, optical communication (block diagram only),

**Practice: 6**

To find the numerical aperture of a given optic fiber and hence to find its acceptance angle.

**Module VII: Optical Fibers (4 hours +1 hours)**

Attenuation in optical fibers (Qualitative only-Scattering losses, Absorption losses, bending losses) Fiber Materials-Glass fibers, Plastic fibers, Light sources for fiber optics

V-number of an optical fiber, optical fiber cables design, optical fiber connection, fiber splices, fiber connectors. Application of optical fibers- Cable TV, Networking, Power companies, Imaging, Sensors, Medical (Dental surgery, Endoscopy, Surgery)

### **Practice: 7**

Measurement of bending loss of optical fibers.

#### ***Text Books:***

1. *A Text Book of Optics* by M.N. Avadhanulu, Brij Lal, N. Subrahmanyam, S Chand; 23rd Rev. Edn. [Module I&II]
2. *Engineering Physics*, by D.Thirupathi Naidu, M.Veeranjaneyulu, V.G.S Book links,2017.[Module-III,IV]
3. *Principles of Engineering Physics-2* by Md.Khan, S.Panigrahi, Cambridge University Press 2016. [module-V,VI&VII]

#### ***Reference Books:***

1. *Optics* by Ajoy Ghatak, McGraw Hill Education; 6 edition, 2017.
2. *Physics-I for engineering degree students* by B.B. Swain and P.K.Jena.
3. *Concepts in Engineering Physics* by I Md. N. Kha, 2016.

***Note: 1 credit theory=10 hrs lecture, 1 credit practice =12.5 hrs lab in a semester***

## Applied Analytical Chemistry

Code	Course Title	Credit	T-P-PJ
CUTM1008	Applied Analytical Chemistry	3	2-1-0

### Course Objectives

- To explain fundamental principles for hardness and their remediation in industrial scale.
- To get brief idea about fuels their classification, quality and application.
- To have hands on experimental expertise in quality analysis for water, soil and fuel.

### Course outcome:

- **CO1:** Define the causes for the deterioration of water quality for industrial applications.
- **CO2:** Explain and identify essential parameters for industrial-scale water softening
- **CO3:** Interpret the causes of rusting of metallic parts and preventive methods
- **CO4:** Differentiate the qualities of various types of fuel, their calorific value, along with the causes of their deterioration.
- **CO5:** Design and sketch electrochemical cells with good efficiency.

### Course Outcome to Program Outcome Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	2					1		2	2	1	1
CO2	3	3	2	2	1					1		2	2	2	1
CO3	2	3	3	2	1					1		2	3	3	1
CO4	2	2	3	2	1					1		2	3	3	1
CO5	1	3	3	2	2					1		2	2	1	1

\*High-3, Medium-2, Low-1

## Course Content

### Module-I (4Hrs)

Water softening processes: Lime-Soda, Zeolite and Ion exchange methods. Removal of DO and dissolved CO<sub>2</sub> from water by De-aeration method, Desalination of Brackish water by Reverse osmosis and electro dialysis process, Numericals on calculation of Temporary and Permanent hardness of water, Lime-Soda calculation

#### Practice

1. Determination of hardness of water by EDTA method. (V. lab)
2. Determination of alkalinity of water. (V. lab)
3. Determination of Dissolved Oxygen in water. (V. lab)
4. Determination of Biological Oxygen Demand. (V. lab)
5. Determination of Chemical Oxygen Demand. (V. lab)

### Module-II (2Hrs)

Soil Analysis: Soil profile, Structure, and properties, Determination of soil properties

#### Practice

6. Determination of specific gravity of the soil by using pycnometer. (V. lab)
7. Determination of pH and electrical conductivity of soil sample. (V. lab)
8. Determination of moisture content in soil by oven drying method. (V. lab)

### Module-III (3 Hrs)

Classification, combustion and chemical principles involved in fuel, calorific value: gross and net calorific values and their determination by bomb calorimeter, Proximate and ultimate analysis of coal and their importance. LPG, Water gas, producer gas, CNG.

#### Practice

9. Determination of calorific value of a fuel sample by using Bomb calorimeter.
10. Analysis of flue gases by Orsat's apparatus.

### Module-IV (4 Hrs)

Petroleum: its chemical composition and fractional distillation, cracking of heavy oil residues – thermal and catalytic cracking, knocking and chemical structure, octane number, synthesis and applications of bio-fuels, Photovoltaic cell.

#### Practice

11. Synthesis of biodiesel by trans esterification process

### Module-V (3 Hrs)

Corrosion-Mechanisms, Factors affecting Corrosion; Protection from corrosion.

#### Practice

12. Estimation of ferrous ion in the given solution using standard potassium dichromate.

### Module-VI (2Hrs)

#### Electrochemical Phenomenon

Electrochemical cell, Electrode potential, Determination of pH of a solution Using Calomel/Quinhydrone Electrode.

### Module-VII (2Hrs)

Error in Chemical analysis

Types of errors, Accuracy and precision, Absolute and relative uncertainty, mean and standard deviation.

### **Text Books**

- Engineering chemistry By Jain &Jain-16th Edn,2015, Dhanpat rai publications
- Engineering chemistry By Sashi Chawla,3rd Edn,Dhanpati roy publications,2011
- Industrial Chemistry By B.K.Sharma 21 st Edn-2018,Satya Publications4.

### **Reference Books**

- Applied Chemistry By Aruna Kumari-2nd Edition,Paramount publications,2016
- Engineering chemistry by OG Palanna,McGrahill Education(India) private Limited,2009
- Engineering chemistry by K.Sesha Maheswaramma,Mridula.Chuch.PearsonIndia Education services pvt Ltd,2016
- Engineering chemistry by Prasanth Rath,Cengage Learning India pvtLtd,2013
- Engineering chemistry by R.V.Gadag,A.Nityananda, Shetty,I.K.International Publishishing house,2006
- Engineering chemistry –Fundamentals and applications,ByShika Agarwaal-Cambridge University PressEdition,2017

## Applied Engineering Material

Code	Course Title	Credit	T-P-PJ
CUTM1009	Applied Engineering Material	3	2-0-1

### Objective

- To give an introduction to materials, ceramics, polymers, and electronic materials in the context of a molecular level understanding and their application in various field
- To provide brief idea about carbon based nanomaterials such as CNT, fullerene, graphene and their polymer nanocomposites with their practical applications
- To be able to get absorbed jobs in different industries processing with these materials.

### Course outcome:

- **CO1:** Recall and relate nanomaterials, hybrid materials with their structure, mechanism of action and their improve performances.
- **CO2:** Describe and discuss the carbon-based nanomaterials and their applications
- **CO3:** Apply and demonstrate the knowledge of nanomaterials and hybrid materials on polymer composite with their enhanced applicabilities
- **CO4:** Analyze different properties of the composite materials.
- **CO5:** Formulate strategies to prepare composite materials and energy storage systems

### Course Outcome to Program Outcome Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	3	3	2	2					1		2	2	1	1
CO2	3	3	2	2	1					1		2	2	2	1
CO3	2	3	3	2	1					1		2	3	3	1
CO4	2	2	3	2	1					1		2	3	3	1
CO5	3	3	3	2	2					1		2	2	1	1

\*High-3, Medium-2, Low-1

## Course content

### **Module I: New Materials/Nanomaterials (5hrs)**

Nanostructures and Nanomaterials: classification (Dimensionality, Morphology/ shape/structure of nano-entities, New Effect/ Phenomena). Hybrid nanomaterials. Effect of size, structure, mechanism, and property on material performance. Applications of nanomaterials in catalysis, telecommunication and medicine.

#### **Project**

Synthesis of TiO<sub>2</sub> and ZnO nanoparticles by Sol Gel ,Sonication and Precipitaion method and study their application .

### **Module II: Carbon Nanomaterials (5hrs)**

Carbon nanomaterials, such as graphene, carbon nanotubes (CNTs), crystalline diamond, and diamond-like carbon, Properties and application of fullerenes,

#### **Project**

Synthesis and Fabrication of Graphene and Graphene Oxide by sol-gel techniques

### **Module III: Polymer (5hrs)**

Mechanism of polymerization and synthesis of polymers, Copolymerization, Viscoelasticity. Elastomers-structure, Conducting polymers and applications, Fabrication and moulding of polymers, Synthesis, properties and uses PMMA, formaldehyde resins, melamine-formaldehyde-urea resins

#### **Project**

Preparation of polystyrene by anionic/cationic/emulsion polymerization method

### **Module IV: Composites (5hrs)**

Composites: characteristics, types and applications, Nanocomposites , Polymer/ Metal oxide nanocomposites and its application

#### **Project**

Fabrication of Ceramic matrix particulate composite by powder metallurgy route.

### **Module V: Adhesives Lubricants (4hrs)**

Adhesives, adhesive mechanism and applications, Lubricants-physical and chemical properties, types and mechanism of lubrication. Additives of lubricants and freezing points of lubricants

### **Module VI: Energy Storages material-I (4Hrs )**

Fundamental aspects related to energy storage and conversion, lithium ion batteries, Lead acid batteries; Nickel Cadmium batteries; advanced batteries

### **Module VII: Energy Storages material-II(4Hrs.)**

Super capacitors, fuel cells and Photovoltaic, Future of battery technology

## Project

### Fabrication of Fuel cell and its application

#### Text Books:

1. A Textbook of Engineering Chemistry, by Shashi Chawla
2. Engineering Chemistry, by P. C Jain and M. Jain
3. Advanced Polymer Chemistry, by M. Chanda

#### Reference Books:

1. Surfactants and Polymers in Aqueous Solution, by K. Holmberg, B. Jonsson, B. Kronberg and B. Lindman
2. Energy Scenario beyond 2100, by S. Muthukrishna Iyer

## Environmental Science

Code	Course Title	Credit	T-P-PJ
CUTM1674	Applied Engineering Material	4	3-0-1

### Introduction

The National Education Policy (NEP) 2020 underlines the importance of making environmental education an integral part of curricula and encouraging environmental awareness and sensitivity towards its conservation and sustainable development. Environment Education, therefore, needs to include areas such as climate change, pollution, waste management, sanitation, conservation of biological diversity, management of biological resources and biodiversity, forest and wildlife conservation, and sustainable development.

### Course Objectives

- To understand the relationship among human being, natural resource and environment on the historical perspectives.
- To orient students towards the principles of sustainable development goals and train them for conserving Biodiversity and maintaining Ecosystem balance.
- To analyze environmental issues and problems critically, and develop strategic environmental management policies and practices.

### Course Outcome

After the successful completion of the course, students should be able to:

- **CO1:** Explain the historical perspectives of human, natural resource and environment interactions
- **CO2:** Identify, classify, evaluate and prospect the natural resources integrated with Sustainable Development Goals
- **CO3:** Analyze issues and concerns of Biodiversity conservation and Ecosystem services at local, regional and global scales
- **CO4:** Demonstrate their environmental management competency to combat pollution, waste generation and climate change.
- **CO5:** Conduct independent project works and address current environmental challenges complying with Environmental agreements, treaties, act and laws.

### Module-1: Human and Environment

**6 Hours**

Introduction to Human and the Environment: Overview of human-environment interactions throughout history; Importance of mastery of fire, the origin of agriculture, and the emergence of city-states; Discussion on the impact of ancient civilisations on the environment. Emergence of Environmentalism: Anthropocentric and eco-centric perspectives; Study of significant thinkers and their contributions to environmental philosophy; Environmental movements, Analysis of critical events such as the UN Conference on Human Environment 1972.

### **Module-2: Natural Resources and Sustainable Development**

**7 Hours**

Understanding Natural Resources: Definition and classification of natural resources; Renewable and Non-renewable, Biotic and abiotic resources, Forest, Grasslands, Wildlife, Water, Mineral, Food, Land, Energy; Introduction to sustainable development: Sustainable Development Goals (SDGs), targets and indicators; Discussion on challenges and strategies for achieving sustainability. World commission on Environment and Development.

### **Module-3: Conservation of Biodiversity and Ecosystem**

**12 Hours**

Levels and types of Biodiversity, Biodiversity in India and the world, Biodiversity Hotspots, Land Use and Loss of Biodiversity: deforestation, urbanisation, desertification; trends in biodiversity loss; Case studies on the impact of human activities on biodiversity hotspots. Conservation of Biodiversity and Ecosystems: Understanding biodiversity and its distribution; Discussion on major ecosystem types: forests, grasslands, agriculture, coastal and marine and their characteristics; Ecosystem services: Classification and significance; Exploration of threats to biodiversity and ecosystems; *in-situ* and *ex-situ* conservation, protected areas, traditional knowledge, sacred groves, community based conservation.

### **Module-4: Environmental Pollution and Management**

**10 Hours**

Pollution and its impact; Overview of pollution: air, water, soil, noise, solid waste, hazardous waste; Discussion on transboundary pollution and its consequences; Understanding environmental issues at micro, meso, synoptic, and planetary scales; Case studies highlighting the adverse effects of pollution on human health and ecosystems. Addressing Environmental Pollution and Health: Strategies for pollution control and management; Examination of air, water, soil, and noise pollution and their health impacts; Introduction to waste management practices and their significance. Introduction to environmental management systems such as ISO 14001 and the role of organizations like UNEP and IPCC in global environmental governance; Case studies on the implementation of environmental policies and regulations in different contexts.

### **Module-5: Environmental Policies and Practices**

**10 Hours**

Introduction to environmental laws and regulation: Constitutional provisions - Article 48A, Article 51A(g) and other derived environmental rights; Introduction to environmental legislations on the forest, wildlife and pollution control: The Wild Life (Protection) Act, 1972; The Water (Prevention and Control of Pollution) Act, 1974; The Forest (Conservation) Act, 1980; The Air (Prevention and Control of Pollution) Act, 1981; The Environment (Protection) Act, 1986; The Biological Diversity Act, 2002; Noise Pollution (Regulation and Control) Rules, 2000; National Green Tribunal; Climate Change policies, Greenhouse gas emissions and their impact on global climate; Climate change mitigation measures and practices: UNFCCC, Concept of NET ZERO. Environmental Treaties: Major international environmental agreements, conventions and their significance: CBD, CITES, UNCCD, Analysis of India's status and commitments under these agreements.

## SUGGESTED READINGS

- Rajagopalan, R. (2011). Environmental Studies: From Crisis to Cure. India: Oxford University Press.
- Sinha, N. (2020) Wild and Wilful. Harper Collins, India.
- Krishnamurthy, K.V. (2003) Textbook of Biodiversity, Science Publishers, Plymouth, UK.
- Kanchi Kohli and Manju Menon (2021). Development of Environment Laws in India, Cambridge University Press.
- Ministry of Environment, Forest and Climate Change (2019). A Handbook on International Environment Conventions & Programmes. <https://moef.gov.in/wp-content/uploads/2020/02/convention-V-16-CURVE-web.pdf>
- Headrick, Daniel R. (2020). Humans versus Nature- A Global Environmental History, Oxford University Press.
- Chiras, D. D and Reganold, J. P. (2010). Natural Resource Conservation: Management for a Sustainable Future. 10th edition, Upper Saddle River, N. J. Benjamin/Cummins/Pearson.
- Harper, Charles L. (2017). Environment and Society, Human Perspectives on Environmental Issues 6th Edition. Routledge.
- Jackson, A. R., & Jackson, J. M. (2000). Environmental Science: The Natural Environment and Human Impact. Pearson Education.
- Pittock, Barrie (2009) Climate Change: The Science, Impacts and Solutions. 2nd Edition. Routledge.

## THRUST AREA OF PROJECTS

### **Theme-1: Human and Environment**

- 1.1 Environmental awareness level of students, faculties and staffs of Centurion University through a questionnaire assessment
- 1.2 Hygiene and sanitation: An important factor of Environment and Women Health
- 1.3 Environmental movements in India and their role in Environmental Protection
- 1.4 Study on major civilizations along river banks: A few case studies
- 1.5 Critical study and analysis of the first world conference on the Human Environment, Stockholm, 1972

### **Theme-2: Natural Resources and Sustainable development**

- 2.1 Plant resource, diversity and their utility in Centurion University campus
- 2.2 Water resource use, management and conservation strategies in Centurion University campus
- 2.3 Energy audit of Centurion University campus
- 2.4 A study on the planning, execution and implementation of Sustainable Development Goals (SDGs) in Centurion University
- 2.5 Critical study and analysis of the World Commission on Environment and Development, 1983

### **Theme-3: Conservation of Biodiversity and Ecosystem**

- 3.1 Biodiversity assessment of Centurion University campus
- 3.2 *Ex-situ* Biodiversity conservation initiatives taken in Centurion University
- 3.3 Identification and documentation of food chain and food webs in Centurion University campus including Pollinators' Paradise
- 3.4 Land use and land cover analysis across campuses of Centurion University in Odisha
- 3.5 Identification, documentation and analysis of micro ecosystems of Centurion University

### **Theme-4: Environmental Pollution and Management**

- 4.1 Water quality assessment with isolation, characterization and application of pollutant-degrading microbes from contaminated and waste water sources
- 4.2 Soil quality assessment within and Outside Centurion University campus
- 4.3 Ambient Air Quality Assessment within and outside of Centurion University campuses using High Volume Air Sampler
- 4.4 Assessment of Noise pollution within and outside of Centurion University campuses using Sound Level Meter
- 4.5 Waste to wealth Management adopted in Centurion University Campus

### **Theme-5: Environmental Policies and Practices**

- 5.1 Provisions for Environmental protection in the Constitution of India: Prospects and Retrospects
- 5.2 A few case studies handled and heard by National Green Tribunal (NGT), India
- 5.3 Green House gases and their impact on Global climate: Role of UNFCCC
- 5.4 A critical analysis of Convention on International trade in Endangered species of Wild Fauna and Flora (CITES) to combat Wild life loss
- 5.5 Best environmental policies and practices of Centurion University across campuses in Odisha

## Course Structure Basket - II

<b>Course Code</b>	<b>Course Title</b>	<b>Credits</b>	<b>Course Type T+P+PJ</b>
CUTM1011	Optimisation Techniques	2	0-2-0
CUTM1012	Engineering Economics and Costing	3	2-0-1
CUTM1013	Project Management	3	2-0-1
CUTM1014	Gender, Human Rights and Ethics	3	1.5-0-1.5
CUTM1015	Climate Change, Sustainability and Organisation	3	1.5-0-1.5
CUTM1016	Job Readiness	6	0-6-0

## Syllabus

### Optimization Techniques (50 hours)

Code	Course Title	Credit	T-P-PJ
CUTM1011	Optimization Techniques	2	0-2-0

#### Course Objectives

- To learn to translate real-world scenarios into mathematical optimization models.
- To develop a deep understanding of the basic principles and mathematical foundations of optimization.
- To create an Engineering design methodology using a mathematical formulation.

#### Course Outcomes

After the completion of the course, students will be able to:

- **CO1:** Gain knowledge on optimization methods and algorithms to develop different types of optimization problems.
- **CO2:** Understand various real life optimization problems by using computer software.
- **CO3:** Apply optimization techniques in problems of Engineering and Technology.
- **CO4:** Evaluate optimization solutions for feasibility, efficiency, and practicality.
- **CO5:** Develop new optimization models or improve existing algorithms for specific applications.

#### Course Outcome to Program Outcome Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3		1									2	1		1
CO2	2	2	2		3								1	2	1
CO3	1	2	3										1	3	
CO4	2	3	3		3								3	3	
CO5	3	3	3		3								2		1

\*High-3, Medium-2, Low-1

## Course Syllabus:

- Experiment 1: Practice of linear programming problems
- Experiment 2: Practice of Graphical method
- Experiment 3: Practice of Simplex method
- Experiment 4: Practice of Penalty Method
- Experiment 5: Transportation models
- Experiment 6: Assignment Models
- Experiment 7: Practice of Sequencing problems
- Experiment 8: Scheduling Models by Johnson's Algorithm

## Text Books

- Harvey M. Wagner, *Principles of Operations Research*, Englewood Cliffs, Prentice-Hall, 1969
- S D Sharma and Himansu Sharma, *Operations Research: Theory, Methods and Applications*, 15 Edition, KedarnathRamnath & Co

## External Links:

<https://www.informs.org/Resource-Center/INFORMS-Student-Union/Consider-an-Analytics-OR-Career>

<https://www.informs.org/>

[https://en.wikipedia.org/wiki/Operations\\_research](https://en.wikipedia.org/wiki/Operations_research)

## ENGINEERING ECONOMICS AND COSTING (56 hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUTM1012	ENGINEERING ECONOMICS AND COSTING	3	2+0+1

### Course Objectives:

- To facilitate students' foundational understanding of economic theories and principles relevant to engineering, enabling them to apply these concepts in real-world scenarios.
- To develop the ability to conduct detailed cost-benefit analyses, ensuring students can evaluate the financial implications of engineering projects and make informed decisions.
- To teach students how to use various investment appraisal techniques, such as Demand & Supply, production theory, and The Time Value of Money, to assess the viability and profitability of engineering investments.
- To strengthen students' decision-making capabilities by providing them with the tools to analyze economic data, forecast future trends, and strategically plan for the financial success of engineering projects

### Course Outcomes:

After the completion of the course, students will be able to:

**CO1:** Understand the fundamental concepts of engineering economics, demand and supply, and production theory of the Market.

**CO2:** Develop awareness and understanding of the cash flow statements and the time value of money.

**CO3:** Evaluate the financial performance of engineering projects using various financial analysis methods.

**CO4:** Understand and apply cost concepts and cost sheets to analyse common business management decisions such as pricing a product and services.

**CO5:** Understand the overview of Indian baking system and Indian financial systems

### Course Outcome to Program Outcome Mapping:

COP	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PS O1	PS O2	PS O3
CO1	3	1	2	-	1	-	-	1	1	1	1	1	3	1	2
CO2	3	2	1	1	1	-	-	1	1	1	2	2	2	2	2
CO3	3	2	2	1	1	-	-	1	1	1	3	2	2	3	1
CO4	3	2	2	1	1	-	-	1	1	1	3	2	3	2	1
CO5	3	1	1	-	1	-	-	1	1	1	3	2	3	2	1

**\*High-3, Medium-2, Low-1**

## Course Syllabus

### Module-I

Engineering Economics – Nature and scope, General concepts on micro & macroeconomics. The Theory of demand, Demand function, Law of demand and its exceptions, Elasticity of demand, Law of supply, and elasticity of supply.

Theory of production, Law of variable proportion, Law of returns to scale.

### Module-II

Time value of money: Simple and compound interest, Cash flow diagram, Principle of economic equivalence.

Evaluation of engineering projects: Present worth method, Future worth method, Net present value method, internal rate of return method, Cost-benefit analysis in public projects.

Depreciation: Meaning Causes, Factors affecting depreciation, Methods of providing depreciation, Straight Line Method & Diminishing Balance Method

### Module-III

Cost concepts, Elements of costs, Preparation of cost sheet, Segregation of costs into fixed and variable costs. Break-even analysis (Simple numerical problems to be solved)

Indian Banking System: Banks: Meaning, nature, characteristic of the Indian banking system, functions of commercial banks, functions of Reserve Bank of India, Overview of Indian Financial System.

#### Text Books:

1. Riggs, Bedworth, and Randhwa, “Engineering Economics”, McGraw Hill Education India.
2. D.M. Mithani, Principles of Economics. Himalaya Publishing House

#### Reference Books:

1. Sasmita Mishra, “Engineering Economics & Costing “, PHI
2. Sullivan and Wicks, “Engineering Economy”, Pearson
3. R.PaneerSeelvan, “ Engineering Economics”, PHI
4. Gupta, “Managerial Economics”, TMH
5. Lal and Srivastav, “Cost Accounting”, TMH

## PROJECT MANAGEMENT (56 Hours)

Course Code	Course Title	(Credit)	Type (T+P+Pj)
CUTM1013	Project Management	3	2+0+1

### Course Objectives:

- Develop and implement all project procedures.
- Learn project management methodology to initiate and manage projects efficiently and effectively
- Acquire key project management skills and strategies for productive guidance, efficient communication, and supervision of the project's team
- Achieve the project's main goal within the given constraints

### Course Outcomes:

**CO1:** Acquire 10 knowledge area identified by PMI and its application while working on a real project.

**CO2:** Apply managerial skill to procure a project, plan, schedule, hire and allocate resource and deliver a project

**CO3:** Will build soft skill to lead and comply and communicate with all stakeholders' expectation

**CO4:** Will be able to prepare a WBS structure

**CO5:** Able to prepare a DPR

### CO-PO Mapping

Course Outcomes (CO)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
<b>CO1</b>	3	3	3	-	-	2	-	2	3	-	-	-
<b>CO2</b>	3	3	3	-	2	-	-	-	-	2	-	-
<b>CO3</b>	-	3	-	3	3	-	-	-	-	-	-	2
<b>CO4</b>	3	3	3	-	-	2	-	-	3	-	-	-
<b>CO5</b>	3	3	3	-	-	2	-	-	3	2	-	-

## Course Outline

### **Module: I**

**Project Management framework; Introduction to Project Management:** Project Life Cycle and Organisation, Project vs. Operational work, Stakeholders, Organisational Influences Project Management Process for a Project, groups, Initiating, planning, executing, monitoring & controlling and closing process groups., Project management Knowledge area; Project Integration Management; Develop project charter, develop project management plan, direct and manage project execution, monitor and control project work, perform integrated change control, close project or phase.

### **Module: II**

**Project Scope Management:** collect requirements, define scope, create WBS, verify scope, control scope, Project Time Management; Define activities, sequence activities, estimate, develop and schedule, Project Cost Management; Estimate costs, determine budget, control costs

### **Module: III**

**Project Quality Management:** Plan quality, perform quality assurance, perform quality control, Project HR Management; Develop HR plan, acquire project team, develop and manage project team, Project Communications Management; Identify stakeholders, plan communication, distribute information, manage expectation of stake holders, report performance.

### **Module: IV**

**Project Risk Management; Plan risks:** identify risks, perform quality and quantitative risk analysis, plan risk responses, monitor and control risks, Project Procurement Management; Plan procurements, conduct procurements, administer procurements, close procurements, Project Stakeholders Management; Identifying stakeholders, stakeholder analysis, engagement.

### **Text Books:**

- Project Management: A Managerial Process, Clifford F Gray & Eric W Larson, Tata McGrawHill
- A Guide to the Project Management Body of Knowledge, 6<sup>th</sup> Edition, PMI
- Project Management- A system Approach to Planning, Scheduling and Controlling (Harold Kerzner). CBS Publishers and Distributors, New Delhi.

### **Reference Books:**

- Projects, Preparation, Appraisal and Implementation (Prasanna Chandra), 3<sup>rd</sup> Edition, Tata Mc Graw Hill, New Delhi.
- Project Management (Nagarajan, K), New Age Publishers, New Delhi.
- Project Management. A Managerial Approach (Meredith, R.J and Mantel, S.J), Wiley (India).

### **Links**

- 1) <https://www.youtube.com/watch?v=qjwDQhbbWdI>
- 2) <https://www.youtube.com/watch?v=rMVEUoANT64>
- 3) <https://www.youtube.com/watch?v=oacSSamqP6s>
- 4) Preparation of project plan in Excel: <https://www.youtube.com/watch?v=kpLnxV3a1bE>
- 5) Gantt Chart for project management:  
<https://www.youtube.com/watch?v=4H77Lvx2pQc>
- 6) <https://www.youtube.com/watch?v=ACjTnkTT7v4>
- 7) <https://www.youtube.com/watch?v=8xxkA20ycck>
- 8) [https://www.youtube.com/watch?v=o\\_vexQUWH4s](https://www.youtube.com/watch?v=o_vexQUWH4s)
- 9) <https://www.youtube.com/watch?v=aqEKLOxIUEY>
- 10) <https://www.youtube.com/watch?v=k8KjFuhzBaQ>
- 11) <https://www.youtube.com/watch?v=bbi2diraL8M>
- 12) <https://www.youtube.com/watch?v=ne7zwSYmWus>
- 13) <https://www.youtube.com/watch?v=SPj-Luod9tI>
- 14) Bitrix:([https://www.bitrix24.in/tasks/free\\_online\\_project\\_management.php?utm\\_source=google&utm\\_medium=cpc&utm\\_campaign=19998176636-149585073993&gclid=EAiaIQobChMI5vCVoKGe\\_wIVnpJmAh3QYARAaAYASAAEgIYrfD\\_BwE](https://www.bitrix24.in/tasks/free_online_project_management.php?utm_source=google&utm_medium=cpc&utm_campaign=19998176636-149585073993&gclid=EAiaIQobChMI5vCVoKGe_wIVnpJmAh3QYARAaAYASAAEgIYrfD_BwE))
- 15) Bitrix24 Project Management Tutorial  
(<https://www.youtube.com/watch?v=0MhGIWcMvKQ>)

### List of Projects

1. Internet of Things (IoT) Integration for Smart Homes
2. Wearable Technology for Health Monitoring: Design a wearable device or application that tracks and analyzes vital signs, physical activity, sleep patterns, or overall well-being.
3. Sustainable Packaging Solutions: Design an innovative product solution that reduces waste, improves recyclability, or uses eco-friendly materials.
4. Virtual Reality (VR) or Augmented Reality (AR) Applications: Develop a product that utilizes VR or AR technology for entertainment, education, training, or immersive experiences.
5. Energy-Efficient Appliances: Design and prototype an energy-efficient appliance that reduces power consumption without compromising performance or functionality.

6. **Smart Agriculture Technology:** Create a solution that integrates sensors, automation, and data analytics to optimize crop yield, reduce resource usage, or improve farming practices.
7. **Renewable Energy Solutions:** Innovate a product (Developing a Solar Dryer) that harnesses renewable energy sources such as solar, wind, or hydroelectric power to address energy needs or provide clean energy alternatives.
8. **Smart Transportation Systems:** Design a product or solution that enhances transportation efficiency, reduces traffic congestion, improves safety, or promotes sustainable transportation options.
9. **Assistive Technologies for Disabilities:** Create a product that assists individuals with disabilities in improving their mobility, communication, accessibility, or quality of life.
10. **Advanced Healthcare Devices:** Develop a medical device or technology that improves diagnosis, treatment, monitoring, or patient care in a specific area of healthcare.
11. **Personalized Nutrition Solutions:** Design a product or service that leverages data analytics and individualised recommendations to promote healthy eating habits and personalized nutrition plans.
12. **Sustainable Fashion or Textile Innovations:** Explore eco-friendly materials, manufacturing processes, or circular economy principles to develop sustainable fashion or textile products.
13. **Home Automation for Aging in Place:** Create a solution that enables older adults to live independently and safely in their own homes through automation, monitoring, and assistive technologies.
14. **Water Conservation Technologies:** Develop a product or system that helps conserve water resources, improves water management, or enhances water quality.

## Gender, Human Rights and Ethics (63 Hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUTM1014	Gender, Human Rights and Ethics	3	1.5+0+1.5

### Course Objectives:

This course is about gender, human rights, and ethics in which the student will be sensitized and exposed to related issues in the context of business and organizations in India. The specific objectives are:

- To develop an understanding of gender, human rights, and ethics in an unequal society like India
- Sensitization of how gender, human rights, and ethics are significant in organizations.
- Integrating concerns related to gender, human rights, and ethics in organizations.

### Course Outcomes:

- **CO1:** Students will analyse the differences between sex and gender, the social construction of gender, and its outcomes, including gender roles, labour division, and power hierarchies.
- **CO2:** Students will evaluate gender implications in workplace practices, management, and leadership
- **CO3:** Will gain an understanding of human rights concepts, types, and their relevance in organizations. They will explore international human rights laws, the Universal Declaration of Human Rights, and organizational challenges related to social discrimination and inequality.
- **CO4:** Develop knowledge of Indian and Western ethical systems, including utilitarianism, duty ethics, virtue ethics, and ethical relativism.
- **CO5:** Investigate the persistence of social discrimination, efforts to address past violations, and the ongoing struggle for justice and accountability.

## CO-PO Mapping

CO/PO	PO-01	PO-02	PO-03	PO-04	PO-05	PO-06	PO-07	PO-08	PO-09	PO-10	PO-11	PO-12
CO1	3	3	2	2	2	3	2	1	2	3	1	2
CO2	3	3	2	2	2	3	3	2	2	2	1	2
CO3	3	3	2	3	2	3	2	1	2	3	2	2
CO4	3	2	2	3	2	3	1	1	2	1	2	2
CO5	3	3	2	3	2	3	2	2	2	2	1	2

### Course Contents:

#### Module: I

Difference between sex and gender; social construction of gender and its outcomes in the form of behavior, roles, gender based division of labour, hierarchy; gender relations. Gender issues in organisations - significance of relations between structures, practices, context, interactions, and power for construction of gender at organisational level Gender implications at workplace, management and leadership, Laws and Acts Comparing different types of organisations; how to create a gender sensitive organisation.

#### Module: II

Introduction to human rights, Meaning and Definition, Types Human Rights Law: Protection, violation and the legal framework for their protection - International Human Rights Law, Universal Declaration of Human Rights Conflicts of Rights and its Significance to Organisations: Challenges of the past and challenges for the future. Persistence of social discrimination and inequality; efforts in the search for justice for past violations, continued struggle for human rights and accountability in an organisational context.

#### Module: III

Introduction to and study of ethics; Indian and Western ethics Different ethical systems and perspectives; ethical relativism and its implications, utilitarianism, duty ethics and virtue ethics in organisations Critique of various ethical positions and develop their own position in an organizational context.

#### References:

- “Why Gender is a Development Issue”, Handout 4, Oxfam Gender Training Manual (1994)
- Freedman, Jane. (2002), “Introduction: Feminism or Feminisms?” in *Feminism*, Viva Books, N. Delhi.
- Chafetz, J.S. (1990), “The Coercive Bases of Gender Inequality”, in *Gender Equity: An Integrated Theory of Stability and Change*, Sage.

## Climate Change, Sustainability and Organisation (63 Hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUTM1015	Climate Change, Sustainability and Organisation	3	1.5+0+1.5

### Course Objectives:

- To develop an understanding about climate change in general, responses and debates
- To create awareness about the impact of climate change on organisations in performance, growth and sustainability
- To facilitate in developing reference points to factor in aspects of climate change in organizational planning and development
- To develop an understanding of sustainable development, SDGs and their relevance for sustainability of organisations
- To comprehend the application of the Integrated Reporting Framework for Sustainability in business.

### Course Outcomes:

- CO1: Develop foundational knowledge of climate change, its impacts on various sectors such as agriculture, forestry, transportation, energy, and manufacturing, and its broader implications, including migration, disasters, and pandemics.
- CO2: Evaluate the sustainability challenges and opportunities presented by climate change for business organizations.
- CO3: Examine the concept of sustainable development, including debates around it and the importance of SDGs.
- CO4: Gain knowledge of the regulatory environment, international policies, and frameworks such as Integrated Reporting for Sustainability.
- CO5: Explore sustainable production and consumption practices, the role of design and technology in sustainability, and strategic communication and marketing for promoting sustainability.

## CO-PO Mapping

CO/PO	PO-01	PO-02	PO-03	PO-04	PO-05	PO-06	PO-07	PO-08	PO-09	PO-10	PO-11	PO-12
CO1	3	3	2	3	2	3	2	1	2	3	1	3
CO2	3	3	2	2	3	3	2	2	3	2	1	3
CO3	3	3	2	3	3	3	1	2	2	3	1	3
CO4	3	2	2	3	2	3	1	2	2	2	2	3
CO5	3	3	2	3	3	3	2	2	2	3	2	3

### Course Contents:

#### Module-I:

Basics of climate change; impacts on various sectors; responses and mitigation efforts by the state agencies; debates and non-state and critiques, Sectoral implications of climate change: Agriculture and Forestry; Transportation; Buildings; Energy; Industry and Manufacturing, Climate change: specific impacts (Migration, Disasters and Pandemics), Mitigation and adaptation keeping the sustainability of business organisations

#### Module-II:

Sustainable development, debates, SDGs, challenges and opportunities; The business case and leadership for action, Regulatory environment and International policy; Integrated Reporting Framework for Sustainability, Production and consumption; Design, technology, and planning for sustainability, Communication and marketing; Collaboration and partnerships

### References:

- Climate Change- Law, Policy and Governance by Usha Tandon, Eastern Book Company, 2018
- Climate Change: A Very Short Introduction by Mark Maslin, Oxford University Press, 2014
- Sustainable Development Goals Series by Zachary Romano, Springer Publication, 2024.

## Job Readiness

Code	Course Title	Credit	T-P-PJ
CUTM1016	Job Readiness	6	0-6-0

### Course Objectives:

The objectives of the course are

- Develop competent level of English proficiency, i.e., 6.5 band on the CELTS Test
- Enhance proficiency in verbal, quantitative aptitude and logical reasoning skills aiming for Level 4 mastery in My Perfectice
- Strengthen students' employability skills through communication, analytical and problem-solving abilities

### Course Outcomes:

After completion of the course students will be able to:

- **CO1.** Achieve competency in English language (6.5 band on the CELTS Test)
- **CO2.** Apply English proficiency in real-world scenarios such as professional presentations
- **CO3.** Exhibit verbal ability, strong quantitative aptitude and advanced logical reasoning (Level 4 mastery in MyPerfectice)
- **CO4.** Develop and apply enhanced employability skills, including effective communication, sharp analytical thinking and problem-solving abilities in various professional contexts.
- **CO5.** Commitment to lifelong learning fostering a mindset of continuous improvement in English proficiency and employability skills.

CO, PO Mapping Matrix															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1			3											
CO2				3	3										
CO3			2	3											
CO4			1	2	3										
CO5			2		3										

## Course Contents

### Course I: CELTS - Listening, Speaking, Reading and Writing

#### Module I: CELTS Listening

- Notes/ Form/Table completion
- Label the Map/Passage, Multiple Choice Questions
- Complete the Sentences, listening to Find Information
- Assessment on Listening Skills

#### Module II: CELTS Speaking

- Speaking about self, family, hobbies, interests
- Introduction & Interview
- Topic Discussion (e.g, Environment, Post Covid 19, Job)
- Assessment on Speaking Skills

#### Module III: CELTS Reading

- Skimming and Scanning
- Sentence Completion
- Choose the Correct options ( A, B, C, D)
- Locating the Specific Information
- Assessment on Reading Skill

#### Module IV: CELTS Writing

- Summarising the chart, table or graph
- Comparing and contrasting graphs and tables
- Describing maps & diagrams
- Agreeing & disagreeing
- Expressing a personal view & opinion
- Assessment on Writing Skill
- Job Application: CV & Cover Letter (2nd year)
- Letter Writing
- Email Writing (2nd year)
- Getting Started –writing an introduction

## **Course II: CELTS Verbal**

### **Module I: Grammar (4 Hrs)**

- Articles
- Prepositions
- Subject-Verb
- Spotting Errors
- Sentence Correction

### **Module II: Vocabulary (5 Hrs)**

- Synonyms
- Antonyms
- Contextual Vocabulary

### **Module III: Reading Comprehension (3 Hrs)**

- Paragraph/ Sentence Completion
- Jumbled Sentences/ Jumbled Paragraph
- Reading Comprehension

### **Module IV: Verbal Analogies (3 Hrs)**

#### **References Recommended:**

##### **Books**

- The Official Cambridge Guide to Ielts Student's Book With Answers with DVD Rom
- Simone Braverman's Target Band 7
- Focus on IELTS Foundation Coursebook.

## Course Structure Basket - III

<b>Course Code</b>	<b>Course Title</b>	<b>Credits</b>	<b>Course Type T+P+PJ</b>
CUTM1017	Industrial IOT and Automation	6	3-2-1
CUTM1018	Data Analysis and Visualisation using Python	4	0-1-3
CUTM1019	Machine Learning using Python	4	1-2-1
CUTM1020	Robotic automation with ROS and C++	4	1-2-1
CUTM1021	Basics of Design Thinking	2	0-0-2
CUTM1022	System Integration with DYMOLA	2	0-0-2
CUTM1023	Smart Engineering Project (G2M)	3	0-0-3

## Industrial IoT and Automation

Code	Course Title	Credit	T-P-PJ
CUTM1017	Industrial IoT and Automation	6	3-2-1

### COURSE OBJECTIVES

- To provide the student with basic skills useful in identifying the concepts of automation using hydraulics, pneumatic and PLC.
- To impart knowledge on robot kinematics and programming for a given application.
- To provide an introduction to Industry 4.0 its applications in industry.

### COURSE OUTCOMES

- **CO1:** design pneumatic and hydraulic circuits
- **CO2:** program PLC for a given application
- **CO3:** choose appropriate materials handling devices and perform robot programming for a given application
- **CO4:** solve direct and inverse kinematics and choose appropriate Robot for given application
- **CO5:** apply IOT to different applications

### COURSE OUTCOME TO PROGRAM OUTCOME MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
<b>CO1</b>	3	3	2	2	3	1	3			2	2	2	3	2	3
<b>CO2</b>	3	3	1	1	3	2	2		2	2	2	1	3	3	2
<b>CO3</b>	2	3	1	3	3	2	2		2	1	1	3	3	2	2
<b>CO4</b>	3	3	1		3	2	2		2	2	1	3	2	2	2
<b>CO5</b>	3	3	1	2	3	1	1		3	1	1	3	1	1	1

**\*HIGH-3, MEDIUM-2, LOW-1**

## COURSE CONTENT

### **MODULE 1: Introduction & Architecture**

Theory

What is IIoT and connected world? The difference between IoT and IIoT, Architecture of IIoT, IOT node. Challenges of IIOT

Hands-On

1. Introduction to Arduino, ESsp8266, Introduction to raspberry Pi.

### **MODULE2: IIOT Components**

Theory:

Fundamentals of Control System, introductions, components, closed loop & open loop system.

Introduction to Sensors (Description and Working principle): What is sensor? Types of sensors, working principle of basic

Sensors -Ultrasonic Sensor, IR sensor, MQ2, Temperature and Humidity Sensors (DHT-11).

Digital switch, Electro

Mechanical switches.

Practice:

2. Measurement of temperature & pressure values of the process using raspberry pi/node mcu.
3. Modules and Sensors Interfacing (IR sensor, ultrasonic sensors ,Soil moisture sensor) using raspberry pi/node mcu.
4. Modules and Actuators Interfacing (Relay, Motor, Buzzer) using raspberry pi/node mcu.

### **MODULE 3: Communication Technologies of IIoT**

Theory:

Communication Protocols: IEEE 802.15.4, ZigBee, Z Wave, Bluetooth, BLE, NFC, RFID

Industry standards communication technology (LoRAWAN, OPC UA, MQTT), connecting into existing Modbus and Profibus

Technology, wireless network communication.

Practice:

5. Demonstration of MQTT communication
6. Demonstration of LoRa communication.

### **MODULE 4: Visualization and Data Types of IIoT**

Theory:

Front end EDGE devices, enterprise data for IIoT, emerging descriptive data standards for IIoT, cloud data base, could

Computing, fog or edge computing,

Connecting an Arduino /raspberry pi to the Web: Introduction, setting up the Arduino/raspberry pi development

Environment, Options for Internet connectivity with Arduino, configuring your Arduino/raspberry pi board for the IoT.

Practice:

7. Visualization of diverse sensor data using dashboard (part of IoT's 'control panel')
8. Sending alert message to the user.

### **MODULE 5:**

Theory

**Extraction from Web:** Grabbing the content from a web page, sending data on the web, troubleshooting basic Arduino

issues, types of IoT interaction, Machine to Machine interaction (M2M).

Practice

9. Device control using mobile Apps or through Web pages.
10. Machine to Machine communication

### **MODULE 6: Control & Supervisory Level of Automation**

Theory

Programmable logic controller (PLC), real-time control system, Supervisory Control & Data Acquisition (SCADA).

HMI in an automation process, ERP &MES

Practice

11. Digital logic gates programming using ladder diagram
12. Implementation of Boolean expression using ladder diagram
13. Simulation of PLC to understand the process control concept.

### **Module 7: Application of IIOT**

Case study: Health monitoring, Iot smart city, Smart irrigation, Robot surveillance

#### **Text Books:**

1. Industrial IoT Challenges, Design Principles, Applications, and Security by Ismail Butun (editor)
2. Internet of Things with Arduino Cookbook, Marco Schwartz, ISBN 978-1-78528-658-2

#### **Reference Books:**

1. The Internet of Things in the Industrial Sector, Mahmood, Zaigham (Ed.) (Springer Publication)
2. Industrial Internet of Things: Cybermanufacturing System, Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer Publication)
3. Internet of Things- A Hands on Approach, Arshdeep Bahga and Vijay Madiseti , Universities Press , 2015.

### Data Analysis and Visualization Using Python (70 Hours)

Code	Course Title	Credit	T-P-PJ
CUTM1018	Data Analysis and Visualization Using Python	4	0-1-3

**Course Description:** This course emphasizes the use of tools and techniques to collect, analyze, and interpret data.

**Course Objectives:**

- Understand how to read, store and display each data type.
- Get skill to quickly and easily draw plot or visualize the information through visualization technique.
- The ability to develop visualization to tell the story.

**Course Outcomes (COs):**

- **CO1:** Able to gain knowledge on visualization with good story line and perform job of a data analyst. (Understand)
- **CO2:** Able to analyse and visualize the dataset. (Analyze)
- **CO3:** Ability to design dashboard. (Create)
- **CO4:** Analyze Text data and gain insights. (Analyze)
- **CO5:** Select appropriate data visualization technique for given data. (Understand)

**CO-PO-PSO Mapping:**

CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	-	-	2	2	2	3	3	3
CO2	3	3	3	3	3	-	-	2	2	2	3	3	3
CO3	3	3	3	3	3	-	-	2	2	2	3	3	3
CO4	3	3	3	3	3	-	-	3	2	3	3	3	3
CO5	3	3	3	3	3	-	-	3	2	3	3	3	3

## Course Syllabus:

### Module 1: STORY BOARD DEVELOPMENT (20 hours)

- The objective and flow of the story to be understood through cases

### Module 2: DATA READING USING PYTHON FUNCTIONS (23 hours)

- Python libraries: Pandas, NumPy, Plotly, Matplotlib, Seaborn, Dash
- Data collection from online data sources, Web scrap, and data formats such as HTML, CSV, MS Excel, data compilation, arranging and reading data, data munging

### Module 3: DATA VISUALSATION USING PYTHON LIBRARIES (27 hours)

- Different graphs such as Scatterplot, Line chart, Histogram, Bar chart, Bubble chart, Heatmaps etc.
- Dashboard Basics – Layout, Reporting, Infographics, Interactive components, live updating

## Projects List:

1. COVID 19
2. World Development Indicators
3. ERP dashboarding
4. Details of Social/ Empowerment schemes of Govt. etc.

## References:

- <https://www.programmer-books.com/wp-content/uploads/2019/04/Python-for-Data-Analysis-2nd-Edition.pdf>
- <https://towardsdatascience.com/data-visualization/home>

### Machine Learning using Python (98 Hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUTM1019	Machine Learning using Python	4	1-2-1

**Course Description:** This course deals with various machine learning algorithms, strategies for model generation and evaluations are covered as per the industry requirement.

#### Course Objectives:

- Understand the meaning, purpose, scope, stages, applications, and effects of ML.
- Explore important packages of python, such as numpy, scipy, OpenCV and scikit-learn.
- To apply and design ML algorithms on given data and interpret the results obtained

#### Course Outcomes (COs):

- **CO1:** Develop a good understanding of fundamental principles of machine learning (Understand, Create)
- **CO2:** Invention of a Machine Learning problem. (Create)
- **CO3:** Develop a model using supervised/unsupervised machine learning algorithms for classification/prediction/clustering. (Design)
- **CO4:** Design and Concrete implementations of various machine learning algorithms to solve a given problem using languages such as Python. (Create)
- **CO5:** Evaluate performance of various machine learning algorithms on various datasets of a domain. (Apply, Evaluate)

#### CO-PO-PSO Mapping:

CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1		-	-	2	2	2	3	3	3
CO2	3	3	2	2	1	-	-	-	2	2	3	3	3
CO3	3	3	3	2	2	-	-	2	-	2	3	3	3
CO4	3	3	3	3	3	-	-	2	2	2	3	3	3
CO5	3	3	3	3	1	-	-	2	2	3	3	3	3

## Course Syllabus:

### Module 1: Application and Environmental-setup (24 hrs)

- Applications of Machine Learning In different fields (Medical science, Agriculture, Automobile, mining and many more).
- Supervised vs Unsupervised Learning based on problem Definition.
- Understanding the problem and its possible solutions using IRIS datasets.
- Python libraries suitable for Machine Learning(numpy, scipy, scikit-learn, opencv)
- Environmental setup and Installation of important libraries.

### Module 2: Regression (24 hrs)

- Linear Regression
- Non-linear Regression
- Model Evaluation in Regression
- Evaluation Metrics in Regression Models
- Multiple Linear Regression
- Feature Reduction using PCA
- Implementation of regression model on IRIS datasets.

### Module 3: Classification (26 hrs)

- Defining Classification Problem with IRIS datasets.
- Mathematical formulation of K-Nearest Neighbour Algorithm for binary classification.
- Implementation of K-Nearest Neighbour Algorithm using sci-kit learn.
- Classification using Decision tree.
- Construction of decision trees based on entropy.
- Implementation of Decision Trees for Iris datasets .
- Classification using Support Vector Machines.
- SVM for Binary classification
- Regulating different functional parameters of SVM using sci-kit learn.
- SVM for multi class classification.
- Implementation of SVM using Iris datasets .
- Implementation of Model Evaluation Metrics using sci-kit learn and IRIS datasets.

### Module 4 - Unsupervised Learning (24 hrs)

- Defining clustering and its application in ML .
- Mathematical formulation of K-Means Clustering.
- Defining K value and its importance in K-Means Clustering.
- Finding appropriate K value using elbow technique for a particular problem.
- Implementation of K-Means clustering for IRIS datasets

## **Projects**

- To be defined based on respective study area of student.

## **References:**

### **Text Book:**

1. EthemAlpaydin, Introduction to Machine Learning, Second Edition, <http://mitpress.mit.edu/catalog/item/default.asp?ttype=2&tid=12012>.

### **Web Resource:**

1. <https://towardsdatascience.com/beginners-guide-to-machine-learning-with-python-b9ff35bc9c51>

## Robotic automation with ROS and C++

Code	Course Title	Credit	T-P-PJ
CUTM1020	Robotic automation with ROS and C++	4	1-2-1

### Course Content:

1. Robotic Automation Introduction
2. Sensors & Controllers
3. Sequential robot control
4. ROS & C++
5. Project

### Course Objectives

- To upgrade knowledge levels of robotic application in modern industries
- Project based training

### Course Outcomes

After the completion of the course students will be able to:

- Advanced knowledge on robotic automation
- Design different types of circuits using devices which are connected to robotic modules
- To write code using C++ for various types of robotic applications.
- Simulate Robotic Modeling with MATLAB and Simulink
- Apply the concepts in Industry based project & advanced learning.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	2								3	1	1
CO2	1	2	3	2	1								3	2	1
CO3	1	1	3	2	2								3	2	1
CO4	1	2	3	2	3								3	2	2
CO5	1	2	2	3	3								3	2	2

## COURSE SYLLABUS

**TOTAL HOURS-60 HOURS**

### **Module – 1 (12 Hours)**

Robotic Automation Introduction

- 1.1 Basic's of automation
- 1.2 Use of robots in industry.

### **Module – 2 (12 Hours)**

Sensor's requirement in robots.

- 2.1 Selecting sensors as per the project.
- 2.2 Specification checking of sensors.
- 2.3 Interfacing of sensor to controllers.

Practice

- P2.1 TILT, PROXIMITY, TEMPERATURE, HUMIDITY, SMOKE, FINGERPRINT  
P2.2 BLUETOOTH, ESP8266, GPS, GSM

### **Module – 3 (12 Hours)**

Controllers and output port handling.

- 3.1 Concept of 8951 controller
- 3.2 Concept of Arduino and concept of Raspberry Pi.

Practice

- P3.1 Port handling of 8951  
P3.2 Port handling of Arduino  
P3.3 Port handling of Raspberry Pi

### **Module- 4 (12 Hours)**

Sequential robot control

- 4.1 Designing of sequential robot control system.
- 4.2 Writing of programs in different programming languages.
- 4.3 Controlling of input/output devices.

Practice

- P4.1 Programming of controllers with different programming languages  
P4.2 Designing of sequential control robot.

### **Module- 5 (12 Hours)**

ROS & C++

- 5.1 What is Ubuntu & ROS?
- 5.2 Requirement and application of ROS.

5.3 ROS based simulation of Turtlebot.

5.4 Adding of robot with wheel & sensor. Placing robot inside Gazebo.

Practice:

P5.1 Ubuntu basic command.

P5.2 Installation of Ubuntu, ROS & Gazebo

P5.3 Turtlebot control application

P5.4 Gazebo based robot control and simulation.

P5.5 Python and C++ based programming to control robot.

Virtual LAB : Using ROBOMASTER (AWS)

Projects

1. Mobile controlled robot
2. Autonomous operated robot.
3. Location targeted robot

## Basics of Design Thinking (60 hrs)

Code	Course Title	Credit	T-P-PJ
CUTM1021	Basics of Design Thinking	2	0-0-2

### Course Objectives

- Learning the five key stages of Design Thinking—Empathize, Define, Ideate, Prototype, and Test—and understand how they contribute to solving complex problems creatively and effectively.
- Gaining the ability to approach challenges with a user-centric mindset, focusing on the needs, pain points, and perspectives of users to design innovative and impactful solutions.
- Acquiring practical knowledge of tools such as empathy mapping, brainstorming techniques, rapid prototyping, and iterative testing to foster collaboration and enhance creative problem-solving in diverse contexts.

### Course Outcomes:

#### After the completion of the course, the students will be able to:

- **CO1:** recall and describe the key stages of the Design Thinking process (Empathize, Define, Ideate, Prototype, and Test) and their importance in problem-solving.
- **CO2:** explain the principles of human-centered design and how it applies to addressing user needs and solving complex problems.
- **CO3:** apply Design Thinking tools and techniques (e.g., empathy mapping, brainstorming, prototyping) to real-world or simulated problems to generate innovative solutions.
- **CO4:** analyze user feedback, identify patterns, and use insights to refine problem definitions and proposed solutions during the iterative process.
- **CO5:** design and develop innovative, user-centered solutions to complex challenges, showcasing their ability to integrate all stages of the Design Thinking process effectively.

**Course Outcome to Program Outcome Mapping:**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1		3							2		3	
CO2	3	1	3		1							2	3		
CO3	2	2	3	3	2							1		2	2
CO4	3	2	3		3							1			
CO5	3	2	3		1							1		2	3

**\*High-3, Medium-2, Low-1**

**Course Syllabus:**

**Projects**

1. Basics of Design Thinking
2. Developing a customer friendly insulin pump design
3. Develop a new customer experience for buying a diamond ring online
4. Develop a new disease monitoring device for health workers working in remote areas.
5. Designing an integrated machinery for end-to-end farm activities for small and marginal farmers.
6. Design a Fund-raising campaign

**Text Books:**

1. Tom Kelly & Jonathan Littman (2001). "The Art of Innovation" Broadway Publication.

## System Integration with DYMOLA

Code	Course Title	Credit	T-P-PJ
CUTM1022	System Integration with DYMOLA	2	0-0-2

### COURSE OBJECTIVES

- To provide powerful multi-disciplinary systems engineering through compatible model libraries for a large number of engineering domains.
- To design high-fidelity modelling of complex integrated systems.
- To design intuitive modelling i.e. advanced, formally defined object-oriented modelling language.

### COURSE OUTCOMES

- **CO1** It can improve the Knowledge to better understand the behavior of systems and to work and communicate accurately with partners and suppliers.
- **CO2** DYMOLA is not only capable of supporting an ad-hoc modelling level, such as functional behavior or detailed design, but is also able to convert these predictive models into real-time models.
- **CO3** Future Centurions are ready for operating in many industries including automotive, aerospace, architecture, Motorsport, energy, and high tech.
- **CO4** To enable users to easily build their own components or adapt existing ones to match their unique needs.
- **CO5** Build custom components or adapt existing ones

### COURSE OUTCOME TO PROGRAM OUTCOME MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	3				1			1	3	2	1
CO2	3	3	1	1	3				1			1	3	3	2
CO3	3	3	1	3	3				2	1		1	3	2	3
CO4	3	3	1		3				2	1		3	2	2	2
CO5	3	3	1	2	3				1			2	1	1	3

\*HIGH-3, MEDIUM-2, LOW-1

## COURSE SYLLABUS

### Module 1 - Introduction Dymola and Modelica library

Package Browser, Component Browser, Parameter and Variable Editor Simulation Window, Modelling, and Simulation.

The Modelling window is used to compose models and model components.

The Simulation experiment on the model, plot results and animate the behaviour.

Creating user-defined models and scripting using Modelica language.

Role Play – Explore the pre-defined libraries and Models, Creating a Package

Practice Project - Preparation of animated projects

<https://www.youtube.com/watch?v=39xyI0k>

<https://www.youtube.com/watch?v=FN8LlnTwzVE&t=314s>

### Module 2 – Physical Modeling using DYMOLA

Import of user-defined libraries and packages, interfacing with physical models using ArduinoUno.

The Simulation experiment on the model using multi-domain libraries such as mechanical, electrical, control, thermal, pneumatic, hydraulic, powertrain, thermodynamics, vehicle dynamics, air-conditioning domains

Dymola interface that is stored in the Python package

Role Play – Explore the pre-defined libraries and Models, Creating a Package

Practice Project - Preparation of projects using user-defined packages,

**Systems Physics with Modelica/Dymola**

<https://www.youtube.com/watch?v=xlpHwX-W3Ns>

### Module 3 – Animation and 3D view Using DYMOLA

MultiBody Frame Connector, Building a Mechanical Model, Concept of Furuta

Role Play - Practical session by students for students

Practice Project - Modelling of animated projects using the MultiBody library.

<https://www.youtube.com/watch?v=c9Ar2b4X5rQ>

<https://www.youtube.com/watch?v=k7ILBASaEJg>

## Session Plan

### Session 1

#### Project

1

#### **Simulating a model – Modelling of Integrated circuits**

Description: Use of Electrical and Electronics components.

Workbench Use: Behaviour Modelling, Functional and Logical Design.

### Session 2

#### Project

2

#### **Simulating a model -Creating a model for Electric DC Motor**

Description: Design a DC Motor Model, Test, and Simulation, creating a library for components,

Creating a model for motor drive, Scripting.

Workbench Use: Behaviour Modelling, Modelica Standard Library.

### Session 3

#### Project

3

#### **Simulating a model -Simple Pendulum with Frictionless joint Using Multi-Body Library**

Description: Design the Simple pendulum and the Furuta joint using Dymola and Modelica language. Friction joint for the Mechanical equipment.

Workbench Use: Behaviour Modelling.

### Session 4

#### Project

4

#### **Simulating a model – Pick and Place Robot**

Description: 5 Axis Pick and Place Robot Design, Validation, and Optimization in the 3DS platform.

Workbench Use: Behaviour Modelling, Functional and Logical Design. Part design and Assembly Design.

<https://www.youtube.com/watch?v=9RgdZUvEjPw>

### Session 5

#### Project

5

#### **Simulating a model – 3D Printer Design**

Description: Design All System and Sub System of the 3D Printer, Validation and Simulation using 3Ds Platform.

Workbench Use: Behaviour Modelling, Functional and Logical Design. Part design and Assembly Design.

### Session 6

#### Project

6

#### **Simulating a model – Bicycle Behaviour Modelling**

Description: Design Power Train, Driving Cycle, part design, and Simulation.

Workbench Use: Behaviour Modelling, Functional and Logical Design. Part design and Assembly Design.

## **Session 7**

### **Project**

**7**

#### **Simulating a model – Refrigerator Compartment Door Design using Thermal Library**

Description: This component models the airflow through the door of a refrigerator or freezer compartment.

Workbench Use: Behaviour Modelling, Functional and Logical Design. Part design and Assembly Design.

## **Session 8**

### **Project**

**8**

#### **Simulating a Model – Engine Analytic Using MultBody Library.**

Description: Engine analytic, an engine with 6 cylinders, 6 planar loops, 1 degree of freedom, and analytic handling of kinematic loops.

Workbench Use: Behaviour Modelling.

## **Session 9**

### **Project**

**9**

#### **Simulating a model – Control the real and Digital servo motor ArduinoUno Library**

Description: Control the Real and Digital Servo motor with simulation.

Workbench Use: Behaviour Modelling, Arduino based System Design, and Functional and logical design.

## **Session 10**

### **Project**

**10**

#### **Simulating a model – Virtual Universes with Poppy Humanoid Using ArduinoUno Library**

Description: Virtual universes with a human assistant robot with simulation.

Workbench Use: Behaviour Modelling, Arduino based System Design, Functional, and logical design.

## **Session 11**

### **Project**

**11**

#### **Simulating a model – Implementation of Model using Python Library**

Description: Modelling using python library, validation and optimization in the 3Ds platform.

Workbench Use: Behaviour Modelling, Functional and Logical Design. Part design and Assembly Design.

## **Session 12**

### **Project 12**

#### **Simulating a model – Industrial Robot Design**

Description: 6 Axis industrial robot design, validation, and optimization in the 3Ds platform.

Workbench Use: Behaviour Modelling, Functional and Logical Design. Part design and Assembly Design.

## Session 13

### Project

13

#### **simulating a model – Temperature Control System Using State Graph**

Description: The model contains an electric circuit with a heating resistor and a switch.

Workbench Use: Behaviour Modelling.

<https://www.youtube.com/watch?v=zz-crJOG0&t=26s>

<https://www.youtube.com/watch?v=Zl592ARjnpU>

## Session 14

### Project 14

#### **Simulating a model – Magnetic Ball System using Magnetic Library**

Description: The electronic circuit consists of a voltage source, a resistor, and an inductor in the form of a tightly wound coil. An iron ball beneath the inductor experiences a gravitational force as well as an induced magnetic force (from the inductor) that opposes the gravitational force.

Workbench Use: Behaviour Modelling.

## Session 15

### Project

15

#### **Simulating a Model – Design of Water to Steam Converter Using Fluid Library**

Description: Create a package under Fluid\_Package called Water\_To\_Stream using temperature sensors.

Workbench Use: Behaviour Modelling.

## Session 16

### Project

16

#### **Simulating a Model – Design of Liquid Valve Control Using Fluid Library**

Description: Building a simple circuit with two valves and a volume block.

Workbench Use: Behaviour Modelling.

[https://www.youtube.com/watch?v=P\\_YI3RiTl14](https://www.youtube.com/watch?v=P_YI3RiTl14)

## SMART ENGINEERING PROJECT (G2M)

Code	Course Title	Credit	T-P-PJ
CUTM1023	Smart Engineering Project (G2M)	3	0-0-3

### COURSE OBJECTIVES

- The main objective of this course is that students from various branches can learn different tools and collaborate to build a smart live project.
- To make the centurions think beyond engineering.
- To provide the platform to express the imagination to reality.

### COURSE OUTCOMES

- **CO1:** Able to identify and formulate the research problem
- **CO2:** Able to design and develop solutions to the problem
- **CO3:** Able to analyze and solve the complex problems
- **CO4:** Able to plan, implement and execute the project
- **CO5:** Able to write an effective technical reports and demonstrate through the presentation

### COURSE OUTCOME TO PROGRAM OUTCOME MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
<b>CO1</b>	3	3	2	2	3				1			1	3	2	1
<b>CO2</b>	3	3	1	1	3				1			1	3	3	1
<b>CO3</b>	3	3	1	3	3				2	1		1	3	2	2
<b>CO4</b>	3	3	1		3				2	1		3	2	2	2
<b>CO5</b>	3	3	1	2	3				1			2	1	1	3

**\*HIGH-3, MEDIUM-2, LOW-1**

## COURSE SYLLABUS

- Interdisciplinary
- Product Based
- Industry 4.0
- Go to Market Based

### **Project categories:**

- Software/Hardware Based
- Real-Time
- Multidisciplinary

### **Basic Project Requirements:**

As per the Project requirements you can select any available boards/software.

Some selected and regular used embedded boards as listed below for your reference.

### **Hardware**

1. Arduino (Uno, Mega, Nano)
2. Node MCU/ESp32
3. Raspberry pi Zero W/Raspberry pi Pico
4. Micro Python
5. Raspberry pi 3b+
6. FPGA Board
7. STM32

### **Simulation Software's**

Some selected and regular used software as listed below for your reference.

8. Proteus Professional
9. MATLAB/Simulink
10. LabVIEW
11. Xilinx ISE
12. Ansys
13. Fusion 360
14. Autodesk
15. Dymola
16. Simulia

17. Maplesoft
18. Modelica
19. Python

**Projects In Track:**

- Analysis Design of G+10 Building using STAAD Pro
- Automated water irrigation controller for rice field
- Automatic Microgrid System
- Automation in Light and Fan in Classroom
- Speed Control Of Dc Motor using Arduino
- Bench Tapping Machine
- Modular E-Rickshaw Design using Catia
- Renewable Energy using Compressor
- Wireless Control Robotic car through MATLAB GUI
- Water Level and Temperature Indicator
- Speech Recognition using Python
- IOT Based Air Pollution Quality Monitoring with ESP8266
- Plant Disease Detection using Image Processing
- IOT Based Air Quality and Monitoring By Using Arduino
- Automatic agriculture field monitoring device
- IOT Based Weather Station Using GY-BME280 Sensor Module and ESP8266-12E Node MCU LUA Wi-Fi Module
- Bluetooth Controlled Car Using ARDUINO
- Crimes Against Women in India
- A Presentation on Analysis of QUAD COPTER
- Collecting Data and Visualizing of a Mobile Sensors of Android Device
- Manufacturing of Knuller Tool

- Smart Product Sanitization and Packaging System

### **Product In Track**

- Insulin Pump Prototype Design
- Electronic Controller Design
- Battery Management System Design
- Poly House
- Apparel Tracking using Apriso webservice
- Android app development using android studio and Java
- Modular E-Rickshaw variant Design
- Autonomous Navigating Vehicle
- Smart Transformer Control Panel Design
- 3-Phase BLDC Motor Driver Design

### **Session Plan**

#### Session 1

- Allocation of projects.
- Defined the gate zero process.

#### Session 2

- Review of gate zero process

#### Recent Comments

- Harolddyday on Dr. Amrutha Gopan
- Fakaza on Dr. Amrutha Gopan
- впр математика 8 класс on Domain course template
- Michaeljab on Dr. Amrutha Gopan
- EdgarWab on Dr. Amrutha Gopan

## Course Structure

### Basket - IV

### Aerospace Engineering

Course Code	Course Title	Credits	Type T+P+PJ	Prerequisite
CUTM1094	Introduction to Aerospace Engineering	3	2+1+0	
CUTM1095	Rotary-wing Flight Dynamics	3	2+0+1	Introduction to Aerospace Engineering
CUTM1096	Aerodynamics	4	3+1+0	Introduction to Aerospace Engineering and Fluid Mechanics with Finite Volume Method
CUTM1097	Flight Mechanics	6	4+0+2	Aerodynamics
CUTM1098	Aircraft Structure	4	3+1+0	Theories of Failure Using Finite Element Analysis
CUTM1099	Aerospace Structural Analysis	6	3+0+3	Aircraft Structure
CUTM1100	Jet Propulsion	4	3+1+0	Thermodynamics
CUTM1101	Advanced Propulsion	3	2+1+0	Jet Propulsion
CUTM1102	Experimental Aerodynamics	3	2+1+0	Aerodynamics
CUTM1103	Space Dynamics	3	2+1+0	Introduction to Aerospace Engineering
CUTM1104	Introduction to Avionics	3	2+1+0	Introduction to Aerospace Engineering
CUTM1088	Thermodynamics	3	2+1+0	
CUTM1089	Fluid Mechanics with Finite Volume Method	3	2+1+0	
CUTM1062	Theories of Failure Using Finite Element Analysis	4	2+2+0	
CUTM1058	Programming in Java(Same as Java Technologies)	3	2-1-0	

CUTM1059	Database Management Systems	3	2-1-0	
CUAS1001	Introduction To Aircraft Documents And Logbook	2	1-1-0	Introduction To Aerospace Engineering
	<b>Total Credits</b>	<b>60</b>		

## Introduction to Aerospace Engineering (60 Hours)

Code	Course Title	Credit	T-P-PJ
CUTM1094	Introduction to Aerospace Engineering	3	2-1-0

### Course Objective

- Student will study this course to gather knowledge about the atmospheric condition with change in altitude, different component and its functions of aircraft, basic working principles behind the flight and different types of engines.
- To identify the types & classifications of Aircraft and its components and systems.
- To provide an exposure of various forces, stability and performance aspects crucial for flying.

### Course Outcomes

At the end of the course, the Students will be able to....

- CO1: Describe different aerospace vehicle, UAV and atmosphere layers.
- CO2: Explain airplane and their main components.
- CO3: Explain different equation related to aerodynamics.
- CO4: Describe different forces, moments and their impact on aircraft and its propulsive Efficiency.
- CO5: Explain flight mechanics and maneuverability.

### Course Outcome to Program Outcome and Program Specific Outcome Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	2	2	2	2	3	3		2		2	1
CO2	3	3	3	2	2	2	2	2	3	3		2	1	1	
CO3	3	3	3	2	2	2	2	2	3	3		2	1	1	
CO4		3	2	2	2	2	2	2	3	3		2	1	1	
CO5		3	2	2	2	2	2	2	3	3		2	1	1	

\* High-3, Medium-2, Low-1

### COURSE CONTENT

**Module I: Aerospace vehicle and atmosphere**

**(6hrs)**

### **Theory**

- Introduction to aerospace engineering, Different aerospace vehicle / airship, Atmosphere,

### **Practice**

- Experiment 1.1: Write a program for variation of temperature, pressure and density with variation of altitude within troposphere and stratosphere.

## **Module II: Airplane and their main element (8hrs)**

### **Theory**

- Fuselage, Wing, Empennage, Propulsion,
- General Aviation-Purposes, history, Different configuration,
- Commercial Aircraft- Purposes, history, Different configuration,
- Military Aircraft- Purposes, history, Different configuration,

### **Practice**

- Experiment 2.1: Draw 3-view diagram of commercial aircraft (Cessna 152) using Dassault system

## **Module III: Basic Aerodynamics (10hrs)**

### **Theory**

- Incompressible flow, Lagrangian method, Eulerian method
- Continuity, momentum and energy equations
- Bernoulli's Equation and Conda Effect
- Compressible flow and Mach No

## **Module IV: Forces and moment on aircraft (11hrs)**

### **Theory**

- Aerodynamic Forces and its dependencies, force Equilibrium, Lift and Drag description,
- Airfoil, Angle of attack, Bernoulli effect, Equation of lift and drag, Cl-alfa curve,
- 3D wing: Lift, Drag, Force distribution over wing, Down wash and induced drag, Wing tip, Wing configuration,
- High Lift Devices, Flap and Slat, deferent types of flap, Spoiler,
- Turbulence and Stall: Laminar and turbulent Flow, its impact on airfoil, Stall, 3D stall,

### **Practice**

- Experiment 4.1: Find the lift and drag of 2 D airfoil (NACA 0012) at 2-degree angle of attack using Dassault system

## **Module V: Airplane Propulsion (9 hrs)**

### **Theory**

- Engine Properties: Definition and overview, Component, Different type,
- Inlets: Overview, Supersonic inlet, Different example,

- Compressors: Overview, Types, Working principle,
- Turbine and Nozzle: Overview, Afterburner,
- Compressors: Multistage compressor in jet engine
- Turbojet and Turbofan review: working principle, advantages and disadvantages

#### **Practice**

- Experiment 5.1: Study the difference between Turbojet and Turbofan engine.

### **Module VI: Flight Mechanics**

**(10hrs)**

#### **Theory**

- Center of Gravity, variation of Center of Pressure with angle of attack
- Aerodynamics Center, Stability
- Control surface and maneuver: Overview, all the moments and Rotational axis, primary control surface, maneuvering, Aileron, Elevator and Rudder.

#### **Practice**

- Experiment 6.1: *Find out  $C_l$ ,  $C_d$  and  $C_l/C_d$  at different angle of attack using Dassault system*

### **Module VII: Unmanned Aerial Vehicles**

**(6hrs)**

#### **Theory**

- Classifications of UAVs and application, Basic working principle, military, government, Civil

#### **Text Books:**

1. Anderson, J.D., Introduction to Flight, McGraw-Hill; 8th edition, 2015
2. Stephen. A. Brandt, Introduction to aeronautics: A design perspective, 2nd edition, AIAA Education Series, 2004.

#### **Reference Books:**

1. Kermode, A.C. Flight without Formulae, Pearson Education; Eleven edition, 2011
2. L J Clancy: Aerodynamics

## Rotary-Wing Flight Dynamics (60 hrs)

Code	Course Title	Credit	T-P-PJ	Prerequisite
CUTM1095	Rotary-Wing Flight Dynamics	3	2-0-1	Introduction to Aerospace Engineering

### Course Objective

- Student will study this course to get the knowledge about different types of helicopters, and working principles of the helicopter flight.
- Students are capable to design a quad copter and able to fly.
- To understand the Rotary wing and its Aerodynamic behavior with respect to flight.

### Course Outcomes

At the end of the course, the Students will be able to....

- CO1: Describe the rotor configurations, maneuverability and stability of Helicopter.
- CO2: Explain various components and control systems.
- CO3: Illustrate the hovering phenomena and stability of helicopter.
- CO4: Design and Simulate the performances of a helicopter.
- CO5: Explain the Hovercrafts principles and performances

### Course Outcome to Program Outcome and Program Specific Outcome Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2				2	2	2	3	3	1	2	3		
CO2	3	2	2	1		2	2	2	3	3	2	2	1		1
CO3		3	2	1	2	2	2	2	3	3	2	2		1	
CO4		3	2	1	2	2	2	2	3	3	2	2		2	
CO5		3	2	1	2	2	2	2	3	3	1	2	1		

\* High-3, Medium-2, Low-1

### COURSE CONTENT

**Module I: Rotor configuration (6hrs)**

**Theory**

- Introduction to rotary wing aircraft and Torque reaction
- Different configurations to nullify the Torque reaction
- Jet rotors and compound helicopters

**Module II: Methods of Control (8hrs)**

**Theory**

- Problem in rotary wing with compare to fixed wing aircraft
- Methods of Control, rotor blade pitch control
- Collective pitch and Cyclic pitch – Lead – Lag and flapping of rotor blade

**Module III: Hovering and Vertical Flight (12hrs)**

**Theory**

- Hovering performance – Momentum Theory, Blade element theories
- Figure of merit – Profile and induced power estimation
- Constant Chord and ideal twist rotors, Ground effect.

**Module IV: Forward Flight (12hrs)**

**Theory**

- Forward flight, Induced, profile and parasite power requirements in forward flight
- Performance curves with effects of altitude
- Hub Loads, Sideward Flight, Rearward Flight, Turning Flight, Autorotation.

**Module V: Helicopter Trim and Stability (7 hrs)**

**Theory**

- Equilibrium condition of helicopter
- Trim analysis, Basics of helicopter stability.

**Module VI: VTOL and STOL (8 hrs)**

**Theory**

- Various configurations – propeller, rotor, ducted fan and jet lift
- Tilt wing and vectored thrust
- Performance of VTOL and STOL aircraft in hover, transition and forward motion.

**Module VII: Ground Effect Machines (7hrs)**

## Theory

- Hovering Flight, lift augmentation and peripheral jet machines
- Drag of hovercraft on land and water
- Applications of hovercraft.

### Text Books:

1. Gupta, L., Helicopter Engineering, Himalayan Books, 1996
2. Gessow, A. and Myers, G. C., Aerodynamics of Helicopter, MacMillan & Co., 1987.

### Reference Books:

1. Johnson, W., Helicopter Theory, Princeton University Press, 1980.
2. Mac Cromick, B. W., Aerodynamics of V/STOL Flight, Academic Press, 1987.

### *Source of reference; NPTL*

<https://nptel.ac.in/courses/101/104/101104017/>,

**Project-** Design and Build a small quad copter and fly it. Use Dassault system for designing.

### Steps:

1. Comparative configuration study of different types of quad copter.
2. Comparative study of specification and performance details of quad copter
3. Preparation of Comparative data sheets
4. Comparative graphs preparation and selection of main parameters for the design purpose of the quad copter
5. Preliminary main parameters Power plant selection , and control
6. Build the quad copter
7. Detailed stability check at ground.
8. Flight testing
9. Documentation

## Aerodynamics (70 hrs)

Code	Course Title	Credit	T-P-PJ	Prerequisite
CUTM1096	Aerodynamics	4	3-1-0	Introduction to Aerospace Engineering and Fluid Mechanics with Finite Volume Method

### Course Objective

- To make the student understand the 2-D flow ideal and real flow.
- To get the idea of the concept of viscous flow.
- To make the student understand the compressible effect over wing.

### Course Outcomes

At the end of the course, the Students will be able to....

- CO1: Understand the two dimensional flow of a body and D'Alembert paradox
- CO2: Understand viscous flow, boundary layer and its thickness using Prandtl system, Interpret flow separation and different control techniques
- CO3: Understand aerodynamics drag and aerodynamics efficiency
- CO4: Analyze different types of shock wave and hodograph
- CO5: Analyze expansion waves Rayleigh and Fanno flow and high speed flow

### Course Outcome to Program Outcome and Program Specific Outcome Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	2	2	2	2	3	3	1	2	1		
CO2	3	3	3	2	2	2	2	2	3	3	2	2		2	
CO3	3	3	3	2	2	2	2	2	3	3	2	2		2	1
CO4		3	2	2	2	2	2	2	3	3	1	2		2	
CO5		3	2	2	2	2	2	2	3	3	1	2	1		

\* High-3, Medium-2, Low-1

### COURSE CONTENT

**Module I: Two-dimensional Flow**

**(10 hrs)**

## Theory

- Aerodynamic force and moments, lift and drag coefficients
- Centre of pressure and aerodynamic centre, moment coefficient, coefficient of pressure, continuity and momentum equations,
- Pressure and velocity distributions on bodies with and without circulations in ideal and real fluid flows, Magnus effect

## Practice

- Experiment 1.1: Pressure distribution over cylinder with and without circulation using 3DS

## Module II: Viscous Flow

(12 hrs)

### Theory

- Reynolds number, laminar flow, transition flow and turbulent flow
- Boundary layer and boundary layer thickness, displacement thickness, momentum thickness, Energy thickness,

### Practice

- Experiment 2.1: Flow over a flat plate at different Reynolds no using Dassault system.

## Module III: Flow separation and control techniques

(10 hrs)

### Theory

- Boundary Layer growth and point of separation
- Techniques to control the point of separation
- Flow over different contours.

### Practice

Experiment 3.1: Flow over a flat plate at different angles of incidence using Dassault system.

## Module IV: Aerodynamics Drag

(10 hrs)

### Theory

- Aerodynamics parameter, Wing tip vortex, down wash

- Different types of drag method to minimizing those.
- Aerodynamic efficiency and dependency,

### Practice

- Experiment 4.1: Compare the Lift, drag and aerodynamic efficiency at different angle of attack of an airfoil using Dassault system and wind tunnel
- Experiment 4.2: Design and simulate nacelles, intakes and nozzles using Dassault system

### Module V: Shock Wave

(8 hrs)

#### Theory

- Normal shock and equations, Oblique shocks and corresponding equations
- $\theta$ -  $\beta$ - M relation, Hodograph and pressure turning angle
- Shock polar, flow past wedges. strong, weak and detached shocks.

#### Practice-

- Experiment 5.1: Design and simulate the flow over nacelles, intakes and nozzles using Dassault system

### Module VI: Flow Analysis

(10 hrs)

#### Theory

- Rayleigh and Fanno Flow. Flow past convex corners,
- Expansion hodograph, Reflection and interaction of shocks and expansion waves
- Methods of Characteristics, Two-dimensional supersonic nozzle contours.

#### Practice-

- Experiment 6.1: Find out pressure and velocity distribution in high-speed jet using *Dassault system* also using experimental and compare the results.

### Module VII: Airfoil in High-Speed Flows

(10hrs)

#### Theory

- Thickness, camber and aspect ratio of wings,
- Transonic area rule, Tip effects.

#### Practice-

- Experiment 7.1: Design the different swept back wing and check the effect on transonic speed using Dassault system

Text Books:

1. Clancy, L.J., "Aerodynamics",
2. Anderson Jr., D., - "Modern compressible flows", McGraw-Hill Book Co., New York 2012.

Reference Books:

1. Rathakrishnan, E., "Gas Dynamics", Prentice Hall of India, 2012.
- Anderson, Jr., J.D. Introduction to Flight, McGraw-Hill International Edition, 1999

## Flight Mechanics (110 hrs)

Code	Course Title	Credit	T-P-PJ	Prerequisite
CUTM1097	Flight Mechanics	6	4-0-2	Aerodynamics

### Course Objective

- To understand performance of aircraft
- To understand static and dynamic stability of aircraft
- Students will get basic knowledge of aircraft designing

### Course Outcomes

At the end of the course, the Students will be able to....

- CO1: Understand the two dimensional flow of a body and D'Alembert paradox
- CO2: Understand viscous flow, boundary layer and its thickness using d'Alembert system, Interpret flow separation and different control techniques
- CO3: Understand aerodynamics drag and aerodynamics efficiency
- CO4: Analyze different types of shock wave and hodograph
- CO5: Analyze expansion waves Rayleigh and fanon flow, and high speed flow

### Course Outcome to Program Outcome and Program Specific Outcome Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	2	2	2	2	3	3	3	1	1		1
CO2	3	3	3	2	2	2	2	2	3	3	3	1		2	1
CO3	3	3	3	2	2	2	2	2	3	3	3	1		2	1
CO4		3	2	2	2	2	2	2	3	3	3	1		2	1
CO5		3	2	2	2	2	2	2	3	3	3	1	1		1

\* High-3, Medium-2, Low-1

## COURSE CONTENT

**Module I: Drag and power required for Steady level flight (15hrs)**

## Theory

- Steady level flight, thrust required and Power required,
- Thrust available and Power available for propeller driven and jet powered aircraft,
- Effect of altitude, maximum level flight speed, minimum drag and minimum power required.

## Module II: Un-Accelerated flight performance (15 hrs)

### Theory

- Range and Endurance of Propeller and Jet airplanes
- Steep angles of climb, Rate of climb, Maximum Climb angle and Maximum Rate of climb,
- Absolute and service ceiling, Gliding flight

## Module III: Take-off and landing performance (10 hrs)

### Theory

- Estimation of take-off and landing distances,
- Methods of reducing landing distance

## Module IV: Turning performance (15 hrs)

### Theory

- Level turn, minimum turn radius, bank angle and load factor,
- Pull up and pull-down maneuvers, maximum turn rate,
- Constraints on load factor, V-n diagram.

## Module V: Longitudinal stability (25 hrs)

### Theory

- Static and dynamic stability - Purpose of controls in airplanes –
- Inherently stable and marginal stable airplanes –
- Static, Longitudinal stability - Stick fixed stability - Basic equilibrium equation - Stability criterion
- Effects of fuselage and nacelle - Influence of CG location - Power effects - Stick fixed neutral point –
- Stick free Stability-Hinge moment coefficient - Stick free neutral Points-Symmetric

## Module VI: Lateral and Directional stability (20 hrs)

### Theory

- Lateral stability and Dihedral effect - Lateral control –
- Coupling between rolling and yawing moments - Adverse yaw effects - Aileron reversal
- Static directional stability - Weather cocking effect - Rudder requirements –
- One engine inoperative condition - Rudder lock.

## **Module VII: Control surface and stick forces**

**(10 hrs)**

### **Theory**

- Ailerons, elevators, rudder, trim, spring tabs, wing flaps and spoilers.
- Use of trim tab, Hinge moment and stick forces.
- Effect of CG on stick forces.

#### *Text Books:*

1. Clancey, L.J., “Aerodynamics”,
2. Anderson, Jr., J.D. Aircraft Performance and Design, McGraw-Hill International
3. Perkins C.D. & Hage R.E. Airplane performance, stability and control, John Wiley & Sons 1976.
4. Daniel P. Raymer, Aircraft Design: A Conceptual Approach

#### *Reference Books:*

1. Houghton, E.L. and Carruthers, N.B. Aerodynamics for engineering students,
2. Edward Arnold Publishers, 1988.
3. Anderson, Jr., J.D. Introduction to Flight, McGraw-Hill International Edition, 1999
4. Nelson, R.C. Flight Stability & Automatic Control, McGraw Hill, 1998.

### **Project-**

- I. Students need to design an aircraft as per their choice, build a small-scale model and fly it.
- II. Designing and testing need to be done using Dassault system and wind tunnel. Structural part is not included in this scope of work

#### **Steps:**

1. Comparative configuration study of different types of aircraft.
2. Comparative study of specification and performance details of aircraft

3. Preparation of Comparative data sheets
4. Comparative graphs preparation and selection of main parameters for the design purpose of the aircraft
5. Preliminary weight estimations, selection of main parameters Power plant selection , aerofoil selection , wing , tail and control surfaces
6. Preparation of layouts of balance diagram and three view diagrams for the aircraft
7. Estimation of drag and preparing drag polar curve
8. Detailed performance calculations and stability analysis.
9. Make wind tunnel testing and compare with simulation result
10. Flight testing
11. Documentation

## Aircraft Structures (70 hrs)

Code	Course Title	Credit	T-P-PJ	Prerequisite
CUTM1098	Aircraft Structures	4	3-1-0	Theories of Failure Using Finite Element Analysis

### Course Objective

- To understand on analysis of aircraft structural components.
- To study the properties of materials used in Aircraft structure.
- To study the shear flow and stress analysis of wing and fuselage etc.

### Course Outcomes

At the end of the course, the Students will be able to....

- CO1: Understand the truss structure and find forces acting in the individual members deflections of the truss with the nature using different methods.
- CO2: Analysis the Shear flow and shear center in open and close sections
- CO3: Analyze the buckling characteristics of rectangular shear panels
- CO4: Understand crippling of panels and shear frailer of bolted and rivet and joints
- CO5: Analysis shear force and bending moment distribution over the aircraft wing and fuselage

### Course Outcome to Program Outcome and Program Specific Outcome Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	2	2	1	1	2	1	1	1	2		1
CO2	3	1	2	2	3	1	2	1	1	2	2	1		2	
CO3	3	1	2	2	3	1	1	1	1	3	2	1		2	
CO4	3	1	2	2	3	1	1	2	1	1	2		2		
CO5	3	1	2	2	3	1	1	1	1	1	2	2		1	

\* High-3, Medium-2, Low-1

### COURSE CONTENT

## Module I: Statically indeterminate structures

(9hrs)

### Theory

- Shear force and bending moment of fixed-fixed beam
- Propped cantilever beam, Continuous beam
- Clapeyron's Three Moment Equation
- Moment Distribution Method.

### Practice:

- Experiment 1.1: Bending stress of an indeterminate beams using 3D Experience Tool

## Module II: Energy methods

(9hrs)

### Theory

- Strain Energy in axial, bending, torsion and shear loadings.
- Castigliano's theorems and their applications.
- Energy theorems – dummy load & unit load methods – energy methods applied to statically determinate and indeterminate beams, frames & trusses.
- Deflection of indeterminate beams using energy method and unit load method

### Practice:

- Experiment 2.1: Deflection of beams using Dassult System Experience Tool free and forced Vibration of a Cantilever Beams using 3D Experience Tool

## Module III: Shear flow in open sections

(12hrs)

### Theory

- Thin-walled beams, Concept of shear flow and shear centre
- Elastic axis. Shear flow in single and multi-cell under bending with walls effective and ineffective
- One axis of symmetry, unsymmetrical beam sections.
- Structural constraint, Shear stress distribution in constrained open sections

### Practice:

- Experiment 3.1: Locate Shear Centre for open section

## Module IV: Shear flow in closed sections

(12 hrs)

### Theory

- Bredt-Batho formula.
- Shear flow in single and multi, cell closed structures under bending and torsion
- Shear stress distribution in constrained closed sections.

**Practice:**

- Experiment 4.1: Locate Shear Centre for closed section
- Experiment 4.2: Determination of Principal axis of Unsymmetrical beams

**Module V: Buckling of plates**

**(12 hrs)**

**Theory**

- Bending of thin plates.
- Rectangular sheets under compression.
- local buckling stress of thin walled sections.

**Practice:** Buckling load estimation of thin plates using 3DS / experimental

**(8 hrs)**

**Theory**

- Crippling stresses by Needham's and Gerard's methods.
- Thin-walled column strength. Sheet stiffener panels.
- Effective sheet width, inter rivet and sheet wrinkling failures

**Practice:**

- Experiment 6.1: Shear failure of bolted and riveted Joints.

**Module VII: Stress analysis of wing and fuselage**

**(8hrs)**

**Theory**

- Shear force and bending moment distribution over the aircraft wing.
- Shear force and bending moment distribution over the aircraft fuselage

**Practice:**

- Experiment 7.1: Stress Analysis of Wing and Fuselage using 3D Experience Tool

**Text Books:**

1. T.M.G. Megson, "Aircraft Structures for Engineering Students", Fifth edition, Butterworth-Heinemann, 2012.
2. D.J. Peery, "Aircraft Structures", Dover Publications Inc., 2011.
3. E.H. Bruhn. 'Analysis and Design of Flight Vehicles Structures', Tri-state off- set company, USA, 1985.
4. Timoshenko. S. and Young D.H. - "Elements of strength materials Vol. I and Vol. II"., T. Van Nostrand Co-Inc Princeton-N.J. 1990.

Reference Books:

1. B.K. Donaldson, "Analysis of Aircraft Structures - An Introduction", Second edition, Cambridge University Press, 2012.
2. Howard D Curtis, 'Fundamentals of Aircraft Structural Analysis', WCB- McGraw Hill, 1997.
3. R.M. Rivello, "Theory and Analysis of Flight Structures", McGraw Hill, 1993

E-BOOK

<http://www.freeengineeringbooks.com/AeroSpace/Aircraft-Structures-Books.php>

<http://libguides.hcc.hawaii.edu/aero>

[http://www.jdrr.yolasite.com/resources/Aeronautical\\_Engineering/BOOKS/Aircraft%20Structures%20by%20Megson%20-%20Book.pdf](http://www.jdrr.yolasite.com/resources/Aeronautical_Engineering/BOOKS/Aircraft%20Structures%20by%20Megson%20-%20Book.pdf)

## Aerospace Structural Analysis (120 hours)

Code	Course Title	Credit	T-P-PJ	Prerequisite
CUTM1099	Aerospace structural Analysis	6	3-0-3	Aircraft Structure

### Course Objective

- To provide the students an understanding on Aerospace Structures and Materials components.
- To study the shear stresses in wing, fuselage, wing spar, attachments
- To study velocity and load diagram for different condition

### Course Outcomes

At the end of the course, the Students will be able to....

- CO1: Understand Aerospace Structures and Materials uses
- CO2: Analysis fuselage wing for bending, shear tensional load
- CO3: Analysis wing spar for bending, shear tensional load
- CO4: Predict the failures of Aircraft fittings and connections
- CO5: Create V-N diagram with gust load

### Course Outcome to Program Outcome and Program Specific Outcome Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	2	2	1	1	1	1	1	1	2		1
CO2	3	3	3	2	2	1	2	1	1	2	2	1		2	
CO3	3	3	3	2	2	1	1	1	1	2	2	1		2	
CO4		3	2	2	2	1	1	2	2	2	2	2	2		
CO5		3	2	2	2	1	1	1	1	2	1	2		1	3

\* High-3, Medium-2, Low-1

### COURSE CONTENT

**Module I: Aerospace Structures and Materials uses**

(24 hrs)

## Theory

- Monocoque, semi-monocoque, corrugated structure.
- Sandwich structure, reinforced and honeycomb structures,
- Aerospace materials, metallic and nonmetallic materials, use of aluminum alloy, titanium, stainless steel,
- Composite and ceramic materials.

## Module II: Analysis of wings

(20 hrs)

### Theory

- Basics of aircraft components and functions of parts,
- Construction concepts for wing, control surfaces and tail plane.
- Analysis of multi-cell wing structures for bending, shear and torsional loads.
- Method of successive approximation, analysis of ribs, cut outs in wings.

## Module III: Analysis of fuselage

(16 hrs)

### Theory

- Construction concepts for fuselage,
- Analysis of fuselage structures for bending, shear and torsional loads.
- Analysis of fuselage frames, cut outs in fuselages.

## Module IV: Analysis of wing spar

(20hrs)

### Theory

- Types of spar construction, diagonal tension concept, semi-diagonal tension concept,
- Design of spar web: shear resistant, diagonal tension, semi-diagonal tension web.
- Analysis of parallel and tapered spar.

## Module VI: Aircraft fittings and connections

(25 hrs)

### Theory

- Types of aircraft fittings, Wing to spar attachments,

- Single bolt fittings, Multi bolt fittings, Bolt group analysis, Shear, bending and tensile failures of bolts,
- Analysis of lugs to normal and oblique loadings. Riveted connections and strength of rivets.

## **Module VII: V-N diagram with gust load**

**(15 hrs)**

### **Theory**

- Loads on an aircraft for different condition,
- V-n diagram

### **Project-**

Students are expected to complete following

- Perform structural calculations establish the structural requirements and constraints apprehend the applicable structural standards for an aircraft
- Perform structural calculations such as buckling, natural mode and frequencies, fatigue, flutter speed, reserve factor, stress analysis on various aircraft sections and design concepts for appropriate aircraft loads. Various analyses to be performed are free-free analysis, normal modes, linear and nonlinear analysis, buckling and post buckling analysis.
- Joint and fastener calculations, attachment lugs etc.
- Perform fatigue life and crack growth analysis through selection of critical primary and secondary locations on structure
- Carry out optimization on the finalized design concepts and make final layout.

### **Steps:**

1. V-n diagram for design study
2. Critical loading performance and final V-n graph calculation
3. Gust and maneuverability envelopes.
4. Structural design study-Theory approach
5. Load estimation of wings
6. Wing spar and stringer calculation
7. Wing shear flow calculation
8. Load estimation of fuselage
9. Fuselages hear flow calculations
10. Design of miscellaneous members
11. Detailed structural layouts.
12. Complete the documentation

*Text Books:*

1. T.M.G. Megson, “Aircraft Structures for Engineering Students”, Fifth edition, Butterworth- Heinemann, 2012.
2. E.H. Bruhn, “Analysis and Design of Flight Vehicles Structures”, Tri-state off- set company, USA, 1985.
3. D.J. Peery and J.J. Azar, “Aircraft Structures”, 2nd edition, McGraw – Hill, N.Y., 1999.
4. S. Timoshenko and D.H. Young, “Elements of strength materials Vol. I and Vol. II”., T. Van Nostrand Co-Inc Princeton-N.J. 1990.

*Reference Books:*

1. B.K. Donaldson, "Analysis of Aircraft Structures - An Introduction", Second edition, Cambridge University Press, 2012.
2. Howard D Curtis, ‘Fundamentals of Aircraft Structural Analysis’, WCB- McGraw Hill, 1997.
3. R.M. Rivello, “Theory and Analysis of Flight Structures”, McGraw Hill, 1993.

## Jet Propulsion (70 Hours)

Code	Course Title	Credit	T-P-PJ	Prerequisite
CUTM1100	Jet Propulsion	4	3-1-0	Thermodynamics

### Course Objective

- Students will be able to understand the internal flow and external characteristics near the inlets. Starting problems and different modes of operation in supersonic inlets.
- Students will be able to Know the types and working principles of axial compressors and centrifugal compressors its velocity diagrams, blade design and performance characteristics of compressors.
- Students will get understanding the types and working methods in combustion chambers, the flame stabilization and flame techniques and understand the flow through nozzle, choking, losses in nozzle, variable area nozzle and thrust vectoring.

### Course Outcomes

At the end of the course, the Students will be able to....

- CO1: Illustrate the working principle and performances of various parts of jet Engines.
- CO2: Interpret the types , working principles and performances of axial compressors and centrifugal compressors.
- CO3: Compare the types, working methods and performances in combustion chambers.
- CO4: Describe the types and working methods in combustion chambers, the flow through nozzle, choking, losses in nozzle, variable area nozzle and thrust vectoring.
- CO5: Explain the Thrust Augmentation process and methods.

### Course Outcome to Program Outcome and Program Specific Outcome Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	2	2	2	2	2	1		1	2		
CO2	3	3	3	2	2	2	2	2	2	1		1	2		
CO3	3	3	3	2	2	2	2	2	2	1		1		2	
CO4		3	2	2	2	2	2	2	2	1		1		2	
CO5		3	2	2	2	2	2	2	2	1		1		2	

\* High-3, Medium-2, Low-1

### COURSE CONTENT

## **Module I: Introduction to aircraft Propulsion**

**(10 hrs)**

### **Theory**

- Introduction to propulsion, Fundamental equations,
- Types of aircraft engines Performance parameters, thrust equation,
- Factors affecting thrust and efficiencies.

### **Practice:**

- Experiment 1.1: Assembly of an aircraft piston engine and Study of an aircraft piston engine, various components, their functions and operating principles

## **Module II: Diffuser**

**(10 hrs)**

### **Theory**

- Subsonic inlet and Internal flow, Major features of external flow,
- Relation between minimum area ratio and external deceleration ratio,
- Supersonic inlets, Starting problem on supersonic inlets,
- Shock swallowing by area variation, External deceleration, Modes of inlet operation.

### **Practice:**

- Experiment 2.1: Velocity and pressure variation in a diffuser using 3DS as well as using apparatus

## **Module III: Axial compressor**

**(12 hrs)**

### **Theory**

- Working principle of axial compressor, Elementary theory, Velocity triangles, Degree of reaction,
- Three dimensional flow, Compressor blade design & stage performance calculation,
- Factors affecting stage pressure ratio, off design performance, Axial compressor performance characteristics.

### **Practice:**

- Experiment 3.1: Assembly of an aircraft jet engine compressor

## **Module IV: Centrifugal compressor**

**(10 hrs)**

### **Theory**

- Working principle of centrifugal compressor, Work done and pressure rise,
- Inducer and impellor, Velocity diagrams, Compressor stage design,
- Concept of pre whirl, Rotation stall, Centrifugal compressor performance characteristics.

**Practice:**

- Experiment 4.1: Cascade testing of a model of axial compressor blade row

**Module V: Combustion chambers**

**(10 hrs)**

**Theory**

- Classification of combustion chambers, Important factors affecting combustion chamber design, Combustion process, Combustion chamber performance,
- Effect of operating variables on performance, Flame tube cooling, Flame stabilization, Use of flame holders, Numerical problems.

**Practice:**

- Experiment 5.1: Determination of heat of combustion of aviation fuel

**Module VI: Nozzles**

**(10hrs)**

**Theory**

- Theory of flow in isentropic nozzles, Convergent nozzles and nozzle choking,
- Nozzle throat conditions, Nozzle efficiency, Losses in nozzles,
- Over expanded, under expanded nozzles, Ejector and variable area nozzles

**Practice:**

- Experiment 6.1: Velocity and pressure variation in a high-speed nozzle using 3DS

**Module VII: Afterburner and thrust augmentation**

**(08 hrs)**

**Theory**

- Working principle of afterburner, afterburner augmentation,
- Thrust and efficiency,

**Practice:**

- Experiment 7.1: Characteristic plots of a free jet through a non-circular and circular orifice using high speed jet

Text Books:

1. N.K. Giri Automobile Engineering, Khanna Publishers 2014
2. Newton and Steeds - Motor Vehicle- Illiffee Publisher- 2010

Reference Books:

1. Hill,  
P.G.&Peterson,C.R."Mechanics&ThermodynamicsofPropulsion"Addison-WesleyLongman INC,  
2014
2. V Ganesan, "Gas Turbines", McGraw-Hill Education, 2010
3. Mathur,M.L and Sharma,R.P, "Gas Turbine Jet and Rocket Propulsion", Standard  
Publishers &Distributors, Delhi,2014

## Advanced Propulsion (60 Hours)

Code	Course Title	Credit	T-P-PJ	Prerequisite
CUTM1101	Advanced Propulsion	3	2-1--0	Jet Propulsion

### Course Objective

- To explore Ramjet, Scram jets and supersonic combustion working principles.
- To impart practical knowledge of solid and liquid propellants
- To determine practically thrust developed by rocket propellants.

### Course Outcomes

At the end of the course, the Students will be able to....

- CO1: Understands the operating principle of ramjet, scramjet and its performance.
- CO2: The various supersonic combustion and their performance
- CO3: Analyze operating principle and design aspect of rocket propulsion
- CO4: Summarize solid liquid propellant rocket
- CO5: Analysis various advanced propulsion systems.

### Course Outcome to Program Outcome and Program Specific Outcome Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	3	3	2	2	2	2	2		2	2		
CO2	3	3	3	3	3	2	2	2	2	2		2	2		
CO3		3	2	3	3	2	2	2	2	2		2		2	
CO4	3	3	2	1	2	2	2	2	2	2		2		2	
CO5	3	3	2	1	2	2	2	1	2	2		2		2	3

\* High-3, Medium-2, Low-1

### COURSE CONTENT

## **Module I: Ramjet propulsion**

**(8 hrs)**

### **Theory**

- Operating principle, Sub critical, critical and supercritical operation,
- Combustion in ramjet engine, Ramjet performance.

### **Practice:**

- Experiment 1.1: Wall pressure measurements of a subsonic diffusers and ramjet ducts

## **Module II: Scramjet propulsion**

**(8 hrs)**

### **Theory**

- Introduction to scramjet, operating principle,
- Combustion in scramjet engine, Pulse jet, difference between Ramjet scramjet

### **Practice:**

- Experiment 2.1: Velocity profiles of wall jets.

## **Module III: Supersonic combustion**

**(8 hrs)**

### **Theory**

- Fundamentals of hypersonic air breathing vehicles, Preliminary concepts in engine airframe integration,
- Various types of supersonic combustors, Requirements for supersonic combustors,
- Performance estimation of supersonic combustors.

### **Practice:**

- Experiment 3.1: Flame stabilization studies using conical and hemispherical flame holders

## **Module IV: Rocket propulsion**

**(12 hrs)**

### **Theory**

- Operating principle, specific impulse of a rocket, internal ballistics, performance characteristics of rockets, simple rocket design problems,
- Types of igniters, rocket nozzle classification, preliminary concepts in nozzle,
- Less propulsion, air augmented rockets, pulse rocket motors, static testing of rockets & instrumentation, safety considerations

### **Practice:**

- Experiment 4.1: Wall Pressure measurements of supersonic nozzle

### **Module V: Solid propellant rockets**

**(8 hrs)**

#### **Theory**

- Solid propellant rockets, Selection criteria of solid propellants, hazards
- Important hardware components of solid rockets, Propellant grain design considerations,
- Combustion of solid propellants, Numerical problems.

#### **Practice:**

- Experiment 5.1: Preparation of solid propellant

### **Module VI: Liquid propellant rockets**

**(8 hrs)**

#### **Theory**

- Liquid propellant rockets, Selection of liquid propellants,
- Thrust control in liquid rockets, Cooling in liquid rockets, Limitations of hybrid rockets,
- Relative advantages of liquid rockets over solid rockets, Numerical Problems.

#### **Practice:**

- Experiment 6.1: Determination of Thrust and heat of combustion of aviation fuel.

### **Module VII: Advanced propulsion systems**

**(8 hrs)**

#### **Theory**

- Electric rocket propulsion: Electrostatic, Electro thermal, Electromagnetic thruster, Ion propulsion techniques,
- Nuclear rocket propulsion: Types, applications, Solar propulsion system, solar sail.

#### **Text Books:**

1. Sutton, G.P., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 5th Edition, 1993.
2. Hill, P.G. & Peterson, C.R. "Mechanics & Thermodynamics of Propulsion" Addison - Wesley Longman INC, 1999.

#### **Reference Books:**

1. Gorden, C.V., "Aero thermodynamics of Gas Turbine and Rocket Propulsion", AIAA Education Series, New York, 1989.
2. Mathur, M., and Sharma, R.P., "Gas Turbines and Jet and Rocket Propulsion", Standard Publishers, New Delhi, 1988. Basics of scramjet engine and integral ram engine.

*<http://nptel.ac.in/courses/101106033/>*

<http://nptel.ac.in/courses/101101001/>  
<http://nptel.ac.in/courses/101101002/>  
<https://www.youtube.com/watch?v=HESOat2iPzU>

## Experimental Aerodynamics (60 Hours)

Code	Course Title	Credit	T-P-PJ	Prerequisite
CUTM1102	Experimental Aerodynamics	3	2-1-0	Aerodynamics

### Course Objective

- To provide knowledge about different types of wind tunnel and limitations
- It enables students to be familiar with data acquisition methods pertaining to experiments in aerodynamics.
- To get exposure on flow visualization techniques pertaining to subsonic flow

### Course Outcomes

At the end of the course, the Students will be able to....

- CO1: To provide about the subsonic and high-speed wind tunnel. To provide Knowledge on measurement techniques in aerodynamic flow.
- CO2: To cover both operating and application procedures of hot wire anemometer.
- CO3: To describe flow visualization techniques and to highlight in depth discussion of analog.
- CO4: Analyze different flow visualization methods
- CO5: Understand Hot wire anemometer and laser Doppler anemometer

### Course Outcome to Program Outcome and Program Specific Outcome Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	1	1	2	2	2	2	2	2		2	2		
CO2	3	2	2	2	1	1	2	2	2	2		2		2	
CO3		3	2	1	2	3	1	2	2	2		2		2	
CO4	3	3	2	1	2	1	2	2	2	2		2		3	
CO5	3	3	2	1	2	1	2	2	2	2		2		1	

\* High-3, Medium-2, Low-1

### COURSE CONTENT

**Module I: Subsonic wind tunnels**

(8 hrs)

## Theory

- Non-dimensional numbers Layout of open circuit and closed-circuit subsonic wind tunnels
- Design parameters-energy ratio - HP calculations. Calibration

## Practice-

- Experiment 1.1: Calibration of subsonic wind tunnel

## Module II: Instruments and measurement in subsonic flow (10 hrs)

### Theory

- Pressure, velocity and temperature instruments and measurements,
- Force measurements – types of balances, Three component and six component balances. \
- Wind tunnel balance (Wire balance, Strut-type, Platform-type, Yoke-type -Pyramid type) and Strain gauge balance

### Practice-

- Experiment 2.1: Lift, Drag and moment measurement by using six component balances

## Module III: High Speed Wind tunnel (10 hrs)

### Theory

- Blow down, in draft and induction tunnel layouts and their design features,
- Transonic, supersonic and hypersonic tunnels, their peculiarities and calibration.
- Helium and gun tunnels, Shock tubes,

## Module IV: Experiments in High-Speed Tunnels (8 hrs)

### Theory

- Mach number estimation in test section by pressure measurement and using a wedge
- Preliminary estimates of blowing and running pressures, nozzle area ratios, mass flow for a given test section size and Mach number.

### Practice-

- Experiment 4.1: Velocity and pressure distribution in a supersonic nozzle.

## Module V: Special problem in testing (8 hrs)

### Theory

- Pitot-static tube correction for subsonic and supersonic Mach numbers.
- Geometric, dynamic and kinematic similarity. Solid blockage, horizontal bounce,
- Calibration of instruments.

### **Module VI: Hot wire anemometer and laser Doppler anemometer (8 hrs)**

#### **Theory**

- Hot wire anemometer and laser Doppler anemometer for turbulence and velocity measurements.
- Use of thermocouples and pyrometers for measurement of static and total Temperatures-  
Use of pressure transducers.
- Rotameters and ultrasonic flow meters.

#### **Practice-**

- Experiment 6.1: Boundary layer velocity profile on a flat plate using Hot wire anemometer

### **Module VII: Flow Visualization Methods (8 hrs)**

#### **Theory**

- Smoke and Tuft grid techniques
- Dye injection special techniques
- Optical methods of flow visualization.

#### **Practice-**

- Experiment 7.1: Flow Visualization in subsonic and supersonic flow (Smoke technique in subsonic and Schlieren systems in supersonic flow.

#### *Text Books:*

1. *Name of Author, Title, Publication, Edition*
2. Rae W.H and Pope. A “Low speed wind tunnel testing” John Wiley Publication, 1984
3. Rathakrishnan. E “Instrumentation, Measurement and Experiments in Fluids”, CRC Press, London, 2007

#### *Reference Books:*

1. Pope. A and Goin. L “High speed wind tunnel testing” John Wiley, 1985
2. Bradsaw “Experimental Fluid Mechanics”, Elsevier, 2nd edition, 1970.

## Space Dynamics (60 Hours)

Code	Course Title	Credit	T-P-PJ	Prerequisite
CUTM1103	Space Dynamics	3	2-1-0	Introduction to Aerospace Engineering

### Course Objective

- To understand the basic concepts of space mechanics and the general N- body.
- To get idea to Study satellite injection and satellite orbit perturbations.
- Get acquire the knowledge of interplanetary and ballistic missile trajectories.

### Course Outcomes

At the end of the course, the Students will be able to....

- CO1: Understand solar system, atmosphere, and different coordinate system
- CO2: Described space environment and materials requirements
- CO3: Describe general N body problems
- CO4: Understand satellite injection and general orbit perturbation
- CO5: Describe different interplanetary trajectory and their performances

### Course Outcome to Program Outcome and Program Specific Outcome Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 2
CO1	3	2	2	2	2	2	2	2	2	2		2	1		
CO2	3	3	3	2	2		2	2	2	2		2		2	
CO3	3	3	3	2	2		2	2	2	2		2	1		
CO4		3	2	2	2		2	2	2	2		2	2		
CO5		3	2	2	2		2	2	2	2		2	2		

\* High-3, Medium-2, Low-1

### COURSE CONTENT

## **Module I: Basic Concepts**

**(10 hrs)**

### **Theory**

- The solar system, reference frame and coordinate systems,
- The celestial sphere, the ecliptic, sidereal time, solar time, standard time,
- The earth atmosphere, basic vector calculus, kinematics, Euler's angles.

## **Module II: Space Environment**

**(9 hrs)**

### **Theory**

- Peculiarities of space environment and its description,
- Effect of space environment on materials of spacecraft structure and astronauts,
- Manned space missions, effect on satellite lifetime.

## **Module III: The General N-Body Problem**

**(8 hrs)**

### **Theory**

- Kepler's laws of planetary motion, Newton's universal law of gravitation.
- The N-body problem, circular restricted three body problem, liberation points, two body problem.
- Satellite orbits, relation between position and time, orbital element.

## **Module IV: Satellite Injection**

**(6 hrs)**

### **Theory**

- General aspects of satellite injections, satellite orbit transfer.
- Various cases, orbit deviations due to injection errors.

## **Module V: Satellite Orbit Perturbations**

**(9 hrs)**

### **Theory**

- Special and general perturbations, Cowell's method.
- Encke's method, method of variations of orbital elements, general perturbations approach.

## **Module VI: Interplanetary Trajectories**

**(12 hrs)**

### **Theory**

- Two-dimensional interplanetary trajectories, fast interplanetary trajectories
- Three-dimensional interplanetary trajectories, launch of interplanetary spacecraft
- Trajectory estimation about the target planet.

## **Module VII: Rocket Performance**

**(6 hrs)**

### **Theory**

- The boost phase, the ballistic phase, trajectory geometry,
- Optimal flights, time of flight, re-entry phase, the position of the impact point, influence coefficients.

### **Text Books:**

1. Cornelisse, J.W., Rocket Propulsion and Space Dynamics, W.H. Freeman & co, 1984.
2. Thomson, Introduction to Space Dynamics, Dover Publications, Revised edition, 2012.

### **Reference Books:**

1. Van de Kamp, P., Elements of Astro mechanics, Pitman, 1979  
William E. Wiesel, Space Flight Dynamics, Create Space Independent Publishing Platform, 3rd Edition, 2010, ISBN-13: 978-1452879598
2. George P. Sutton and Oscar Biblarz, Rocket Propulsion Elements, Wiley India Pvt. Ltd, 7th edition, 2010, ISBN-13: 978-8126525775.

## Introduction to Avionics (60 Hours)

Code	Course Title	Credit	T-P-PJ	Prerequisite
CUTM1104	Introduction to Avionics	3	2-1-0	Introduction to Aerospace Engineering

### Course Objective

- To introduce the basics of avionics and its need for civil and military aircrafts
- To gain more knowledge on various avionics subsystems
- To get idea on navigation systems

### Course Outcomes

At the end of the course, the Students will be able to....

- CO1: Ability to build Digital avionics architecture.
- CO2: Ability to Design Navigation system.
- CO3: Analyze types of flight decks and different display technologic in cockpit
- CO4: Summaries the faction of air data systems and auto pilot
- CO5: ability to design and perform analysis on air system.

### Course Outcome to Program Outcome and Program Specific Outcome Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 2
CO1	3	2	1	1	1	2	2	2	2	3		2	1		
CO2	3	2	1	2	1	2	2	2	2	3		2		2	
CO3	3	3	1		1	2	2	2	2	3		2	1		1
CO4	3	3	1		2	2	2	2	2	3		2	2		
CO5		3	2	1	1	2	2	2	2	3		2		1	1

\* High-3, Medium-2, Low-1

## COURSE CONTENT

### Module I: Introduction to avionics (8 hrs)

#### Theory

- Need for avionics in civil and military aircraft and space systems,
- Avionics systems essentials integrated avionics and weapon systems-
- Typical avionics subsystem, design, technologies.

#### Practice-

- Experiment 1.1: Addition/ subtraction of binary numbers.

### Module II: Digital avionics architecture (8 hrs)

#### Theory

- Introduction to digital computer and memories,
- Digital Communication, Digital Data Bus System.

#### Practice-

- Experiment 2.1: Timer Circuits, Shift Registers, Binary Comparator Circuits.

### Module III: Avionics system architecture (8 hrs)

#### Theory

- Data buses– MIL-STD-1553B – ARINC– 420 – ARINC – 629

#### Practice-

- Experiment 3.1: *Encoder*/Decoder Circuits

### Module IV: Flight decks and cockpits (10 hrs)

#### Theory

- Control and display technologies: CRT, LED, LCD, EI and plasma panel
- Touch screen–Direct voice input (DVI)
- Civil and Military Cockpits: MFDS, HUD, MFK, HOTAS.

#### Practice-

- Experiment 4.1: Addition and Subtraction of 8-bit and 16-bit numbers.

## Module V: Introduction to navigation systems

(8 hrs)

### Theory

- Radio navigation- ADF, DME, VOR, LORAN, DECCA, OMEGA, ILS, MLS.
- Inertial Navigation Systems(INS), Inertial sensors and Navigation systems, Multi-sensors Navigation Systems, INS block diagram.

### Practice-

- Experiment 5.1: Interface programming with 4-digit 7 segment Display & Switches & LED's

## Module VI: Satellite navigation systems

(10 hrs)

### Theory

- landing systems

### Practice-

- Experiment 6.1: *Greatest* in a given series & multi-byte addition in BCD mode

## Module VII: Air data systems and auto pilot

(8 hrs)

### Theory

- Air data quantities–Altitude, Airspeed, Vertical speed, Mach Number
- Total air temperature, Mach warning, Altitude warning
- Auto pilot– Basic principles, Longitudinal and lateral auto pilot.

### *Text Books:*

1. Albert Helfrick.D., "*Principles of Avionics*", Avionics Communications Inc., 2004
2. Collinson.R.P.G. "*Introduction to Avionics*", Chapman and Hall, 1996.

### *References:*

- 1.Spitzer,C.R. "*Digital Avionics Systems*", Prentice-Hall, Englewood Cliffs, N.J., U.S.A.1993.

## Thermodynamics (60 hours)

Code	Course Title	Credit	T-P-PJ
CUTM1088	Thermodynamics	3	2-1-0

### Course Objectives

- To know the laws of thermodynamics and conditions for energy transformation.
- To get familiar with different thermodynamic properties of pure substances.
- To learn the properties of pure substances.

### Course Outcomes:

**After the completion of the course, the students will be able to:**

- **CO1:** Remember different system and properties of thermodynamics
- **CO2:** Understand different processes and laws of thermodynamics
- **CO3:** Apply thermodynamic principles to solve engineering problems related to heat transfer and energy conversion.
- **CO4:** Analyze the entropy change for different thermodynamic processes
- **CO5:** Evaluate the quality and property of different types steams

### Course Outcome to Program Outcome Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1		1	2	2	2	3	3		2			
CO2	3	1	1		1	2	2	2	3	3		2			
CO3	2	2	3	3	2	2	2	2	3	3		2			
CO4	3	2	2		2	2	2	2	3	3		2			
CO5	3	2	1		1	2	2	2	3	3		2			

**\*High-3, Medium-2, Low-1**

## **Course Syllabus:**

### **Module I: Basic Concepts of Thermodynamics (8 hours)**

#### **Theory**

System, Surroundings, Universe, State, Thermodynamic Properties, Process, Types of Process, Reversible and Irreversible process, Quasi-static Process, Cycle, Point and path functions, Thermodynamic Equilibrium, Ideal gas, Ideal gas equation

### **Module II: Zeroth Law of Thermodynamics (8 hours)**

#### **Theory**

Zeroth Law of Thermodynamics, Temperature, Measurement of Temperature, Temperature Measuring Instruments, Relationship between Temperature Scales

#### **Practice**

Experiment 1: Temperature Measurement by using Thermocouple, Thermistors and Resistance Temperature Detector (RTD)

### **Module III: Work Transfer and Heat Transfer (12 hours)**

#### **Theory**

Work Transfer, Sign Convention of Work, PdV Work for Various Quasistatic Processes, Heat Transfer, Different Modes of Heat Transfer

#### **Practice**

Experiment 2: Simulation of Heat Transfer in Conduction, Convection and Radiation using Finite Element Method in Simulia (Plane Wall, Fin, Metal Rod)

Experiment 3: Thermal Stress Analysis of IC Engine Piston using Simulia

Experiment 4: Thermal Analysis of Intake Manifold of Engine using Simulia

### **Module IV: First Law of Thermodynamics (8 hrs)**

## **Theory**

First Law of Thermodynamics Applied to Closed System, Energy, PMM1, Enthalpy, Specific Heat at Constant Volume and Constant Pressure, First Law of Thermodynamics Applied to Open System, Control Volume, Mass Balance and Energy Balance, Nozzle, Diffuser, Turbine, Compressor, Throttling Device, Heat Exchanger

## **Practice**

Experiment 5: Thermal Analysis of Nozzle, Diffuser, Turbine, Compressor, Boiler, Heat exchanger using Simulia

## **Module V: Second Law of Thermodynamics (6 hrs)**

### **Theory**

Kelvin Planks statement, Clausius Statement, PMM2, Working of Heat Engine, Refrigerator and Heat Pump, Carnot Cycle & Carnot Theorem

### **Practice**

Experiment 6: Working of Refrigerator and Heat Engine

## **Module VI: Entropy (8 hours)**

### **Theory**

Introduction to Entropy, Principle of Increase of Entropy, Clausius Inequality, Change in Entropy in Different Processes

### **Practice**

Experiment 7: Entropy Change of Metal Bar with Temperature Gradient using Simulia

## **Module VII: Properties of Pure Substances (10 hours)**

### **Theory**

Introduction to Pure Substance, Phase Change Processes of Pure Substances, T-V, P-V, P-T and H-S Diagram for Steam, Dryness Fraction of Steam, Different Types of Steam. Introduction to Steam Tables: Specific Volume, Pressure, Temperature, Enthalpy and Entropy

### **Practice**

Experiment 9: Conversion of water to steam

Experiment 10: Determination of properties of steam from Mollier Chart

### **Text Books:**

1. Y.A Cengel, M. A Boles, "Thermodynamics an Engineering Approach", Tata Mcgraw-Hill Publishing Company Limited
2. P.K. Nag, "Engineering Thermodynamics", Tata Mcgraw-Hill Publishing Company Limited

### **Reference Books:**

1. Sontag,Borgnakke, Van Wylen, " Fundamentals of Thermodynamics", Willey
2. R K Rajput, "A Text Book of Engineering Thermodynamics ", Laxmi Publications

### Fluid Mechanics with FVM (60 hours)

Code	Course Title	(Credit)	T-P-PJ
CUTM1089	Fluid Mechanics with FVM	3	2-1-0

#### Course Objectives:

- To learn fundamentals of computational methods like FVM for solving linear and non-linear partial differential equations related to fluid dynamics.
- To emphasize the basic underlying fluid mechanical principles, governing energy transfer in a fluid flow system with their performances in different field of engineering applications.
- To use numerical methods and computational tools to analyze fluid flow problems.

#### Course Outcomes:

**After the completion of the course, the students will be able to:**

- **CO1:** Gain Knowledge on Finite Volume Method, discretize diffusion and convection-diffusion equation used in fluid flows.
- **CO2:** Apply and understand how to implement in getting stable results for pressure and velocity in different grids.
- **CO3:** Analyze the Bernoulli's equation to the fluid flow problems and to determine lift and drag forces on a submerged body.
- **CO4:** Evaluating for Navier-stokes equation with the Fluid kinematics Fluid Dynamics problems in fluid flows Scenarios.
- **CO5:** Create appropriate equations and principles to analyze pipe flow problems and measuring devices.

## Course Outcome to Program Outcome Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2		3	1	2	2	2	3	3		2	2		1
CO2	3	3	1	3	2	2	2	2	3	3		2	2	2	1
CO3	2	3	2	2	2	2	2	2	3	3		2	3	3	
CO4	1	3	2	1	3	2	2	2	3	3		2	3	3	
CO5	1	2	3	1	2	2	2	2	3	3		2	2		1

**\*High-3, Medium-2, Low-1**

### Course Syllabus:

#### Module I: Introduction to FVM (12 hours)

##### Theory

Need to Study FVM Types of Fluid Flow Analysis, Discretization of fluid Flow Equations, Meshing in the fluid domain, convergence, stability, and consistency in FVM

Types of Boundary Condition, General Procedure for FVM used in Fluid Flow Analysis.

##### Practice

Experiment 1: Introduction to SIMULIA- 3D Experience Platforming FVM Simulation Setup- Assigning Materials to fluid extraction models, Generating Output parameters for fluid flow calculations.

Experiment 2: 3D Unstructured Mesh of Circular pipe.

Experiment 3: 3D structure mesh of Circular Cylinder

#### Module II: Governing Equations of Flow Field (6 hours)

##### Theory

Control volume, Conservation Laws, Navier-stokes equation (Conservation of Mass, Momentum (Navier-Stoke Equation and Energy)- Differential Form, Integral Form.

Lagrangian and Eulerian Approaches, Classification of Fluid Flow, Fluid, Properties of Fluid

### **Practice**

Experiment 4: 3D unstructured mesh of Circular sphere

### **Module III: Incompressible Inviscid Flow and Flow Kinematics (10 hours)**

#### **Theory**

Bernoulli equations, static, stagnation, dynamic Pressure, streamlines, streaklines, pathlines, timelines, vorticity and rotationality in fluid flow kinematics

#### **Practice**

Experiment 5: Reynolds's Experiment in pipe

Experiment 6: Fluid Analysis of Bernoulli's equation: Flow in a contracting pipe through CFD simulation

### **Module IV: Internal Incompressible viscous Flow (8 hours)**

#### **Theory**

Laminar and Turbulent Flow in pipes, Minor Losses, Hagen Poiseulle Equation for laminar flow through the pipe, Darcy-Weisbach Equation for Turbulent flow through the pipe, Reynolds's Experiment.

#### **Practice**

Experiment 7: Simulation of Fluid Analysis of Laminar flow in 3D Circular Pipe.

Experiment 8: Determining the frictional losses in the pipe.

### **Module V: External Incompressible viscous flow (8 hours)**

#### **Theory**

Drag and lift, Friction and Pressure drag, Flow over Cylinder and spheres, Flow separation, Effect of surface roughness.

#### **Practice**

Experiment 9: Simulation of External Fluid Analysis over 3D Sphere

### **Module VI: Compressible Flow (6 hours)**

#### **Theory**

Propagation of Sound Waves, the Mach Cone, stagnation Properties, Isentropic Flow through Nozzles.

### **Practice**

Experiment 10: CFD Simulation of the Water Flow Passing Through a Converging Pipe.

### **Module VII: Flow Measurements (10 hours)**

#### **Theory**

Orifice, Venturi, Nozzle meters, Pitot tube, Rotameters, Hotwire and Hot Film Anemeters

Particle Image Velocimetry, Flow rate Measurement in channel- Weir and Notches

#### **Practice**

Experiment 11: CFD Analysis of Fluid flow through Orifice meter

Experiment 12: CFD Analysis of Fluid flow through adjustable channel

Experiment 13: Analysis of Fluid flow simulation through Venturi Meter

## Theories of Failure Analysis using FEA (80 hours)

Code	Course Title	Credit	T-P-Pj
CUTM1062	Theories of Failure Analysis using FEA	4	2-2-0

### Course Objectives

- To educate the students on basic theories behind mechanics of solids.
- To educate the students on Finite Element Analysis concept applicable to Practical conditions.
- To educate the students on using 3D Experience Tools for analysis of various mechanical structures and load transmitting elements.

### Course Outcomes

After the completion of the course, the students will be able to:

- CO1: Gain knowledge on basic theory and practical engineering skills strength analysis and load transmission of elements
- CO2: Apply the basic principles of failure criteria to practical problems
- CO3: Deploy 3D experience platform to develop design solutions
- CO4 : Analyze the performance of various practical problems based on input data
- CO5: Create simulation scenario for static and dynamic structural analysis

### Course Outcome to Program Outcome Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3		1	2		2	2	2	3	3		2	1		1
CO2	2	2	2	2	3	2	2	2	3	3		2	1	2	1
CO3	1	2	3	2		2	2	2	3	3		2	1	3	
CO4	2	3	3	2	3	2	2	2	3	3		2	3	3	
CO5	3	3	3	2	3	2	2	2	3	3		2	2		1

\*High-3, Medium-2, Low-1

## Course Syllabus:

### Module I: Introduction to Finite Element Analysis (FEA) (13 Hours)

#### Theory

**Introduction to FEA:** Need for Studying FEA; Types of Analysis; Types of Elements and Nodes; Discretization, Mesh Refining, Element Aspect Ratio, Use of Symmetry, Principle of Convergence; Stiffness Matrix for Different Types of Elements, General Procedure of FEA, FEA Application to Axially Loaded Bars.

#### Practice

Experiment 1: Introduction to SIMULIA- 3D Experience Platforming FEA Simulation Setup- Assigning Materials to 3d Models, Generating Output parameters for strength calculations.

Link: Structural Scenario Creation in 3DEXP | Simulation | FEA |  
<https://youtu.be/kAkbqeEllxg>

Experiment 2: Performing a Tensile Test Simulation for 3D circular bar (ASTM Standard Mild Steel Specimen).

Link: Linear Static Analysis of a Bracket Part Using Structural Designer SIMULIA App.  
<https://youtu.be/12vJCeMqYms>

### Module II: Simple and Complex Stress System (12 Hours)

#### Theory

**Simple Stress System:** Types of Stresses and Strains, Hooke's Law, Elastic Constants, Stress-strain Diagrams for Ductile and Brittle Materials, Bars of Varying Cross-sections.

**Complex Stress System:** Stresses on Inclined Planes, Principal Planes and Principal Stresses, Maximum Shear Stress, Mohr's Circle of Stress.

#### Practice

Experiment 3: Stress-Strain Curve of a Ductile Material (ASTM Standard Mild Steel Specimen) using Universal Testing Machine

Experiment 4: Performing Mohr's Circle of Stress.

Link: <https://youtu.be/KgLXhOYWmxk>

### Module III: Beam Analysis (12 Hours)

#### Theory

**Shear Force and Bending Moment:** Types of Supports, Beams and Loading, Procedure for Drawing Shear Force and Bending Moment Diagrams, Point of Contra-flexure.

**Bending Stresses (No Derivation):** Simple or Pure Bending, Flexure Formula, Section Modulus, Neutral Axis, Bending and Shear Stresses Distribution.

## Practice

Experiment 5: Performing Shear force bending moment diagram considering Point loads and UDL for 3D simulation of cantilever beam.

Link: [https://youtu.be/yG\\_0c-fz5Xs](https://youtu.be/yG_0c-fz5Xs)

Experiment 6: Performing Shear force bending moment diagram considering Point loads and UDL for 3D simulation of simple supported beam.

Link: <https://youtu.be/8k0IFA4inrc>

## Module IV: Deflection in Beam (12 Hours)

### Theory

**Deflection in Beams (No Derivation):** Equation of Elastic Curve, Calculation of Slope and Deflection by Direct Integration Method and Moment Area Method.

### Practice

Experiment 7: Static simulation of loaded beams.

## Module V: Theories of Failure (12 Hours)

### Theory

**Theories of Failure:** Failure Under Biaxial Loading, Different theories of failure, Graphical Representation of Failure, Safety Factors, Prevention of Failure in Design Stage.

**Fatigue Failure:** Failure under Cyclic Loading, Endurance Limit, S-N Curve, Stress Concentration.

### Practice

Experiment 8: 3D simulation of Bicycle Frame Structural Analysis

Experiment 9: 3D simulation of Fatigue Analysis of Crankshaft of Two-Wheeler

## Module VI: Torsion and Thin Shell Theory (12 Hours)

**Torsion (No Derivation):** Torsion Equation, Power Transmitted by Shafts, Closed-Coiled Helical Springs.

**Thin Pressure Vessels: Thin Cylindrical and Spherical Vessel** Subjected to Internal Pressure, Longitudinal and Hoop Stress, Change in Dimensions due to Internal Pressure.

### Practice:

Experiment 9: 3D simulation of Torsion Analysis of Shaft

Experiment 10: Failure Analysis of Thin-walled Pressure Vessels.

## Module VII: Column Analysis (7 Hours)

**Columns and Struts:** Failure of Column, End Conditions and Equivalent Length, Euler's Column Theory, Rankine's Formula, Slenderness Ratio.

**Practice:**

Experiment 11: Simulation of Buckling/Column Analysis of Structural Components

Text Books:

3. Strength of Materials, R.K. Bansal, Laxmi Publications.
4. Finite Element Analysis, S.S. Bhavikatti, New Age international Publishers

Reference Books:

1. Fundamentals of Finite Element Analysis, David V. Hutton, McGraw Hill Higher Education
2. Engineering Mechanics of Solids, Egor P. Popov, Pearson publication

## Programming in Java

Course Code	Course Title	Credits	Type (T+P+Pj)
CUTM1058	Programming in Java	3	2+1+0

### Course Objective

- To introduce the Java programming language, its features, and implement object-oriented programming concepts.
- To utilize the Java Collections Framework, manage exceptions, and perform file I/O operations.
- To develop multithreaded applications and connect to databases using JDBC.

### Course Outcomes

After the completion of the course, the students will be able to:

- **CO1:** Remember the features and basic syntax of Java
- **CO2:** Explain object-oriented programming concepts
- **CO3:** Apply collections, exception handling, and file I/O operations in Java
- **CO4:** Analyze multithreaded applications and concurrency issues
- **CO5:** Develop complex Java applications with advanced features.

### Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	P01	P02	P03	P04	P05	P06	P07	P08	P09	P010	P011	P012	PS01	PS02	PS03
CO1	3	2	2			2	2	2	3	3		2			
CO2	3	3	3	2	2	2	2	2	3	3		2			
CO3	2		2			2	2	2	3	3		2			
CO4	2	3	3	2		2	2	2	3	3		2			
CO5	3	3	3	2	2	2	2	2	3	3		2			

**\*High-3, Medium-2, Low-1**

## Course Syllabus:

### Module I: Introduction to Java

(8 hrs)

Features and Installation, Java Programming Basics, Decision Making and Looping, Class and Object, Inheritance

Practice 1 (1 Hr)

Practice 2 (1 Hr)

### Module II: Package and Safe Code

(5 Hr)

Interfaces, Packages and Access Protection, Exception Handling (Fault Tolerant Programming)

Practice 3 (1 Hr)

### Module III: Collection and Threads

(5 Hr)

ArrayList, Vector, Set, Map, Multi-threaded Programming, Synchronization

Practice 4 (1 Hr)

### Module IV: Language and Utility Packages

(5 Hr)

String Handling, Wrappers, Runtime Memory Management, Cloning, Calendar, Date and Time Facilities, Scanner, Internationalization

Practice 5 (1 Hr)

Practice 6 (1 Hr)

### Module V: Input/ Output and Applets

(5 Hr)

Byte and Character Stream I/O, Persistence, Applet: Architecture, Skeleton, and Implementation

Practice 7 (1 Hr)

Practice 8 (1 Hr)

### Module VI: GUI Programming

(5 Hr)

AWT: Container, Components, Layout Managers, Event Handling

Practice 9 (1 Hr)

Practice 10 (1 Hr)

### Module VII: Networking and Advanced

(5 Hr)

Networking Fundamental, Client-Server Communication, Remote Method Invocation (RMI), Java Virtual Machine (JVM) Tuning, Java Profiler

Practice 11 (1 Hr)

Practice 12 (1 Hr)

*Text Book(s):*

1. Java The Complete Reference, Fifth Edition, C25 Herbert Schildt, McGraw-Hills

*Reference Book(s):*

1. Murach's Java Programming, 5th Edition, Joel Murach, Mike Murach & Associates, 2011, ISBN-78-1-943872-07-7

2. Introduction to Java Programming, Comprehensive, 10th ed., Y. Daniel Liang, 2014. ISBN-10: 0133813460, ISBN-13: 9780133813463

<https://nqr.gov.in/qualification-title?nid=3002>

<https://www.cdac.in/index.aspx?id=DAC&courseid=0#>

<https://canvas.harvard.edu/courses/63117/assignments/syllabus>

<https://canvas.harvard.edu/courses/69911/assignments/syllabus>

<https://xid.harvard.edu/xid-apps/submitAccountForm.do>

### Online Source(s):

1. <https://docs.oracle.com/javase/tutorial/java/index.html>

2. <https://www.programiz.com/java-programming>

3. <https://marcus-biel.com/>

Software/Tool(s): Java 8, Eclipse IDE

Online Compiler: <https://ideone.com/>

Online Coding Practice: <https://www.hackerrank.com/>

### List of Practices:

#### Practice 1 (Module-I)

Program-1:

Write a program that computes the standard deviation of a set of floating point numbers that the user enters. First the user says how many numbers N are to follow. Then the program asks for and reads in each floating point number. Finally, it writes out the standard deviation. The standard deviation of a set of numbers  $X_i$  is:

$$SD = \text{Math.sqrt}( \text{avgSquare} - \text{avg}^2 )$$

Here, avg is the average of the N numbers, and avg<sup>2</sup> is its square.

avgSquare is the average of  $X_i * X_i$ . In other words, this is the average of the squared value of each floating point number.

For example, if N = 4, say the numbers were:

$X_i \quad X_i * X_i$

2.0 4.0

3.0 9.0

1.0 1.0

2.0 4.0

sum 8.0 18.0

Now:

avg = 8.0/4 = 2.0

avg2 = 4.0

avgSquare = 18.0/4 = 4.5

SD = Math.sqrt( 4.5 - 4.0 ) = Math.sqrt( .5 ) = 0.7071067812

To do this you will need to do several things inside the loop body for each floating point value as it comes in: add it to a sum, square it and add it to a sum of squares. Then after the loop is finished apply the formula.

Program-2 and Program-3:

Two suggested competitive programs to solve on HackerRank

<https://www.hackerrank.com/domains/java>

### **Practice 2 (Module-I)**

Program-1:

Better encapsulation of the Goods class would call making instance variables private and using getter and setter methods to access them. A further refinement would be to make the class abstract and to define additional child classes. Here is a revised Goods class:

```
public abstract class GoodsSGA{
    private String description;
    private double price;
    private int quantity;
    public GoodsSGA( String des, double pr, int quant )
    {description = des;
    price = pr;
    quantity = quant;}
    double getPrice()
    {return price;}
    void setPrice( double newPrice)
    {price = newPrice;}
    int getQuantity()
    {return quantity;}
    void setQuantity ( int newQuantity )
    {quantity = newQuantity;}
```

```
public String toString()  
{return "item: " + description + " quantity: " + quantity + " price: " + price ;}
```

Revise the source code for the classes Food, Toy, and Book. (Perhaps call the revised classes FoodSG, ToySG, and BookSG.) create a new class ToiletrySG for things like bubble bath. Create a new testing class, StoreSG to test your revised classes.

Note: the child classes will need to use the getter and setter methods to access the instance variables that are declared as private in GoodsSG.

Program-2 and Program-3:

Two suggested competitive programs to solve on HackerRank

<https://www.hackerrank.com/domains/java>

### Practice 3 (Module-II)

Program-1:

User-Friendly Division Practice:

Put in a loop so that the user is repeatedly asked for the numerator and the divisor. For each set of data, the program prints out the result, or an informative error message if there is a problem (division by zero or poor input data).

The program continues looping, even if there is a problem Exit the loop when data entered for the numerator start with characters "q" or "Q". Don't print out an error message in this case.

Don't ask for the divisor if the user just asked to quit.

Here is sample output from one run:

Enter the numerator: 12

Enter the divisor: 4

12 / 4 is 3

Enter the numerator: 12

Enter the divisor : 0

You can't divide 12 by 0

Enter the numerator: glarch

You entered bad data.

Please try again.

Enter the numerator: quit

You will need to use the method charAt() from the String class.

Program-2 and Program-3:

Two suggested competitive programs to solve on HackerRank

<https://www.hackerrank.com/domains/java>

## Practice 4 (Module-III)

### Program-1:

In mathematics, several operations are defined on sets. The union of two sets A and B is a set that contains all the elements that are in A together with all the elements that are in B. The intersection of A and B is the set that contains elements that are in both A and B. The difference of A and B is the set that contains all the elements of A except for those elements that are also in B.

Suppose that A and B are variables of type set in Java. The mathematical operations on A and B can be computed using methods from the Set interface. In particular:

A.addAll(B) computes the union of A and B; A.retainAll(B) computes the intersection of A and B; and A.removeAll(B) computes the difference of A and B. (These operations change the contents of the set A, while the mathematical operations create a new set without changing A, but that difference is not relevant to this exercise.)

For this exercise, you should write a program that can be used as a “set calculator” for simple operations on sets of non-negative integers. (Negative integers are not allowed.) A set of such integers will be represented as a list of integers, separated by commas and, optionally, spaces and enclosed in square brackets. For example: [1,2,3] or [17, 42, 9, 53,108]. The characters +, \*, and - will be used for the union, intersection, and difference operations. The user of the program will type in lines of input containing two sets, separated by an operator. The program should perform the operation and print the resulting set.

Here are some examples:

Input Output

```
-----
[1, 2, 3] + [3, 5, 7] [1, 2, 3, 5, 7]
[10,9,8,7] * [2,4,6,8] [8]
[ 5, 10, 15, 20 ] - [ 0, 10, 20 ] [5, 15]
```

To represent sets of non-negative integers, use sets of type TreeSet<Integer>. Read the user’s input, create two TreeSets, and use the appropriate TreeSet method to perform the requested operation on the two sets. Your program should be able to read and process any number of lines of input. If a line contains a syntax error, your program should not crash. It should report the error and move on to the next line of input. (Note: To print out a Set, A, of Integers, you can just say System.out.println(A). We’ve chosen the syntax for sets to be the same as that used by the system for outputting a set.)

Program-2 and Program-3:

Two suggested competitive programs to solve on HackerRank

<https://www.hackerrank.com/domains/java>

## Practice 5 (Module-IV)

Program-1:

Password Checker:

Write a program that repeatedly asks the user for a proposed password until the user enters an acceptable password. When the user enters an acceptable password, the program writes a message and exits.

Acceptable passwords:

Are at least 7 characters long.

Contain both upper and lower case alphabetic characters. Contain at least 1 digit. The logic of this program can be quite tricky. Hint: use `toUpperCase()`, `toLowerCase()`, and `equals()`. You will also need nested ifs.

Here is a run of the program:

Enter your password:

snowflake

That password is not acceptable.

Enter your password:

SnowFlake

That password is not acceptable.

Enter your password:

snowflake47

That password is not acceptable.

Enter your password:

Snowflake47

Acceptable password.

Program-2 and Program-3:

Two suggested competitive programs to solve on HackerRank

<https://www.hackerrank.com/domains/java>

## Practice 6 (Module-IV)

Program-1:

Secret Code:

A text message has been encoded by replacing each character of the message with an integer. Each integer is an index into a key-phrase that contains all the lower case letters of the alphabet as well as the space character. The key-phrase may contain the same character in several locations. The encoded text is series of integers, like this:

35 10 10 33 9 24 3 17 41 8 3 20 51 16 38 44 47 32 33 10 19 38 35 28 49

To decode the message, look up each integer in the key-phrase and output the corresponding character.

For example, say that the key-phrase is this (the index of each character has been written above it):

111111111122222222223333333333444444444455

0123456789012345678901234567890123456789012345678901

six perfect quality black jewels amazed the governor

using each integer from the encoded text as an index into the phrase results in the decoded message:

attack the bridge at dawn

Write a program that decodes a secret message contained in a text file. The first line of the text file contains the key-phrase. Then the file contains a sequence of integers, each of which indexes the key-phrase. Find the character corresponding to each integer and output the secret message. Note if a character character such as 'e' occurs several places in the key-phrase it may be encoded as different integers in different parts of the secret message.

(The recipient of the secret message gets only the file of integers and must put the key-phrase at the top of the file.) For example, here is the contents of a secret message file ready for the program:

six perfect quality black jewels amazed the governor

35 10 10 33 9 24 3 17 41 8 3 20 51 16 38 44 47 32 33 10 19 38 35 28 49

Here is a sample run of the program:

```
C:\> java Decode < secretFile.txt
```

attack the bridge at dawn

You will need the charAt() method of String.

Here is another secret message file, with key-phrase inserted, that you can use to test your program:

six perfect quality black jewels amazed the governor

31 16 2 3 4 42 48 7 27 9 10 43 12 13 35 15 1 40 18 3

20 15 33 23 24 32 26 29 28 27 21 31 25 14 34 14 36

42 38 19 40 41 27 3 44 50 46 42 48 49 50 6

Program-2 and Program-3:

Two suggested competitive programs to solve on HackerRank

<https://www.hackerrank.com/domains/java>

### **Practice 7 (Module-V)**

Program-1:

Stop Word Remover:

Write a program that reads in a file of text, perhaps the text of a novel. The program copies the same text to an output file, except that all the useless words such as "the", "a", and "an" are removed. (Decide on

what other words you wish to remove. The list of words removed is called a stop list.) Do this by reading the text file token by token using hasNext() and next(), but only writing out tokens not on the stop list. Prompt the user for the names of the input and output files.

Fairly Easy: The output file will have only N tokens per line. Do this by counting tokens as you output them. N will be something like 10 or 12.

Improved Program: Preserve the line structure of the input file. Do this by reading each line using nextLine() and then creating a new Scanner for that line. (Look at the on-line documentation for Scanner.) With each line's Scanner, use hasNext() and next() to scan through its tokens.

Harder: Write out no more than N characters per line. N will be something like 50. Do this by keeping count of the number of characters written out per line. The length() method of String will be useful. If X characters has already been written to the current line, and if X plus the length of the current token exceeds N, then start a new line.

Program-2 and Program-3:

Two suggested competitive programs to solve on HackerRank

<https://www.hackerrank.com/domains/java>

### **Practice 8 (Module-V)**

Program-1:

E-Mail Address Extractor:

Write a program that scans a text file for possible e-mail addresses. Addresses look like this:

someone@somewhere.net

Read tokens from the input file one by one using hasNext() and next(). With the default delimiters of Scanner, an entire e-mail address will be returned as one token. Examine each token using the indexOf() method of String. If a token contains an at sign @ followed some characters later by a period, regard it as a possible e-mail address and write it to the output file.

Programs such as this scan through web pages looking for e-mail addresses that become the targets of spam. Because of this, many web pages contain disguised e-mail addresses that can't easily be automatically extracted.

Program-2 and Program-3:

Two suggested competitive programs to solve on HackerRank

<https://www.hackerrank.com/domains/java>

### **Practice 9 (Module-VI)**

Program-1:

User-friendly Fat Calculator, with Advice:

Further modify the calories from fat calculator so that it includes another TextField that will be set with the text "Too many fat calories" if the percentage of calories from fat is equal or greater than 30 percent, or to "Healthy amount of fat" if the percentage is less than that.

Program-2 and Program-3:

Two suggested competitive programs to solve on HackerRank

<https://www.hackerrank.com/domains/java>

### **Practice 10 (Module-VI)**

Program-1:

Three Button Monte:

Write a program to implement a game:

There are three buttons in the frame. Two of the buttons cause the program to quit using System.exit(0); the remaining button changes the frame to green (a win!) The winning button is different each time the game is played.

The easy way to do this (although it seems unfair to the user) treats each button the same way. The actionPerformed() method does not check which button was clicked. When any button is clicked, the method picks a random integer from 0 to 2 and performs the "winning" action if the integer happens to be 0. Otherwise, it performs the "losing" action. To the user, it seems like there is a "winning" button and two "losing" buttons. But, in fact, it does not matter which button was clicked.

This is similar to some electronic gambling devices in casinos, where it appears to the user that there are "winning moves" and "losing moves" but in fact the machine actually ignores what the user has done and just declares a "win" every now and then, according to predetermined odds.

You will need the Random class:

```
Random randNum = new Random(); // create a Random number object
int someInt = randNum.nextInt(3); // someInt gets a number from 0 to 2
```

Program-2 and Program-3:

Two suggested competitive programs to solve on HackerRank

<https://www.hackerrank.com/domains/java>

### **Practice 11 (Module-VII)**

Content Delivery with Networking:

Write a Client-Server program where the client queries with a name of file and the server delivers the content of requested files to the client over the network.

(Improve the program by making the server multi-threaded)

### **Practice 12 (Module-VII)**

Greet the user with Remote Method Invocation:

Write a program using RMI, where the user invokes a method on remote object with username as parameter and receives a greeting message based on time of the day along with username.

### **Projects**

However, not limited to:

1. Chat application
2. Text Editor application
3. GUI based Scientific Calculator
4. Paint application
5. Slam book

(\*PROJECT REVIEWS WILL COMMENCE BEYOND CLASS HOURS)

### **Monitoring:**

Credit will be received only on making an honest effort. It is expected that students will finish watching all lecture video and complete all challenge problems by the end of each lecture week. Borrowing code from other sources is allowed only with proper attribution and credit given to the original author(s).

### **List of Common Programs to solve using Java:**

1. Program to calculate area of a triangle
2. Program to solve quadratic equation
3. Program to swap two variables (with and without using third variable)
4. Program to generate random numbers in various ways
5. Program to convert miles to kilometers and vice-versa
6. Program to convert celsius to fahrenheit and vice-versa
7. Program to check if a number is odd or even
8. Program to check if input year is leap year
9. Program to test primality
10. Program to print all prime numbers in an interval using "Sieve of Eratosthenes"
11. Program to generate factorial of all elements in an array
12. Program to display the multiplication table up to 20
13. Program to print the fibonacci sequence
14. Program to check armstrong number, perfect number, Harshad number
15. Program to generate armstrong numbers in an Interval
16. Program to find the sum of Harshad numbers in an interval
17. Program to display powers of two Using lambda
18. Program to perform conversions among decimal to binary, octal and hexadecimal

19. Program to display ASCII table
20. Program to find HCF/GCD and LCM
21. Program to find factors of given natural number
22. Program to make a simple calculator
23. Program to shuffle deck of cards
24. Program to generate fibonacci sequence using recursion
25. Program to find sum of natural numbers using recursion
26. Program to find factorial of number using recursion
27. Program to convert decimal to binary using recursion
28. Program to add two matrices
29. Program to obtain transpose of a matrix
30. Program to multiply two matrices
31. Program to check if a string is palindrome
32. Program to remove punctuations from a string
33. Program to sort words lexicographically
34. Program to illustrate different set operations
35. Program to count frequency of each vowel in a string
36. Program to find hash value of a file

### Database Management Systems (60 hrs)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUTM1059	Database Management Systems	3	2+1+0

#### Course Objective

- To understand the basic concepts of databases and DBMS, and master SQL and relational database design.
- To comprehend transaction management, concurrency control, and learn about database recovery and security.
- To explore distributed databases and NoSQL databases.

#### Course Outcomes

After the completion of the course, the students will be able to:

- **CO1:** Recall fundamental concepts of databases and DBMS
- **CO2:** Explain SQL and relational database design principles
- **CO3:** Apply transaction management and concurrency control techniques.
- **CO4:** Analyze database recovery methods and security measures
- **CO5:** Develop and manage relational and NoSQL databases.

#### Course Outcome to Program Outcome Mapping:

COs / Pos / PSOs	P01	P02	P03	P04	P05	P06	P07	P08	P09	P010	P011	P012	PS01	PS02	PS03
CO1	2	2	1			2	2	2	3	3		2			
CO2	2	1	2	1	3	2	2	2	3	3		2			
CO3		1	2	1	2	2	2	2	3	3		2			
CO4		2			1	2	2	2	3	3		2			
CO5	1	1	2	2		2	2	2	3	3		2			

**\*High-3, Medium-2, Low-1**

## Course Syllabus:

### Module-1: DBMS Concepts [8 Hrs]

#### Theory

Data Abstraction - Data models and data independence. Instances and Schemas. Components of a DBMS and overall structure of a DBMS- Life Cycle of a DBMS application- Database terminology.

### Module-2: Data Modeling [8Hrs]

#### Theory

Basic concepts- Types of data models- Conceptual, physical and logical database models- E-R data model and Object-oriented data model. Components of ER Model- ER Modeling symbols. Entity and entity sets- Relations and relationship sets- E-R Diagrams- Reducing E-R Diagrams into tables.

#### Practice

- Experiment 1.1: Assume we have the following application that models soccer teams, the games they play, and the players in each team. In the design, we want to capture the following.
- Experiment 1.2: We have a set of teams, each team has an ID (unique identifier), name, main stadium, and to which city this team belongs.
  - Each team has many players, and each player belongs to one team. Each player has a number (unique identifier), name, DoB, start year, and shirt number that he uses.
  - Teams play matches, in each match there is a host team and a guest team. The match takes place in the stadium of the host team.
  - For each match we need to keep track of the following:
    - The date on which the game is played
    - The final result of the match
    - The players participated in the match. For each player, how many goals he scored, whether or not he took yellow card, and whether or not he took red card. During the match, one player may substitute another player. We want to capture this substitution and the time at which it took place.
  - Each match has exactly three referees. For each referee we have an ID (unique identifier), name, DoB, years of experience. One referee is the main referee and the other two are assistant referee.

- Experiment 1.3: Design an ER diagram to capture the above requirements. State any assumptions you have that affects your design (use the back of the page if needed). Make sure cardinalities and primary keys are clear.

### **Module-3: Relational DBMS Model [8 Hrs]**

#### **Theory**

Basic concepts, Attributes and domains- Intention and extensions of a relation- concept of integrity and referential constraints- Relational Query Languages (Relational algebra and relational calculus (Tuple and domain relational calculus).

### **Module-4: Relational Database Design [8 Hrs]**

Notion of normalized relations- Normalization using Functional Dependency- First Normal form- Second Normal Form- Third Normal form- BCNF.

#### **Practice**

- Experiment 4.1: Perform NF on the given table [CLICK HERE FOR TABLE](#)

### **Module-5: SQL [8 Hrs]**

#### **Theory**

Structure of a SQL query- DDL and DML, TCL- SQL queries and sub queries- Tables, views and indexes.

#### **Practice**

- Experiment 5.1: (i) Create tables according to the following definition.  
CREATE TABLE DEPOSIT (ACTNO VARCHAR2(5), CNAME VARCHAR2(18),  
BNAME VARCHAR2(18), AMOUNT NUMBER (8,2), ADATE DATE);  
CREATE TABLE BRANCH (BNAME VARCHAR2(18), CITY VARCHAR2(18));  
CREATE TABLE CUSTOMERS (CNAME VARCHAR2(19), CITY VARCHAR2(18));  
CREATE TABLE BORROW(LOANNO VARCHAR2(5), CNAME VARCHAR2(18),  
BNAME VARCHAR2(18), AMOUNT NUMBER (8,2));
- Experiment 5.2: (ii) Insert the data as shown below.  
DEPOSIT  
[CLICK HERE FOR TABLE](#)  
BRANCH  
[CLICK HERE FOR TABLE](#)  
CUSTOMERS  
[CLICK HERE FOR TABLE](#)

## BORROW

### [CLICK HERE FOR TABLE](#)

- (1) Describe deposit, branch.
- (2) Describe borrow, customers.
- (3) List all data from table DEPOSIT.
- (4) List all data from table BORROW.
- (5) List all data from table CUSTOMERS.
- (6) List all data from table BRANCH.
- (7) Give account no and amount of depositors.
- (8) Give name of depositors having amount greater than 4000.
- (9) Give name of customers who opened account after date '1-12-96'.

## Module-6: Aggregate functions [12 Hrs]

### Theory

Set Operations, predicates and joins, Set Membership- Tuple variables- Set comparison- Database modifications using SQL.

### Practice

- Experiment 6.1: Create the below given table and insert the data accordingly.

Create Table Job (job\_id, job\_title, min\_sal, max\_sal)

COLUMN NAME DATA TYPE

job\_id Varchar2(15)

job\_title Varchar2(30)

min\_sal Number(7,2)

max\_sal Number(7,2)

Create table Employee (emp\_no, emp\_name, emp\_sal, emp\_comm, dept\_no)

COLUMN NAME DATA TYPE

emp\_no Number(3)

emp\_name Varchar2(30)

emp\_sal Number(8,2)

emp\_comm Number(6,1)

dept\_no Number(3)

Create table deposit(a\_no,cname,bname,amount,a\_date).

COLUMN NAME DATA TYPE

a\_no Varchar2(5)

cname Varchar2(15)

bname Varchar2(10)

amount Number(7,2)

a\_date Date

Create table borrow(loanno,cname,bname,amount).

COLUMN NAME DATA TYPE

loanno Varchar2(5)

cname Varchar2(15)

bname Varchar2(10)

amount Varchar2(7,2)

Insert following values in the table Employee.

emp\_n emp\_name emp\_sal emp\_comm dept \_no

101 Smith 800 20

102 Snehal 1600 300 25

103 Adama 1100 0 20

104 Aman 3000 15

105 Anita 5000 50,000 10

106 Sneha 2450 24,500 10

107 Anamika 2975 30

Insert following values in the table job.

[CLICK HERE FOR TABLE](#)

Insert following values in the table deposit.

[CLICK HERE FOR TABLE](#)

- Experiment 6.2: Perform following queries
  - (1) Retrieve all data from employee, jobs and deposit.
  - (2) Give details of account no. and deposited rupees of customers having account opened between dates 01-01-06 and 25-07-06.
  - (3) Display all jobs with minimum salary is greater than 4000.
  - (4) Display name and salary of employee whose department no is 20. Give alias name to name of employee.
  - (5) Display employee no,name and department details of those employee whose department lies in(10,20)
- Experiment 6.3: To study various options of LIKE predicate
  - (1) Display all employee whose name start with 'A' and third character is 'a'.

- (2) Display name, number and salary of those employees whose name is 5 characters long and first three characters are 'Ani'.
  - (3) Display the non-null values of employees and also employee name second character should be 'n' and string should be 5 character long.
  - (4) Display the null values of employee and also employee name's third character should be 'a'.
  - (5) What will be output if you are giving LIKE predicate as '%\\_%' ESCAPE '\'
- Experiment 6.4: To Perform various data manipulation commands, aggregate functions and sorting concept on all created tables.
    - (1) List total deposit from deposit.
    - (2) List total loan from karolbagh branch
    - (3) Give maximum loan from branch vrce.
    - (4) Count total number of customers
    - (5) Count total number of customer's cities.
    - (6) Create table supplier from employee with all the columns.
    - (7) Create table sup1 from employee with first two columns.
    - (8) Create table sup2 from employee with no data
    - (9) Insert the data into sup2 from employee whose second character should be 'n' and string should be 5 characters long in employee name field.
    - (10) Delete all the rows from sup1.
    - (11) Delete the detail of supplier whose sup\_no is 103.
    - (12) Rename the table sup2.
    - (13) Destroy table sup1 with all the data.
    - (14) Update the value dept\_no to 10 where second character of emp. name is 'm'.
    - (15) Update the value of employee name whose employee number is 103.
  - Experiment 6.5: To study Single-row functions.
    - (1) Write a query to display the current date. Label the column Date
    - (2) For each employee, display the employee number, job, salary, and salary increased by 15% and expressed as a whole number. Label the column New Salary
    - (3) Modify your query no 4.(2) to add a column that subtracts the old salary from the new salary. Label the column Increase
    - (4) Write a query that displays the employee's names with the first letter capitalized and all other letters lowercase, and the length of the names, for all employees whose name starts with J, A, or M. Give each column an appropriate label. Sort the results by the employees' last names.

- (5) Write a query that produces the following for each employee:  
    earns monthly
  - (6) Display the name, hire date, number of months employed and day of the week on which the employee has started. Order the results by the day of the week starting with Monday.
  - (7) Display the hiredate of emp in a format that appears as Seventh of June 1994 12:00:00 AM.
  - (8) Write a query to calculate the annual compensation of all employees (sal+comm.).
- Experiment 6.6: Displaying data from Multiple Tables (join)
    - (1) Give details of customers ANIL.
    - (2) Give name of customer who are borrowers and depositors and having living city Nagpur
    - (3) Give city as their city name of customers having same living branch.
    - (4) Write a query to display the last name, department number, and department name for all employees.
    - (5) Create a unique listing of all jobs that are in department 30. Include the location of the department in the output
    - (6) Write a query to display the employee name, department number, and department name for all employees who work in NEW YORK.
    - (7) Display the employee last name and employee number along with their manager's last name and manager number. Label the columns Employee, Emp#, Manager, and Mgr#, respectively.
    - (8) Create a query to display the name and hire date of any employee hired after employee SCOTT.

## **Module-7: Transaction Management [8 Hrs]**

### **Theory**

Subqueries, Manipulating Data, Transaction management and Concurrency control

### **Practice**

- Experiment 7.1: To apply the concept of Aggregating Data using Group functions.
  - (1) List total deposit of customer having account date after 1-jan-96.
  - (2) List total deposit of customers living in city Nagpur.
  - (3) List maximum deposit of customers living in bombay.
  - (4) Display the highest, lowest, sum, and average salary of all employees. Label the columns Maximum, Minimum, Sum, and Average, respectively. Round your results to the nearest whole number.

- (5) Write a query that displays the difference between the highest and lowest salaries. Label the column DIFFERENCE.
  - (6) Create a query that will display the total number of employees and, of that total, the number of employees hired in 1995, 1996, 1997, and 1998.
  - (7) Find the average salaries for each department without displaying the respective department numbers.
  - (8) Write a query to display the total salary being paid to each job title, within each department.
  - (9) Find the average salaries > 2000 for each department without displaying the respective department numbers.
  - (10) Display the job and total salary for each job with a total salary amount exceeding 3000, in which excludes president and sorts the list by the total salary.
  - (11) List the branches having sum of deposit more than 5000 and located in city bombay.
- Experiment 7.2: To solve queries using the concept of sub query.
    - (1) Write a query to display the last name and hire date of any employee in the same department as SCOTT. Exclude SCOTT
    - (2) Give name of customers who are depositors having same branch city of mr. sunil.
    - (3) Give deposit details and loan details of customer in same city where pramod is living.
    - (4) Create a query to display the employee numbers and last names of all employees who earn more than the average salary. Sort the results in ascending order of salary.
    - (5) Give names of depositors having same living city as mr. anil and having deposit amount greater than 2000
    - (6) Display the last name and salary of every employee who reports to ford.
    - (7) Display the department number, name, and job for every employee in the Accounting department.
    - (8) List the name of branch having highest number of depositors.
    - (9) Give the name of cities where in which the maximum numbers of branches are located.
    - (10) Give name of customers living in same city where maximum depositors are located.
  - Experiment 7.3: Manipulating Data
    - (1) Give 10% interest to all depositors.
    - (2) Give 10% interest to all depositors having branch vrce
    - (3) Give 10% interest to all depositors living in Nagpur and having branch city Bombay.
    - (4) Write a query which changes the department number of all employees with empno 7788's job to employee 7844's current department number.

- (5) Transfer 10 Rs from account of anil to sunil if both are having same branch.
  - (6) Give 100 Rs more to all depositors if they are maximum depositors in their respective branch.
  - (7) Delete depositors of branches having number of customers between 1 to 3.
  - (8) Delete deposit of vijay.
  - (9) Delete borrower of branches having average loan less than 1000.
- Experiment 7.4: To apply the concept of security and privileges.
  - Experiment 7.5: To study Transaction control commands

#### VIRTUAL LAB

#### **Text/Reference Books:**

Database Management Systems: Raghu Ramakrishnan

ORACLE PL/SQL Programming – Scott Urman BPB Publications.

Database Systems Concepts – Henry F Korth, Abraham Silberschatz.

Database Management Systems – Alexis Leon, Mathews Leon – Leon, Vikas Publications

## Introduction to Aircraft Documents and Logbooks (45 Hours)

CODE	Course Title	Credit	T-P-PJ	Prerequisite
CUAS1001	Introduction To Aircraft Documents And Logbook	02	1-1-0	Introduction To Aerospace Engineering

### Course Objective

- To make awareness about various aircraft documents and to know various log books associated with different types of aircraft.
- To teach the students about different manuals associated with aircraft
- To give students hands on practice for filling up various aircraft documents, logbooks and various aircraft maintenance manuals

### Course Outcomes

At the end of the course, the Students will be able to....

- CO1: Understand the basic types of aircraft documents
- CO2: Understand various log books associated with different types of aircraft.
- CO3: Interpret about different manuals associated with aircraft
- CO4: Explain hands on practice for filling up various aircraft documents, logbooks.
- CO5: Describe the practices for filling up various aircraft maintenance manuals

### Course Outcome to Program Outcome and Program Specific Outcome Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	1	1	2	2	2	2	2	3	3		2	2		
CO2	3	2		1	2	2	2	2	3	3		2	2	1	
CO3	3	2		2	2	2	2	2	3	3		2	2		
CO4	3	1	2		2	2	2	2	3	3		2		2	
CO5	3		2	1	2	2	2	2	3	3		2		2	

\* High-3, Medium-2, Low-1

## COURSE CONTENT

### **Module 01: (Introduction to Aircraft Manuals) (10hrs)**

#### **Theory**

- Introduction, Familiarisation with all aircraft manual like flight manual
- AMM, CMM, IPC, WDM, TSM, ESPM etc.

### **Module 02: (Introduction to Aviation Documents) (10hrs)**

#### **Theory**

- Introduction, Familiarisation with ATA code, MIL specification, iSpec 2200, S 1000D, STE Chapters.
- ECN (Engineering Change Notice), BOM (Bill of Materials) API Documentation etc.

### **Module 03: (Introduction to Manufacturer Documents) (07 hrs)**

#### **Theory**

- Familiarisation of documents issued by aircraft, engine manufacturer like SB, SI, SL, SA, LR, MB and other documents related to maintenance.

### **Module 04: (Introduction to Logbooks) (10 hrs)**

#### **Theory**

- Purpose, types of logbook and its entry procedure after maintenance of aircraft.

#### **Practice**

- **Experiment 4.1:** Log book entry process and procedure

### **Module 05: (Loading and Weighing) (08 hrs)**

#### **Theory**

- Purpose and use of load and trim sheet, weight schedule, Passenger manifest. etc.

#### **Practice**

- Experiment 5.1: Load documents entry process and procedure.

#### **Text Books:**

1. Module 10 Aviation Legislation By EASA
2. Civil Aviation Requirements (CAR), Section 2 Issued by Director General of Civil Aviation

## Basket - V (Domain)

Sr. No	Course Title	Credits	Type T+P+PJ
1	<b>Full-Stack Development with MERN</b>	18	1+8+9
2	<b>Generative AI</b>	12	0+8+4
3	<b>Data Analytics and Machine Learning</b>	18 + 4 (Optional)	0+6+12
4	<b>Cloud Technology</b>	12	0+6+6
5	<b>Drone Imaging and Spectral Analysis</b>	12	0+6+6
6	<b>Software Technology</b>	18	0+6+12
7	<b>Mobile App Development</b>	12	1+6+5
8	<b>Gaming and Immersive Learning-AR/VR</b>	20	5+5+10
9	<b>Blockchain Development</b>	18	0+7+11
10	<b>Cyber Security</b>	20	8+8+4
11	<b>CONSTRUCTION PLANNING, MONITORING AND PROJECT MANAGEMENT</b>	20	4+8+8
12	<b>Aerial Surveying and Remote Sensing Applications</b>	20	4+10+6
13	<b>Go To Market</b>	22	4+10+8
14	<b>Automobile Engineering</b>	24	7+9+8
15	<b>Manufacturing (Conventional, CNC and Additive)</b>	26	2+14+10



<b>16</b>	<b>Computational Fluid Dynamics</b>	<b>20</b>	<b>2+10+8</b>
<b>17</b>	<b>Composite Design and Manufacturing</b>	<b>24</b>	<b>6+12+6</b>
<b>18</b>	<b>Electronics Hardware Design and Automation</b>	<b>18</b>	<b>0+8+10</b>
<b>19</b>	<b>Communication Systems Domain</b>	<b>18</b>	<b>4+8+6</b>
<b>20</b>	<b>Chip Design and Fabrication Using VLSI</b>	<b>20</b>	<b>6+8+6</b>
<b>21</b>	<b>Embedded System Design</b>	<b>20</b>	<b>4+10+6</b>
<b>22</b>	<b>RENEWABLE ENERGY APPLICATIONS</b>	<b>24</b>	<b>6+14+4</b>
<b>23</b>	<b>Operation and Maintenance of Electrical Grid System &amp; Transformers</b>	<b>24</b>	<b>6+14+4</b>
<b>24</b>	<b>Industrial Automation</b>	<b>24</b>	<b>5+9+10</b>
<b>25</b>	<b>ELECTRIC VEHICLE DESIGN</b>	<b>22</b>	<b>8+8+6</b>
<b>26</b>	<b>POWER SYSTEM OPERATION &amp; CONTROL</b>	<b>3</b>	<b>2+1+0</b>
<b>27</b>	<b>ENERGY AUDITING &amp; DEMAND SIDE MANAGEMENT</b>	<b>3</b>	<b>2+1+0</b>

## BASKET-V (Domain-CSE)

Course type	Course Code	Course Title	Credit	Type (T+P+Pj)
Domain	<b>FDCU1000</b>	<b>Full-Stack Development with MERN</b>	<b>18</b>	<b>1+8+9</b>
	CUFD1001	MongoDB for Developers	3	1+2+0
	CUFD1002	Node.js and Express.js Development	3	0+2+1
	CUFD1003	Front-End Development with React	3	0+2+1
	CUFD1004	Full Stack Integration and Deployment	3	0+2+1
	CUFD1005	Product Development	6	0+0+6
	<b>GACU1010</b>	<b>Generative AI</b>	<b>12</b>	<b>0+8+4</b>
	CUGA1011	Fundamentals of Generative AI	1	0+1+0
	CUGA1012	Advanced Techniques in Generative AI	2	0+2+0
	CUGA1013	Real-Time Generative AI	3	0+1+2
	CUGA1014	Research and Development in Generative AI	2	0+2+0
	CUGA1015	Capstone Project in Generative AI	4	0+2+2
	<b>MLCU1020</b>	<b>Data Analytics and Machine Learning</b>	<b>18 + 4 (Optional)</b>	<b>0+6+12</b>
	CUML1021	Machine Learning for Predictive Analytics	4	0+2+2
	CUML1022	Deep Learning for Image Analytics	4	0+2+2
	CUML1023	Data Analytics using Tableau	4	0+2+2
	CUML1024	ML for Spectral Imaging (Optional)	4	0+2+2
	CUML1025	Project	6	0+0+6
	<b>CTCU1030</b>	<b>Cloud Technology</b>	<b>12</b>	<b>0+6+6</b>
	CUCT1031	Advanced Cloud Architecture and Design	3	0+2+1
	CUCT1032	Cloud Development and DevOps	3	0+2+1
	CUCT1033	Cloud Security and Compliance	3	0+2+1
	CUCT1034	Capstone Project	3	0+0+3



	<b>DSCU1040</b>	<b>Drone Imaging and Spectral Analysis</b>	<b>12</b>	<b>0+6+6</b>
	CUDS1041	Drone Image Processing using Pix4D	3	0+2+1
	CUDS1042	Multispectral Image Analytics for Agriculture	3	0+2+1
	CUDS1043	Drone Imaging Applications	2	0+2+0
	CUDS1044	Domain Project	4	0+0+4
	<b>STCU1050</b>	<b>Software Technology</b>	<b>18</b>	<b>0+6+12</b>
	CUST1051	Advanced Java	4	0+2+2
	CUST1052	Angular	4	0+2+2
	CUST1053	Spring Boot	4	0+2+2
	CUST1054	Product Development	6	0+0+6
	<b>MACU1070</b>	<b>Mobile App Development</b>	<b>12</b>	<b>1+6+5</b>
	CUMA1071	Introduction to Mobile App Development	3	1+2+0
	CUMA1072	React Native Development	3	0+2+1
	CUMA1073	Flutter Development	3	0+2+1
	CUMA1074	Advanced Mobile App Development Project	3	0+0+3
	<b>GICU1080</b>	<b>Gaming and Immersive Learning-AR/VR</b>	<b>20</b>	<b>5+5+10</b>
	CUGI1081	Introduction to Gaming & Simulation	2	1+1+0
	CUGI1082	Game Assets and Objects	3	1+1+1
	CUGI1083	Building Game Environment	3	1+1+1
	CUGI1084	Game Animation, Scripting & UI	3	1+1+1
	CUGI1085	Binary Deployment and Cross-Platform Controls	3	1+1+1
	CUGI1086	Project	6	0+0+6
	<b>BDCU1090</b>	<b>Blockchain Development</b>	<b>18</b>	<b>0+7+11</b>
	CUBD1091	INTRODUCTION TO BLOCKCHAIN	2	0+2+0
	CUBD1092	CRYPTOCURRENCIES AND SMART CONTRACTS	3	0+2+1



	CUBD1093	BLOCKCHAIN DEVELOPMENT	3	0+1+2
	CUBD1094	WEB3 AND DECENTRALIZED TECHNOLOGIES	3	0+1+2
	CUBD1095	ADVANCED BLOCKCHAIN CONCEPTS AND DEVELOPMENT	3	0+1+2
	CUBD1096	CAPSTONE PROJECT IN BLOCKCHAIN DEVELOPMENT	4	0+0+4
	<b>CSCU1100</b>	<b>Cyber Security</b>	<b>20</b>	<b>8+8+4</b>
	CUCS1101	Linux Server Management and Security	4	2+2+0
	CUCS1102	Offensive Security	4	2+2+0
	CUCS1103	Defensive Security	4	2+2+0
	CUCS1104	Security Analytics	4	2+2+0
	CUCS1105	Project	4	0+0+4

## MINI AND MICRO DOMAINS PROPOSAL

**Domain Track: Full-Stack Development with MERN (18 Credits) (1+8+9)**

### MongoDB for Developers (70 Hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUFD1001	<b>MongoDB for Developers</b>	03	1+2+0

**Course Description:** This course covers the fundamental and advanced aspects of MongoDB, focusing on how to utilize this NoSQL database for full-stack development within the MERN stack.

#### Course Objectives:

- To understand the basics of MongoDB and NoSQL databases.
- To perform CRUD operations, complex queries, and manage databases using MongoDB Atlas.
- To implement data modelling and schema design.

#### Course Outcomes:

- **CO1:** Understand the fundamentals of NoSQL databases, MongoDB architecture, and perform CRUD operations using MongoDB tools.
- **CO2:** Apply advanced MongoDB features, including indexing, aggregation, geospatial queries, and text search for optimized data management.
- **CO3:** Design effective data models and schemas, utilizing best practices in schema design, embedding vs. referencing, and data modeling.
- **CO4:** Implement replication and sharding techniques to ensure data distribution, redundancy, and scalability in MongoDB applications.
- **CO5:** Utilize MongoDB Atlas for cloud deployment, ensuring security, backup, and restore strategies for robust and secure data management.

## CO-PO Mapping

CO/PO/PS O	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3	3	2	2	3	-	-	-	-	2	-	2	3	2	3
CO2	3	2	3	2	3	-	-	-	-	2	-	2	3	2	3
CO3	3	2	3	2	3	-	-	-	2	2	1	2	3	3	3
CO4	3	2	3	2	3	-	-	-	2	2	2	2	3	2	3
CO5	3	2	3	2	3	-	-	-	2	2	2	2	3	3	3

**\*High-3, Medium-2, Low-1**

### Course Syllabus:

#### Module 1: Introduction to MongoDB (10 hours)

- Overview of NoSQL databases.
- MongoDB architecture and concepts.
- Setting up MongoDB locally and on the cloud.

#### Experiments:

1. **Experiment 1.1:** Set up MongoDB locally on your machine.
2. **Experiment 1.2:** Set up MongoDB on a cloud service like MongoDB Atlas.
3. **Experiment 1.3:** Compare the performance of MongoDB with a traditional SQL database.
4. **Experiment 1.4:** Create a sample database and collection in MongoDB.
5. **Experiment 1.5:** Insert multiple documents into a collection.
6. **Experiment 1.6:** Explore the MongoDB architecture and identify key components.
7. **Experiment 1.7:** Connect to MongoDB using a client (e.g., MongoDB Compass).
8. **Experiment 1.8:** Perform basic queries to retrieve documents from a collection.
9. **Experiment 1.9:** Experiment with different data types supported by MongoDB.
10. **Experiment 1.10:** Set up and configure MongoDB authentication and authorization.

#### Module 2: CRUD Operations (10 hours)

- Create, Read, Update, Delete (CRUD) operations.
- MongoDB Shell and Compass.
- Data validation and schema design.

#### Experiments:

1. **Experiment 2.1:** Create documents in a MongoDB collection using MongoDB Shell.

2. **Experiment 2.2:** Read documents from a MongoDB collection using various query operators.
3. **Experiment 2.3:** Update documents in a collection using different update operators.
4. **Experiment 2.4:** Delete documents from a collection using MongoDB Shell.
5. **Experiment 2.5:** Use MongoDB Compass to perform CRUD operations.
6. **Experiment 2.6:** Implement data validation rules in a MongoDB collection.
7. **Experiment 2.7:** Design a schema for a sample application and implement it in MongoDB.
8. **Experiment 2.8:** Experiment with different data validation techniques in MongoDB.
9. **Experiment 2.9:** Create an index on a collection and observe its effect on query performance.
10. **Experiment 2.10:** Use MongoDB transactions to perform multiple operations atomically.

### Module 3: Advanced MongoDB Features (10 hours)

- Indexing and performance optimization.
- Aggregation framework.
- Geospatial queries and text search.

#### Experiments:

1. **Experiment 3.1:** Create and use indexes to optimize query performance.
2. **Experiment 3.2:** Experiment with different types of indexes (e.g., single field, compound).
3. **Experiment 3.3:** Use the aggregation framework to perform data analysis.
4. **Experiment 3.4:** Implement and query geospatial data in MongoDB.
5. **Experiment 3.5:** Perform text search queries on a collection.
6. **Experiment 3.6:** Compare the performance of indexed vs. non-indexed queries.
7. **Experiment 3.7:** Create a complex aggregation pipeline to process data.
8. **Experiment 3.8:** Use map-reduce operations for large-scale data processing.
9. **Experiment 3.9:** Experiment with TTL indexes to automatically delete documents.
10. **Experiment 3.10:** Monitor and analyze query performance using MongoDB tools.

### Module 4: Data Modeling and Schema Design (10 hours)

- Schema design patterns.
- Embedding vs. referencing.
- Data modeling best practices.

#### Experiments:

1. **Experiment 4.1:** Design a schema for a blog application using embedding.
2. **Experiment 4.2:** Design a schema for an e-commerce application using referencing.
3. **Experiment 4.3:** Compare the performance of embedded vs. referenced data models.
4. **Experiment 4.4:** Implement one-to-many and many-to-many relationships in MongoDB.
5. **Experiment 4.5:** Design a schema for a social media application.
6. **Experiment 4.6:** Implement data modeling best practices in a sample application.
7. **Experiment 4.7:** Optimize a data model for read-heavy workloads.
8. **Experiment 4.8:** Optimize a data model for write-heavy workloads.
9. **Experiment 4.9:** Experiment with different schema design patterns (e.g., bucket pattern).
10. **Experiment 4.10:** Use MongoDB Atlas to visualize and analyze data models.

### Module 5: Replication (10 hours)

- Understanding replication.
- Setting up replica sets.

#### Experiments:

1. **Experiment 5.1:** Set up a replica set locally.
2. **Experiment 5.2:** Add members to a replica set and configure their roles.
3. **Experiment 5.3:** Perform read and write operations on a replica set.
4. **Experiment 5.4:** Simulate a primary node failure and observe the failover process.
5. **Experiment 5.5:** Monitor replica set status and performance using MongoDB tools.
6. **Experiment 5.6:** Configure read preferences to read from secondary nodes.
7. **Experiment 5.7:** Implement write concern and read concern settings in a replica set.
8. **Experiment 5.8:** Perform a backup and restore operation on a replica set.
9. **Experiment 5.9:** Experiment with delayed replica set members.
10. **Experiment 5.10:** Implement and test a hidden replica set member.

### Module 6: Sharding (10 hours)

- Introduction to sharding and partitioning data.

#### Experiments:

1. **Experiment 6.1:** Set up a sharded cluster locally.
2. **Experiment 6.2:** Add shards to a sharded cluster and configure shard keys.
3. **Experiment 6.3:** Perform data distribution across shards using different shard keys.
4. **Experiment 6.4:** Monitor and analyze sharded cluster performance.
5. **Experiment 6.5:** Perform read and write operations on a sharded cluster.
6. **Experiment 6.6:** Experiment with different shard key selection strategies.
7. **Experiment 6.7:** Implement zone sharding to control data distribution.
8. **Experiment 6.8:** Migrate chunks between shards manually.

9. **Experiment 6.9:** Handle a shard failure and observe the recovery process.
10. **Experiment 6.10:** Experiment with balancing data across shards.

### **Module 7: MongoDB Atlas and Cloud Deployment (10 hours)**

- Using MongoDB Atlas.
- Backup and restore strategies.
- Security best practices.

#### **Experiments:**

1. **Experiment 7.1:** Set up a MongoDB Atlas cluster.
2. **Experiment 7.2:** Configure backup and restore strategies in MongoDB Atlas.
3. **Experiment 7.3:** Implement security best practices in MongoDB Atlas (e.g., IP whitelisting, encryption).
4. **Experiment 7.4:** Monitor MongoDB Atlas performance and usage metrics.
5. **Experiment 7.5:** Scale a MongoDB Atlas cluster vertically and horizontally.
6. **Experiment 7.6:** Perform a data migration to MongoDB Atlas from a local instance.
7. **Experiment 7.7:** Implement automated backups and test data recovery.
8. **Experiment 7.8:** Configure and use MongoDB Atlas triggers.
9. **Experiment 7.9:** Integrate MongoDB Atlas with a serverless platform (e.g., AWS Lambda).
10. **Experiment 7.10:** Implement role-based access control in MongoDB Atlas.

#### **Assignments and Projects:**

- Implement a database for a sample application.
- Perform complex queries and aggregations.

## Node.js and Express.js Development (84 Hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUFD1002	Node.js and Express.js Development	03	0+2+1

**Course Description:** This course delves into backend development using Node.js and Express.js, equipping students with the skills to create robust and scalable server-side applications.

### Course Objectives:

- Understand the Node.js runtime and asynchronous programming.
- Develop RESTful APIs using Express.js.
- Implement middleware and error handling to build secure and scalable backend applications.

### Course Outcomes (COs):

- **CO1:** Explain the architecture of Node.js and set up Node.js projects. (Understand, Apply)
- **CO2:** Utilize asynchronous programming concepts such as callbacks, promises, and async/await in Node.js. (Apply, Analyze)
- **CO3:** Develop RESTful APIs using Express.js, including route setup and middleware implementation. (Create, Evaluate)
- **CO4:** Implement authentication and authorization mechanisms using JWT and session-based strategies. (Apply, Analyze)
- **CO5:** Build and deploy secure and scalable Node.js applications, incorporating testing and real-time features. (Create, Evaluate)

### CO-PO-PSO Mapping:

CO/PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3	3	2	2	3	-	-	-	-	2	-	2	3	2	3
CO2	3	2	3	2	3	-	-	-	-	2	-	2	3	2	3
CO3	3	2	3	2	3	-	-	-	2	2	1	2	3	3	3
CO4	3	2	3	2	3	-	-	-	2	2	2	2	3	2	3
CO5	3	2	3	2	3	-	-	-	2	2	2	2	3		

**\*High-3, Medium-2, Low-1**

## Course Syllabus:

### Module 1: Introduction to Node.js (12 hours)

- Node.js architecture.
- Setting up a Node.js project.
- Node.js modules and npm.

#### Experiments:

1. **Experiment 1.1:** Install and configure Node.js and npm.
2. **Experiment 1.2:** Create a simple Node.js application.
3. **Experiment 1.3:** Explore Node.js modules and their usage.
4. **Experiment 1.4:** Use npm to manage project dependencies.
5. **Experiment 1.5:** Build a basic server using Node.js.
6. **Experiment 1.6:** Implement environment variables in Node.js.
7. **Experiment 1.7:** Use Nodemon to automate server restarts.
8. **Experiment 1.8:** Create custom Node.js modules.
9. **Experiment 1.9:** Handle errors in a Node.js application.
10. **Experiment 1.10:** Explore the Node.js file system module.

### Module 2: Asynchronous Programming (12 hours)

- Callbacks, Promises, and Async/Await.
- Event-driven programming.
- Streams and buffers.

#### Experiments:

1. **Experiment 2.1:** Implement callbacks in Node.js.
2. **Experiment 2.2:** Convert callback-based code to Promises.
3. **Experiment 2.3:** Use async/await for asynchronous operations.
4. **Experiment 2.4:** Handle multiple asynchronous operations with Promises.
5. **Experiment 2.5:** Create and manage events using the EventEmitter.
6. **Experiment 2.6:** Implement streams for reading and writing files.
7. **Experiment 2.7:** Use streams to process large data sets.
8. **Experiment 2.8:** Create a custom readable and writable stream.
9. **Experiment 2.9:** Handle backpressure in streams.
10. **Experiment 2.10:** Explore buffers and their usage in Node.js.

### Module 3: Introduction to Express.js (12 hours)

- Basics of Express.js.
- Setting up routes and middleware.
- Handling requests and responses.

#### Experiments:

1. **Experiment 3.1:** Install and configure Express.js.
2. **Experiment 3.2:** Create a basic Express.js application.
3. **Experiment 3.3:** Set up routes in an Express.js application.
4. **Experiment 3.4:** Implement middleware functions in Express.js.
5. **Experiment 3.5:** Handle GET and POST requests in Express.js.
6. **Experiment 3.6:** Create a RESTful API with Express.js.
7. **Experiment 3.7:** Implement error handling in Express.js.
8. **Experiment 3.8:** Use query parameters and URL parameters.
9. **Experiment 3.9:** Serve static files with Express.js.
10. **Experiment 3.10:** Implement request logging using middleware.

### Module 4: Building RESTful APIs (12 hours)

- REST principles and API design.
- CRUD operations with Express.js.
- Data validation and error handling.

#### Experiments:

1. **Experiment 4.1:** Design and implement a RESTful API.
2. **Experiment 4.2:** Create endpoints for CRUD operations.
3. **Experiment 4.3:** Validate incoming data using middleware.
4. **Experiment 4.4:** Handle errors in API responses.
5. **Experiment 4.5:** Implement pagination and filtering in APIs.
6. **Experiment 4.6:** Use Postman to test API endpoints.
7. **Experiment 4.7:** Implement versioning in APIs.
8. **Experiment 4.8:** Add documentation to APIs using Swagger.
9. **Experiment 4.9:** Secure APIs with rate limiting.
10. **Experiment 4.10:** Implement CORS in Express.js.

### Module 5: Authentication and Authorization (12 hours)

- JWT and session-based authentication.
- Role-based access control.
- Security best practices.

## Experiments:

1. **Experiment 5.1:** Implement JWT authentication in an Express.js app.
2. **Experiment 5.2:** Create protected routes using JWT.
3. **Experiment 5.3:** Implement session-based authentication.
4. **Experiment 5.4:** Set up role-based access control.
5. **Experiment 5.5:** Encrypt passwords using bcrypt.
6. **Experiment 5.6:** Secure API endpoints with middleware.
7. **Experiment 5.7:** Implement refresh tokens for JWT.
8. **Experiment 5.8:** Prevent common security vulnerabilities (e.g., XSS, CSRF).
9. **Experiment 5.9:** Monitor authentication attempts and logout.
10. **Experiment 5.10:** Log security events and audit logs.

## Module 6: Advanced Topics in Express.js (12 hours)

- Building real-time applications with WebSockets.
- Testing with Mocha and Chai.
- Deployment and scaling Node.js applications.

## Experiments:

1. **Experiment 6.1:** Implement WebSockets for real-time communication.
2. **Experiment 6.2:** Build a chat application using WebSockets.
3. **Experiment 6.3:** Write unit tests for Express.js routes using Mocha.
4. **Experiment 6.4:** Write integration tests using Chai and Supertest.
5. **Experiment 6.5:** Set up continuous integration with GitHub Actions.
6. **Experiment 6.6:** Deploy a Node.js application to Heroku.
7. **Experiment 6.7:** Deploy a Node.js application to AWS.
8. **Experiment 6.8:** Use Docker to containerize a Node.js application.
9. **Experiment 6.9:** Scale a Node.js application using Docker Swarm.
10. **Experiment 6.10:** Monitor and optimize performance of a Node.js app.

## Module 7: Capstone Project Development (12 hours)

- Develop a RESTful API for a web application.
- Implement user authentication and authorization.
- Peer reviews and feedback sessions.
- Final project presentations.

## Experiments:

1. **Experiment 7.1:** Plan and design a full-stack application.
2. **Experiment 7.2:** Develop the backend API using Node.js and Express.js.
3. **Experiment 7.3:** Implement authentication and authorization.
4. **Experiment 7.4:** Integrate the backend with a frontend application.
5. **Experiment 7.5:** Perform unit and integration testing.
6. **Experiment 7.6:** Deploy the application to a cloud service.
7. **Experiment 7.7:** Conduct a peer review of the project.
8. **Experiment 7.8:** Incorporate feedback and optimize the application.
9. **Experiment 7.9:** Prepare a presentation of the project.
10. **Experiment 7.10:** Demonstrate the final application.

## Front-End Development with React (84 Hours)

**Course Description:** This course provides an in-depth exploration of React, focusing on building dynamic, responsive, and efficient front-end applications.

Course Code	Course Title	Credits	Type (T+P+Pj)
CUFD1003	Front-End Development with React	03	0+2+1

### Course Objectives:

- Connect front-end and back-end components.
- Implement real-time communication and GraphQL.
- Deploy applications using modern CI/CD pipelines.

### Course Outcomes (COs):

- **CO1:** Explain the basics of React and JSX, and set up React projects using Create React App. (Understand, Apply)
- **CO2:** Utilize state and props to manage data and handle events in React components. (Apply, Analyze)
- **CO3:** Implement React Router for navigation and dynamic routing in React applications. (Apply, Create)
- **CO4:** Apply state management techniques using Context API and Redux in React applications. (Analyze, Evaluate)
- **CO5:** Optimize React applications for performance and integrate them with back-end services. (Create, Evaluate)

### CO-PO-PSO Mapping:

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CO4	3	2	3	2	3	-	-	-	2	2	2	2	3	2	3
CO5	3	2	3	2	3	-	-	-	2	2	2	2			

\*High-3, Medium-2, Low-1

## Syllabus:

### Module 1: Introduction to React (10 hours)

- Basics of React and JSX.
- Setting up a React project with Create React App.
- Functional vs. class components.

#### Experiments:

1. **Experiment 1.1:** Set up a React project using Create React App.
2. **Experiment 1.2:** Create and render a simple React component.
3. **Experiment 1.3:** Compare functional and class components.
4. **Experiment 1.4:** Use JSX to create React elements.
5. **Experiment 1.5:** Create nested components in React.
6. **Experiment 1.6:** Implement conditional rendering in React.
7. **Experiment 1.7:** Pass data between components using props.
8. **Experiment 1.8:** Use props to customize component behavior.
9. **Experiment 1.9:** Manage component state using useState.
10. **Experiment 1.10:** Handle events in React components.

### Module 2: State and Props (12 hours)

- Understanding state and props.
- Handling events in React.
- Lifting state up and state management patterns.

#### Experiments:

1. **Experiment 2.1:** Create a stateful component using useState.
2. **Experiment 2.2:** Pass state as props to child components.
3. **Experiment 2.3:** Handle form inputs using state.
4. **Experiment 2.4:** Lift state up to a parent component.
5. **Experiment 2.5:** Implement a controlled component.
6. **Experiment 2.6:** Use callback functions to handle events.
7. **Experiment 2.7:** Implement state management patterns.
8. **Experiment 2.8:** Manage multiple state variables.
9. **Experiment 2.9:** Use useReducer for complex state management.
10. **Experiment 2.10:** Create a simple state management library.

### Module 3: React Lifecycle Methods and Hooks (14 hours)

- Component lifecycle methods.
- Introduction to React hooks (useState, useEffect).
- Custom hooks.

### Experiments:

1. **Experiment 3.1:** Implement component lifecycle methods in class components.
2. **Experiment 3.2:** Use useEffect to manage side effects.
3. **Experiment 3.3:** Create a custom hook for data fetching.
4. **Experiment 3.4:** Use useState and useEffect together.
5. **Experiment 3.5:** Implement cleanup in useEffect.
6. **Experiment 3.6:** Manage component updates with useEffect.
7. **Experiment 3.7:** Create a custom hook for form handling.
8. **Experiment 3.8:** Implement a custom hook for authentication.
9. **Experiment 3.9:** Use useRef to manage component references.
10. **Experiment 3.10:** Optimize performance with useMemo and useCallback.

### Module 4: React Router (12 hours)

- Setting up React Router.
- Navigation and dynamic routing.
- Protected routes.

### Experiments:

1. **Experiment 4.1:** Set up React Router in a React project.
2. **Experiment 4.2:** Create routes for different components.
3. **Experiment 4.3:** Implement dynamic routing using URL parameters.
4. **Experiment 4.4:** Create a navigation menu with React Router.
5. **Experiment 4.5:** Implement protected routes using authentication.
6. **Experiment 4.6:** Redirect users based on authentication status.
7. **Experiment 4.7:** Use React Router hooks for navigation.
8. **Experiment 4.8:** Implement nested routing in React Router.
9. **Experiment 4.9:** Handle 404 pages with React Router.
10. **Experiment 4.10:** Optimize route loading with React.lazy.

### Module 5: State Management with Context API and Redux (10 hours)

- Context API basics.
- Introduction to Redux.
- Connecting Redux with React components.

### Experiments:

1. **Experiment 5.1:** Implement global state management using Context API.
2. **Experiment 5.2:** Create a context provider and consumer.
3. **Experiment 5.3:** Use useContext to access context values.
4. **Experiment 5.4:** Set up Redux in a React project.
5. **Experiment 5.5:** Create Redux actions and reducers.
6. **Experiment 5.6:** Connect Redux state to React components using useSelector.
7. **Experiment 5.7:** Dispatch actions using useDispatch.
8. **Experiment 5.8:** Use Redux middleware for asynchronous actions.
9. **Experiment 5.9:** Integrate Redux DevTools for debugging.
10. **Experiment 5.10:** Compare Context API and Redux for state management.

### Module 6: Form Handling and Validation (10 hours)

- Controlled vs. uncontrolled components.
- Form validation with Formik and Yup.
- Handling form submissions.

#### Experiments:

1. **Experiment 6.1:** Create controlled form components.
2. **Experiment 6.2:** Implement uncontrolled form components.
3. **Experiment 6.3:** Validate form inputs using Formik.
4. **Experiment 6.4:** Use Yup for schema-based form validation.
5. **Experiment 6.5:** Handle form submission events.
6. **Experiment 6.6:** Implement dynamic form validation.
7. **Experiment 6.7:** Create reusable form components with Formik.
8. **Experiment 6.8:** Use Formik hooks for form handling.
9. **Experiment 6.9:** Manage form state with useReducer.
10. **Experiment 6.10:** Integrate form validation with backend APIs.

### Module 7: Performance Optimization and Best Practices (12 hours)

- Code splitting and lazy loading.
- Memoization and useMemo/useCallback.
- Debugging and profiling.

#### Experiments:

1. **Experiment 7.1:** Implement code splitting with React.lazy.
2. **Experiment 7.2:** Use React Suspense for lazy loading components.
3. **Experiment 7.3:** Optimize component rendering with React.memo.
4. **Experiment 7.4:** Use useMemo to memoize expensive calculations.
5. **Experiment 7.5:** Implement useCallback to memoize functions.

6. **Experiment 7.6:** Use React Profiler to measure component performance.
7. **Experiment 7.7:** Debug React applications with React Developer Tools.
8. **Experiment 7.8:** Optimize performance with `shouldComponentUpdate`.
9. **Experiment 7.9:** Implement lazy loading for images and other assets.
10. **Experiment 7.10:** Apply best practices for React project structure.

### Assignments and Projects

1. **Assignment 1:** Build a dynamic front-end application using React.
2. **Assignment 2:** Implement state management with Context API or Redux.
3. **Assignment 3:** Create a multi-page application using React Router.
4. **Assignment 4:** Develop a form with validation using Formik and Yup.
5. **Project:** Integrate React front-end with an Express.js backend to create a full-stack application.

## Full Stack Integration and Deployment (84 Hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUFD1004	Full Stack Integration and Deployment	03	0+2+1

**Course Description:** This course focuses on integrating all components of the MERN stack and deploying full-stack applications to production environments.

### Course Objectives:

- Connect front-end and back-end components.
- Implement real-time communication and GraphQL.
- Deploy applications using modern CI/CD pipelines.

### Course Outcomes (COs):

- **CO1:** Explain the full-stack architecture and configure CORS and security for connecting React with Express.js API. (Understand, Apply)
- **CO2:** Implement real-time communication features in MERN applications using WebSockets and Socket.io. (Apply, Analyze)
- **CO3:** Set up and integrate GraphQL with React and Express.js. (Apply, Create)
- **CO4:** Perform unit, integration, and end-to-end testing on full-stack applications using Jest and Cypress. (Apply, Evaluate)
- **CO5:** Deploy MERN applications to production environments using Heroku, AWS, Docker, and CI/CD pipelines. (Apply, Create)

### CO-PO-PSO Mapping:

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CO2	3	2	3	2	3	-	-	-	-	2	-	2	3	2	3
CO3	3	2	3	2	3	-	-	-	2	2	1	2	3	3	3
CO4	3	2	3	2	3	-	-	-	2	2	2	2	3	2	3
CO5	3	2	3	2	3	-	-	-	2	2	2	2	3	3	3

### Course Syllabus:

## Module 1: Connecting MERN Components (10 hours)

- Overview of full-stack architecture.
- Setting up CORS and security configurations.
- Connecting React with Express.js API.

### Experiments:

1. **Experiment 1.1:** Set up a full-stack MERN application.
2. **Experiment 1.2:** Configure CORS in an Express.js application.
3. **Experiment 1.3:** Secure API endpoints with JWT.
4. **Experiment 1.4:** Connect a React front-end to an Express.js back-end.
5. **Experiment 1.5:** Implement basic CRUD operations in a MERN application.
6. **Experiment 1.6:** Set up and use environment variables.
7. **Experiment 1.7:** Use Axios to make API requests from React.
8. **Experiment 1.8:** Handle authentication and authorization in a MERN app.
9. **Experiment 1.9:** Secure the MERN application against common vulnerabilities.
10. **Experiment 1.10:** Monitor API performance and log requests.

## Module 2: Real-Time Communication with WebSockets (12 hours)

- Introduction to WebSockets.
- Implementing WebSockets with Socket.io.
- Real-time features in MERN applications.

### Experiments:

1. **Experiment 2.1:** Set up a WebSocket server using Socket.io.
2. **Experiment 2.2:** Create a real-time chat application.
3. **Experiment 2.3:** Implement real-time notifications in a MERN app.
4. **Experiment 2.4:** Handle real-time data updates with WebSockets.
5. **Experiment 2.5:** Use Socket.io with React for real-time communication.
6. **Experiment 2.6:** Implement WebSocket authentication.
7. **Experiment 2.7:** Integrate real-time features with a database.
8. **Experiment 2.8:** Monitor WebSocket connections and traffic.
9. **Experiment 2.9:** Handle disconnections and reconnections in Socket.io.
10. **Experiment 2.10:** Scale WebSocket applications with multiple servers.

## Module 3: Introduction to GraphQL (14 hours)

- Basics of GraphQL.
- Setting up a GraphQL server with Express.js.
- Integrating GraphQL with React.

## Experiments:

1. **Experiment 3.1:** Set up a GraphQL server with Express.js.
2. **Experiment 3.2:** Create GraphQL schemas and resolvers.
3. **Experiment 3.3:** Implement queries and mutations in GraphQL.
4. **Experiment 3.4:** Use Apollo Client to connect React with GraphQL.
5. **Experiment 3.5:** Implement authentication in a GraphQL server.
6. **Experiment 3.6:** Use GraphQL to fetch data in a React component.
7. **Experiment 3.7:** Handle errors and validations in GraphQL.
8. **Experiment 3.8:** Integrate GraphQL with MongoDB.
9. **Experiment 3.9:** Optimize GraphQL queries for performance.
10. **Experiment 3.10:** Monitor and debug GraphQL requests.

## Module 4: Testing Full Stack Applications (12 hours)

- Unit testing with Jest.
- Integration testing.
- End-to-end testing with Cypress.

## Experiments:

1. **Experiment 4.1:** Set up Jest for unit testing in a MERN application.
2. **Experiment 4.2:** Write unit tests for React components.
3. **Experiment 4.3:** Test Express.js routes and controllers with Jest.
4. **Experiment 4.4:** Implement integration tests for the MERN stack.
5. **Experiment 4.5:** Set up Cypress for end-to-end testing.
6. **Experiment 4.6:** Write end-to-end tests for a MERN application with Cypress.
7. **Experiment 4.7:** Mock API requests in tests.
8. **Experiment 4.8:** Use testing libraries to simulate user interactions.
9. **Experiment 4.9:** Measure test coverage and improve test quality.
10. **Experiment 4.10:** Automate tests with CI/CD pipelines.

## Module 5: Preparing for Production (10 hours)

- Environment variables and configuration management.
- Logging and monitoring.
- Performance tuning and optimization.

## Experiments:

1. **Experiment 5.1:** Manage environment variables in a MERN application.
2. **Experiment 5.2:** Implement logging with Winston in Express.js.
3. **Experiment 5.3:** Monitor application performance with PM2.

4. **Experiment 5.4:** Optimize database queries for performance.
5. **Experiment 5.5:** Use New Relic for monitoring and performance tuning.
6. **Experiment 5.6:** Implement application-level caching.
7. **Experiment 5.7:** Optimize front-end performance with code splitting.
8. **Experiment 5.8:** Set up and monitor health checks for the application.
9. **Experiment 5.9:** Use a performance monitoring tool like Lighthouse.
10. **Experiment 5.10:** Conduct load testing and stress testing.

## Module 6: Deployment Strategies (12 hours)

- Deploying with Heroku and AWS.
- Dockerizing MERN applications.
- Setting up CI/CD pipelines with GitHub Actions.

### Experiments:

1. **Experiment 6.1:** Deploy a MERN application to Heroku.
2. **Experiment 6.2:** Deploy a MERN application to AWS.
3. **Experiment 6.3:** Set up Docker for a MERN application.
4. **Experiment 6.4:** Create Docker images and containers for deployment.
5. **Experiment 6.5:** Use Docker Compose to manage multi-container applications.
6. **Experiment 6.6:** Set up CI/CD pipelines with GitHub Actions.
7. **Experiment 6.7:** Automate deployments with CI/CD pipelines.
8. **Experiment 6.8:** Monitor deployments and rollbacks.
9. **Experiment 6.9:** Secure Docker containers and images.
10. **Experiment 6.10:** Scale MERN applications using Docker Swarm or Kubernetes.

## Product Development (168 Hours)

**Course Description:** This course focuses on the end-to-end process of product development, from conceptualization to deployment. Students will work on a capstone project integrating all aspects of the MERN stack and deploy their application to a production environment.

### Course Objectives:

- Develop a comprehensive understanding of product development lifecycle.
- Integrate and apply knowledge from the MERN stack to build a complete application.
- Deploy applications to a production environment and manage them effectively.

### Course Outcomes (COs):

- **CO1:** Plan and design a comprehensive product using the MERN stack. (Create, Evaluate)
- **CO2:** Implement front-end and back-end components and integrate them seamlessly. (Apply, Analyze)
- **CO3:** Incorporate real-time features and GraphQL in the application. (Apply, Create)
- **CO4:** Perform thorough testing and debugging of the product. (Apply, Evaluate)
- **CO5:** Deploy the application to a production environment and manage its performance and security. (Apply, Evaluate)

### CO-PO-PSO Mapping:

Course Code	Course Title										Credits	Type (T+P+Pj)			
CUFD1005	Product Development										06	0+0+6			
CO/PO/PS O	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
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CO4	3	2	3	3	3	-	-	-	3	2	2	2	3	3	3
CO5	3	2	3	3	3	-	-	-	3	3	3	3	3	3	3

\*High-3, Medium-2, Low-1

## Course Syllabus:

### Module 1: Product Conceptualization and Planning (20 hours)

- Understanding the product development lifecycle.
- Requirements gathering and analysis.
- Designing the product architecture and UI/UX.

### Module 2: Front-End Development with React (30 hours)

- Building the user interface with React.
- State management with Context API and Redux.
- Implementing routing and form handling.

### Module 3: Back-End Development with Node.js and Express.js (30 hours)

- Setting up the server with Node.js and Express.js.
- Building RESTful APIs and GraphQL endpoints.
- Implementing authentication and authorization.

### Module 4: Integration and Testing (30 hours)

- Integrating front-end and back-end components.
- Unit, integration, and end-to-end testing.
- Debugging and performance optimization.

### Module 5: Deployment and Production Management (20 hours)

- Preparing the application for deployment.
- Setting up CI/CD pipelines.
- Managing production environment and security.

### Assignments and Projects

1. **Assignment 1:** Develop a capstone project integrating all aspects of the MERN stack.
2. **Assignment 2:** Deploy the application to a production environment.

**Domain Track: Generative AI (12 Credits) (0+8+4)**

**Fundamentals of Generative AI (28 Hours)**

Course Code	Course Title	Credits	Type (T+P+Pj)
CUGA1011	Fundamentals of Generative AI	01	0+1+0

**Course Description:** This course introduces the fundamental concepts and techniques in generative AI, providing a solid foundation for understanding and building generative models.

**Course Objectives:**

- Understand the basic concepts and history of generative AI.
- Learn about various generative models and their applications.
- Gain proficiency in basic machine learning concepts relevant to generative AI.

**Course Outcomes (COs):**

- **CO1:** Explain the basic concepts and history of generative AI. (Understand, Remember)
- **CO2:** Distinguish between different types of machine learning, including supervised and unsupervised learning. (Understand, Analyze)
- **CO3:** Describe the architecture and functioning of various generative models. (Understand, Apply)
- **CO4:** Understand the basic concepts and challenges of training Generative Adversarial Networks (GANs). (Understand, Analyze)
- **CO5:** Evaluate and compare different generative models based on their performance and applications. (Evaluate, Analyze)

**CO-PO-PSO Mapping:**

CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO11	PO12	PSO1	PSO2	PSO3
<b>CO1</b>	3	2	2	1	2	-	-	-	-	1	3	2	3
<b>CO2</b>	3	3	2	2	2	-	-	-	-	2	3	2	3
<b>CO3</b>	3	2	3	2	2	-	-	-	1	2	3	3	3
<b>CO4</b>	3	2	3	2	3	-	-	-	2	2	3	3	3
<b>CO5</b>	3	3	3	3	3	-	-	-	2	2	3	3	3

**\*High-3, Medium-2, Low-1**

## **Course Syllabus:**

### **Module 1: Introduction to Generative AI (2 hours)**

- Overview of AI and machine learning.
- History and evolution of generative AI.
- Applications of generative AI in various fields.

### **Module 2: Basic Machine Learning Concepts (2 hours)**

- Supervised vs. unsupervised learning.
- Introduction to neural networks and deep learning.
- Basic optimization techniques.

### **Module 3: Generative Models (2 hours)**

- Introduction to generative models.
- Gaussian Mixture Models (GMMs).
- Hidden Markov Models (HMMs).

### **Module 4: Generative Adversarial Networks (GANs) (2 hours)**

- Basic concepts of GANs.
- Architecture of GANs: Generator and Discriminator.
- Training GANs and common challenges.

### **Module 5: Variational Autoencoders (VAEs) (2 hours)**

- Introduction to VAEs.
- VAE architecture and loss functions.
- Applications of VAEs.

### **Module 6: Other Generative Models (2 hours)**

- Restricted Boltzmann Machines (RBMs).
- Normalizing Flows.
- Autoregressive models.

### **Module 7: Applications and Future of Generative AI (2 hours)**

- Current applications of generative AI in various fields.
- Ethical considerations and challenges in generative AI.
- Future directions and advancements in generative AI.

### Assignments and Projects:

- **Assignment 1:** Implement basic generative models using Python.
- **Assignment 2:** Compare and contrast different generative models based on their performance and applications.

### Relevant Job Roles:

- Machine Learning Engineer: Understand and implement foundational generative models.
- Data Scientist: Analyze and apply generative AI techniques to data.
- AI Research Scientist: Study and develop new generative AI methods.
- AI Developer: Build and integrate basic generative AI applications.

### Advanced Techniques in Generative AI (54 Hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUGA1012	Advanced Techniques in Generative AI	02	0+2+0

**Course Description:** This course delves into advanced generative AI techniques, exploring state-of-the-art models and their applications in various domains.

### Course Objectives:

- Master advanced techniques in generative AI.
- Understand and implement state-of-the-art generative models.
- Explore applications of generative AI in creative and scientific fields.

### Course Outcomes (COs):

- **CO1:** Explain the architecture and functionality of advanced generative models such as DCGANs, cGANs, StyleGAN, and BigGAN. (Understand, Analyze)
- **CO2:** Implement sequence generation models using RNNs and LSTMs, and apply GANs and VAEs for sequence generation. (Apply, Create)
- **CO3:** Understand and implement attention mechanisms and transformer architectures, including GPT. (Understand, Apply)

- **CO4:** Describe diffusion models and their applications in image and text generation. (Understand, Analyze)
- **CO5:** Evaluate and apply advanced training techniques for GANs and VAEs, and understand ethical considerations in generative AI. (Evaluate, Apply)

**CO-PO-PSO Mapping:**

CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	3	-	-	-	-	2	3	3	3
CO2	3	2	3	2	3	-	-	-	-	2	3	3	3
CO3	3	2	3	3	3	-	-	-	1	2	3	3	3
CO4	3	2	3	2	3	-	-	-	2	2	3	3	3
CO5	3	3	3	3	3	-	-	-	2	2	3	3	3

**\*High-3, Medium-2, Low-1**

**Course Syllabus:**

**Module 1: Deep Generative Models (9 hours)**

- Deep Convolutional GANs (DCGANs).
- Conditional GANs (cGANs).
- StyleGAN and BigGAN.

**Module 2: Sequence Generation Models (9 hours)**

- Recurrent Neural Networks (RNNs).
- Long Short-Term Memory (LSTM) networks.
- Generating sequences with GANs and VAEs.

**Module 3: Attention Mechanisms and Transformers (9 hours)**

- Introduction to attention mechanisms.
- Transformer architecture.
- Generative Pre-trained Transformers (GPT).

**Module 4: Diffusion Models (9 hours)**

- Introduction to diffusion models.
- Training and inference processes.
- Applications in image and text generation.

### Module 5: Advanced Topics in GANs and VAEs (9 hours)

- CycleGAN and Pix2Pix.
- Denoising Autoencoders.
- Advanced training techniques and loss functions.

### Module 6: Applications and Ethics (9 hours)

- Applications in art, music, and design.
- Ethical considerations and biases in generative AI.
- Fairness, accountability, and transparency.

### Assignments and Projects:

- **Assignment 1:** Implement advanced generative models.
- **Assignment 2:** Explore creative applications of generative AI.

### Relevant Job Roles:

- **Machine Learning Engineer:** Develop and optimize advanced generative models.
- **Data Scientist:** Apply advanced generative techniques to complex datasets.
- **AI Research Scientist:** Conduct cutting-edge research in generative AI.
- **AI Developer:** Create sophisticated generative AI applications for various industries.

### Real-Time Generative AI (84 Hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUGA1013	Real-Time Generative AI	03	0+1+2

**Course Description:** This course focuses on the practical aspects of implementing generative AI models, including programming, optimization, and deployment.

### Course Objectives:

- Gain hands-on experience with generative AI tools and libraries.
- Learn to optimize and fine-tune generative models.
- Deploy generative AI models in real-world applications.

### Course Outcomes (COs):

- **CO1:** Implement basic neural networks using TensorFlow and PyTorch, and utilize pre-trained models. (Apply, Create)
- **CO2:** Apply training techniques and hyperparameter tuning to optimize generative models. (Apply, Analyze)
- **CO3:** Implement transfer learning and fine-tune pre-trained generative models for specific tasks. (Apply, Create)
- **CO4:** Evaluate generative models using common metrics and interpret the results. (Evaluate, Analyze)
- **CO5:** Deploy generative AI models using cloud platforms and build APIs for real-world applications. (Apply, Create)

### CO-PO-PSO Mapping:

CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	3	-	-	-	-	2	3	3	3
CO2	3	2	3	2	3	-	-	-	-	2	3	3	3
CO3	3	2	3	3	3	-	-	-	1	2	3	3	3
CO4	3	2	3	2	3	-	-	-	2	2	3	3	3
CO5	3	2	3	3	3	-	-	-	2	2	3	3	3

**\*High-3, Medium-2, Low-1**

### Course Syllabus:

#### Module 1: Programming Tools and Libraries (6 hours)

- Introduction to TensorFlow and PyTorch.
- Implementing basic neural networks.
- Utilizing pre-trained models.

#### Experiments:

1. **Experiment 1.1:** Set up TensorFlow and PyTorch environments.
2. **Experiment 1.2:** Implement a simple feedforward neural network in TensorFlow.
3. **Experiment 1.3:** Implement a simple feedforward neural network in PyTorch.
4. **Experiment 1.4:** Load and utilize pre-trained models from TensorFlow Hub.
5. **Experiment 1.5:** Load and utilize pre-trained models from PyTorch Hub.
6. **Experiment 1.6:** Compare the performance of TensorFlow and PyTorch models.
7. **Experiment 1.7:** Implement a Convolutional Neural Network (CNN) in TensorFlow.

8. **Experiment 1.8:** Implement a Convolutional Neural Network (CNN) in PyTorch.
9. **Experiment 1.9:** Fine-tune a pre-trained model for a specific task in TensorFlow.
10. **Experiment 1.10:** Fine-tune a pre-trained model for a specific task in PyTorch.

## Module 2: Model Training and Optimization (6 hours)

- Training techniques and strategies.
- Hyperparameter tuning.
- Optimization algorithms (SGD, Adam, etc.).

### Experiments:

1. **Experiment 2.1:** Train a neural network using SGD in TensorFlow.
2. **Experiment 2.2:** Train a neural network using Adam in PyTorch.
3. **Experiment 2.3:** Implement learning rate scheduling in TensorFlow.
4. **Experiment 2.4:** Implement learning rate scheduling in PyTorch.
5. **Experiment 2.5:** Perform hyperparameter tuning using TensorFlow.
6. **Experiment 2.6:** Perform hyperparameter tuning using PyTorch.
7. **Experiment 2.7:** Use TensorBoard to visualize training metrics.
8. **Experiment 2.8:** Use PyTorch's visualization tools to monitor training.
9. **Experiment 2.9:** Apply gradient clipping in TensorFlow.
10. **Experiment 2.10:** Apply gradient clipping in PyTorch.

## Module 3: Fine-Tuning and Transfer Learning (6 hours)

- Transfer learning concepts.
- Fine-tuning pre-trained generative models.
- Practical examples and case studies.

### Experiments:

1. **Experiment 3.1:** Implement transfer learning using a pre-trained CNN in TensorFlow.
2. **Experiment 3.2:** Implement transfer learning using a pre-trained CNN in PyTorch.
3. **Experiment 3.3:** Fine-tune a GAN for image generation in TensorFlow.
4. **Experiment 3.4:** Fine-tune a GAN for image generation in PyTorch.
5. **Experiment 3.5:** Transfer learning for text generation using GPT in TensorFlow.
6. **Experiment 3.6:** Transfer learning for text generation using GPT in PyTorch.
7. **Experiment 3.7:** Case study: Fine-tuning a VAE for image reconstruction in TensorFlow.
8. **Experiment 3.8:** Case study: Fine-tuning a VAE for image reconstruction in PyTorch.
9. **Experiment 3.9:** Implement domain adaptation using transfer learning in TensorFlow.
10. **Experiment 3.10:** Implement domain adaptation using transfer learning in PyTorch.

## Module 4: Evaluation and Metrics (6 hours)

- Evaluating generative models.
- Common metrics (FID, Inception Score).
- Visualizing and interpreting results.

### Experiments:

1. **Experiment 4.1:** Evaluate a GAN using the Frechet Inception Distance (FID) score.
2. **Experiment 4.2:** Evaluate a GAN using the Inception Score.
3. **Experiment 4.3:** Visualize GAN outputs using TensorBoard in TensorFlow.
4. **Experiment 4.4:** Visualize GAN outputs using Matplotlib in PyTorch.
5. **Experiment 4.5:** Implement precision and recall metrics for generative models.
6. **Experiment 4.6:** Compare the performance of different generative models using FID.
7. **Experiment 4.7:** Visualize latent space interpolations in VAEs.
8. **Experiment 4.8:** Use t-SNE for visualizing high-dimensional data in generative models.
9. **Experiment 4.9:** Interpret model outputs using SHAP values in TensorFlow.
10. **Experiment 4.10:** Interpret model outputs using SHAP values in PyTorch.

### Module 5: Deployment of Generative Models (6 hours)

- Model deployment strategies.
- Using cloud platforms for deployment (AWS, Google Cloud).
- Building APIs for generative models.

### Experiments:

1. **Experiment 5.1:** Deploy a generative model on AWS SageMaker.
2. **Experiment 5.2:** Deploy a generative model on Google Cloud AI Platform.
3. **Experiment 5.3:** Create a REST API for a generative model using Flask.
4. **Experiment 5.4:** Create a REST API for a generative model using FastAPI.
5. **Experiment 5.5:** Use Docker to containerize a generative model.
6. **Experiment 5.6:** Deploy a Dockerized model to AWS ECS.
7. **Experiment 5.7:** Deploy a Dockerized model to Google Kubernetes Engine.
8. **Experiment 5.8:** Implement model versioning and rollback strategies.
9. **Experiment 5.9:** Monitor model performance in production using Prometheus.
10. **Experiment 5.10:** Set up continuous deployment for generative models with GitHub Actions.

### Module 6: Practical Applications (6 hours)

- Integrating generative models into applications.
- Case studies in various industries.
- Future trends and research directions.

## Experiments:

1. **Experiment 6.1:** Integrate a generative model into a web application.
2. **Experiment 6.2:** Develop a chatbot using a generative model.
3. **Experiment 6.3:** Create an image generation application using GANs.
4. **Experiment 6.4:** Implement a music generation system using RNNs.
5. **Experiment 6.5:** Use generative models for data augmentation in computer vision.
6. **Experiment 6.6:** Apply generative models to generate synthetic data for training.
7. **Experiment 6.7:** Case study: Generative AI in healthcare for medical imaging.
8. **Experiment 6.8:** Case study: Generative AI in finance for synthetic data generation.
9. **Experiment 6.9:** Research trends: Latest advancements in generative AI.
10. **Experiment 6.10:** Explore ethical implications and bias in generative models.

## Assignments and Projects:

- **Assignment 1:** Implement and fine-tune a generative model for a specific application.
- **Assignment 2:** Deploy a generative AI model as a web service.

## Relevant Job Roles:

- **Machine Learning Engineer:** Train, optimize, and deploy generative AI models.
- **Data Scientist:** Evaluate and improve generative models based on performance metrics.
- **AI Developer:** Implement and deploy generative AI solutions in production environments.

### Research and Development in Generative AI (54 Hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUGA1014	Research and Development in Generative AI	02	0+2+0

**Course Description:** This course emphasizes research methodologies and the development of innovative solutions in the field of generative AI.

## Course Objectives:

- Conduct research in generative AI.
- Develop innovative solutions and contribute to the field.
- Learn about recent advancements and open research areas.

### Course Outcomes (COs):

- **CO1:** Understand and apply AI research methodologies, including literature review and critical analysis. (Understand, Apply)
- **CO2:** Analyze recent advances and emerging trends in generative AI. (Analyze, Evaluate)
- **CO3:** Formulate research questions and design experiments to develop innovative solutions in generative AI. (Create, Evaluate)
- **CO4:** Collaborate effectively in research teams and present research findings. (Apply, Evaluate)
- **CO5:** Identify open problems in generative AI and propose future research directions. (Analyze, Create)

### CO-PO-PSO Mapping:

CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	-	-	2	2	2	3	3	3
CO2	3	3	3	3	3	-	-	2	2	2	3	3	3
CO3	3	3	3	3	3	-	-	2	2	2	3	3	3
CO4	3	3	3	3	3	-	-	3	2	3	3	3	3
CO5	3	3	3	3	3	-	-	3	2	3	3	3	3

**\*High-3, Medium-2, Low-1**

### Course Syllabus:

#### Module 1: Research Methodologies (9 hours)

- Introduction to AI research methodologies.
- Literature review and critical analysis.
- Identifying research gaps.

#### Experiments:

1. **Experiment 1.1:** Conduct a literature review on a generative AI topic.
2. **Experiment 1.2:** Critically analyze a seminal paper in generative AI.
3. **Experiment 1.3:** Identify research gaps from recent studies.
4. **Experiment 1.4:** Develop a research proposal based on identified gaps.
5. **Experiment 1.5:** Present a literature review summary.
6. **Experiment 1.6:** Create a mind map of current research trends.

7. **Experiment 1.7:** Use reference management software for organizing literature.
8. **Experiment 1.8:** Write an abstract summarizing a research paper.
9. **Experiment 1.9:** Analyze the methodology section of a research paper.
10. **Experiment 1.10:** Conduct a peer review of a literature review draft.

### **Module 2: Recent Advances in Generative AI (9 hours)**

- Review of recent papers and studies.
- Advanced topics in GANs, VAEs, and Transformers.
- Emerging trends and technologies.

#### **Experiments:**

1. **Experiment 2.1:** Summarize key findings from a recent GANs paper.
2. **Experiment 2.2:** Present a recent study on VAEs.
3. **Experiment 2.3:** Analyze a paper on Transformer models.
4. **Experiment 2.4:** Identify emerging trends in generative AI from recent publications.
5. **Experiment 2.5:** Conduct a comparative analysis of two recent papers.
6. **Experiment 2.6:** Present an advanced topic in GANs to the class.
7. **Experiment 2.7:** Review a paper on the latest advancements in VAEs.
8. **Experiment 2.8:** Create a presentation on recent trends in Transformer models.
9. **Experiment 2.9:** Analyze the impact of emerging technologies on generative AI.
10. **Experiment 2.10:** Write a summary of recent advances in generative AI.

### **Module 3: Developing Innovative Solutions (9 hours)**

- Formulating research questions.
- Designing experiments and studies.
- Prototyping and iterative development.

#### **Experiments:**

1. **Experiment 3.1:** Formulate a research question in generative AI.
2. **Experiment 3.2:** Design an experiment to test a generative AI hypothesis.
3. **Experiment 3.3:** Develop a prototype for a generative AI model.
4. **Experiment 3.4:** Conduct an initial experiment and gather data.
5. **Experiment 3.5:** Analyze experimental results and refine the prototype.
6. **Experiment 3.6:** Iterate on the prototype based on feedback.
7. **Experiment 3.7:** Write a research methodology section for a paper.
8. **Experiment 3.8:** Create a project plan for iterative development.
9. **Experiment 3.9:** Present the progress of an innovative solution.
10. **Experiment 3.10:** Conduct a peer review of a research design proposal.

## Module 4: Collaborative Research (9 hours)

- Collaboration tools and platforms.
- Working in research teams.
- Presenting and publishing research.

### Experiments:

1. **Experiment 4.1:** Use a collaboration platform (e.g., Overleaf) to write a research paper.
2. **Experiment 4.2:** Participate in a virtual research team meeting.
3. **Experiment 4.3:** Present research findings to the class.
4. **Experiment 4.4:** Write a draft research paper for submission.
5. **Experiment 4.5:** Use a version control system (e.g., Git) for research collaboration.
6. **Experiment 4.6:** Conduct a peer review of a draft research paper.
7. **Experiment 4.7:** Collaborate on a research presentation.
8. **Experiment 4.8:** Submit a research paper to a conference or journal.
9. **Experiment 4.9:** Create a poster presentation for a research project.
10. **Experiment 4.10:** Conduct a mock research presentation and receive feedback.

## Module 5: Case Studies and Applications (9 hours)

- Case studies of successful generative AI applications.
- Analysis of failures and challenges.
- Learning from industry and academia.

### Experiments:

1. **Experiment 5.1:** Analyze a case study of a successful generative AI application.
2. **Experiment 5.2:** Present a case study of a failed generative AI project.
3. **Experiment 5.3:** Identify lessons learned from a successful AI project.
4. **Experiment 5.4:** Conduct a SWOT analysis of a generative AI application.
5. **Experiment 5.5:** Review an industry report on generative AI.
6. **Experiment 5.6:** Create a case study of a generative AI project.
7. **Experiment 5.7:** Analyze the challenges faced by a generative AI application.
8. **Experiment 5.8:** Present findings from a case study analysis.
9. **Experiment 5.9:** Compare academic and industry approaches to generative AI.
10. **Experiment 5.10:** Write a case study report on a generative AI application.

## Module 6: Future Directions (9 hours)

- Open problems in generative AI.
- Potential impact on society and industries.
- Preparing for a career in AI research.

## Experiments:

1. **Experiment 6.1:** Identify open research questions in generative AI.
2. **Experiment 6.2:** Write a research proposal for an open problem.
3. **Experiment 6.3:** Present potential societal impacts of generative AI.
4. **Experiment 6.4:** Analyze the impact of generative AI on a specific industry.
5. **Experiment 6.5:** Create a roadmap for future research in generative AI.
6. **Experiment 6.6:** Review ethical considerations in generative AI research.
7. **Experiment 6.7:** Develop a career plan for AI research.
8. **Experiment 6.8:** Conduct a mock interview for an AI research position.
9. **Experiment 6.9:** Write a statement of research interests.
10. **Experiment 6.10:** Present a vision for the future of generative AI research.

## Assignments and Projects:

- **Assignment 1:** Conduct a mini-research project.
- **Assignment 2:** Present findings and propose future research directions.

## Relevant Job Roles:

- **AI Research Scientist:** Conduct advanced research and contribute to scientific knowledge in generative AI.
- **Machine Learning Engineer:** Innovate and develop new generative models and techniques.
- **Data Scientist:** Apply research methodologies to analyze and improve generative models.

### Capstone Project in Generative AI (112 Hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUGA1015	Capstone Project in Generative AI	04	0+2+2

**Course Description:** The capstone project is a comprehensive, hands-on project that synthesizes the knowledge and skills acquired throughout the program. Students will work on real-world problems, develop innovative solutions, and present their work.

## Course Objectives:

- Apply theoretical knowledge to practical problems.
- Develop a comprehensive generative AI project.

- Demonstrate proficiency in model development, implementation, and deployment.

### **Project Phases:**

#### **Phase 1: Project Proposal and Planning (Weeks 1-2) (18 Hours)**

- Identify a real-world problem or research question.
- Conduct a literature review.
- Develop a project proposal outlining objectives, methodology, and timeline.

#### **Deliverables:**

1. Project proposal document.
2. Literature review summary.

#### **Experiments:**

1. **Experiment 1.1:** Identify and define a real-world problem suitable for a generative AI solution.
2. **Experiment 1.2:** Conduct a comprehensive literature review on the chosen problem.
3. **Experiment 1.3:** Develop a detailed project proposal with objectives, methodology, and timeline.

#### **Phase 2: Research and Development (Weeks 3-6) (36 Hours)**

- Conduct necessary research and data collection.
- Develop and train generative models.
- Iterate and refine models based on feedback and results.

#### **Deliverables:**

1. Research and development logs.
2. Initial model prototypes.

#### **Experiments:**

1. **Experiment 2.1:** Collect and preprocess data required for the project.
2. **Experiment 2.2:** Develop an initial generative model.
3. **Experiment 2.3:** Train the generative model using collected data.
4. **Experiment 2.4:** Evaluate the initial model and gather feedback.
5. **Experiment 2.5:** Refine the model based on feedback and re-evaluate.

#### **Phase 3: Implementation and Testing (Weeks 7-10) (36 Hours)**

- Implement the generative AI solution.

- Test the model rigorously using appropriate metrics.
- Optimize and fine-tune the solution.

#### **Deliverables:**

1. Finalized generative model.
2. Testing and evaluation reports.

#### **Experiments:**

1. **Experiment 3.1:** Implement the generative AI model into a functional system.
2. **Experiment 3.2:** Conduct extensive testing using relevant metrics (e.g., FID, Inception Score).
3. **Experiment 3.3:** Optimize the model for performance and accuracy.
4. **Experiment 3.4:** Fine-tune hyperparameters to enhance model performance.
5. **Experiment 3.5:** Document the testing process and results.

#### **Phase 4: Deployment and Presentation (Weeks 11-12) (24 Hours)**

- Deploy the solution to a production environment.
- Prepare a comprehensive project report.
- Present the project to peers and instructors.

#### **Deliverables:**

1. Deployed generative AI application.
2. Final project report.
3. Project presentation.

#### **Experiments:**

1. **Experiment 4.1:** Deploy the generative AI model to a cloud platform (e.g., AWS, Google Cloud).
2. **Experiment 4.2:** Ensure the deployed model is accessible and functional.
3. **Experiment 4.3:** Prepare a detailed project report documenting the entire process.
4. **Experiment 4.4:** Develop a presentation summarizing the project findings and outcomes.
5. **Experiment 4.5:** Conduct a mock presentation and receive feedback.

**Domain Track: Data Analytics and Machine Learning (0+6+12 Credits)**

**Machine Learning for Predictive Analytics (112 hrs)**

Course Code	Course Title	Credits	Type (T+P+Pj)
CUML1021	Machine Learning for Predictive Analytics	04	0+2+2

**Course Description:** This course covers the foundational concepts and techniques of machine learning with a focus on predictive analytics. Students will learn to build, evaluate, and interpret predictive models using various machine learning algorithms.

**Course Objectives:**

- Understand the core concepts of predictive analytics.
- Develop and evaluate predictive models using supervised and unsupervised learning algorithms.
- Deploy machine learning models and interpret their outcomes in real-world applications.

**Course Outcomes (COs):**

- **CO1:** Explain the fundamental concepts and applications of predictive analytics. (Understand, Remember)
- **CO2:** Apply data preprocessing techniques to prepare data for machine learning models. (Apply, Analyze)
- **CO3:** Build and evaluate predictive models using supervised learning algorithms. (Apply, Evaluate)
- **CO4:** Utilize advanced machine learning techniques and unsupervised learning methods. (Apply, Analyze)
- **CO5:** Deploy machine learning models and interpret their outcomes in real-world applications. (Apply, Create)

**CO-PO-PSO Mapping**

CO/PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3	2	2	1	2	-	-	-	-	-	-	1	3	2	3
CO2	3	3	3	2	2	-	-	-	1	-	-	2	3	3	3
CO3	3	3	3	2	3	-	-	-	1	-	-	2	3	3	3



CO4	3	3	3	3	3	1	1	-	2	-	2	2	3	3	3
CO5	3	3	3	3	3	2	2	3	2	2	2	3	3	3	3

**\*High-3, Medium-2, Low-1**

**Syllabus:**

**Module 1: Introduction to Predictive Analytics (16 hours)**

- Overview of Predictive Analytics
- Applications and Case Studies

**Experiments:**

1. **Experiment 1.1:** Research and present a case study on predictive analytics.
2. **Experiment 1.2:** Identify and discuss real-world applications of predictive analytics.
3. **Experiment 1.3:** Conduct a literature review on predictive analytics methodologies.
4. **Experiment 1.4:** Develop a project proposal for a predictive analytics project.

**Module 2: Data Preprocessing (6 hours)**

- Data Cleaning
- Feature Engineering
- Data Transformation

**Experiments:**

1. **Experiment 2.1:** Clean a raw dataset and handle missing values.
2. **Experiment 2.2:** Perform feature engineering on a dataset.
3. **Experiment 2.3:** Apply data transformation techniques such as normalization and standardization.
4. **Experiment 2.4:** Encode categorical variables in a dataset.
5. **Experiment 2.5:** Implement feature selection techniques.
6. **Experiment 2.6:** Split a dataset into training and testing sets.

**Module 3: Supervised Learning Algorithms (16 hours)**

- Linear Regression
- Logistic Regression
- Decision Trees
- Random Forests
- Support Vector Machines

### Experiments:

1. **Experiment 3.1:** Implement linear regression on a dataset.
2. **Experiment 3.2:** Apply logistic regression for binary classification.
3. **Experiment 3.3:** Build a decision tree model and visualize it.
4. **Experiment 3.4:** Train a random forest model and evaluate its performance.
5. **Experiment 3.5:** Use support vector machines for classification tasks.
6. **Experiment 3.6:** Compare the performance of different supervised learning algorithms.
7. **Experiment 3.7:** Conduct a hyperparameter tuning experiment for a random forest model.
8. **Experiment 3.8:** Implement a multi-class classification using logistic regression.
9. **Experiment 3.9:** Evaluate model performance using confusion matrix and classification report.
10. **Experiment 3.10:** Document the implementation and evaluation process of a supervised learning model.

### Module 4: Model Evaluation and Selection (16 hours)

- Train-Test Split
- Cross-Validation
- Performance Metrics (Accuracy, Precision, Recall, F1 Score, AUC-ROC)

### Experiments:

1. **Experiment 4.1:** Split a dataset into training and testing sets and evaluate model performance.
2. **Experiment 4.2:** Implement k-fold cross-validation for model evaluation.
3. **Experiment 4.3:** Calculate and interpret accuracy, precision, recall, and F1 score.
4. **Experiment 4.4:** Plot and analyze ROC curves and calculate AUC.
5. **Experiment 4.5:** Perform model selection using cross-validation scores.
6. **Experiment 4.6:** Compare different performance metrics for model evaluation.

### Module 5: Advanced Machine Learning Techniques (16 hours)

- Ensemble Methods (Bagging, Boosting)
- Gradient Boosting Machines (GBM)
- Hyperparameter Tuning

### Experiments:

1. **Experiment 5.1:** Implement bagging with decision trees.
2. **Experiment 5.2:** Apply boosting techniques using AdaBoost.

3. **Experiment 5.3:** Train a gradient boosting machine model.
4. **Experiment 5.4:** Compare the performance of bagging, boosting, and GBM.
5. **Experiment 5.5:** Perform hyperparameter tuning for a GBM model.
6. **Experiment 5.6:** Implement stacking ensemble method.
7. **Experiment 5.7:** Analyze the impact of hyperparameters on model performance.
8. **Experiment 5.8:** Use random search for hyperparameter optimization.
9. **Experiment 5.9:** Evaluate the performance of ensemble methods on different datasets.
10. **Experiment 5.10:** Document and present the advanced techniques used in model building.

## Module 6: Unsupervised Learning (16 hours)

- Clustering (K-Means, Hierarchical Clustering)
- Dimensionality Reduction (PCA, LDA)

### Experiments:

1. **Experiment 6.1:** Implement K-Means clustering on a dataset.
2. **Experiment 6.2:** Perform hierarchical clustering and visualize dendrograms.
3. **Experiment 6.3:** Apply PCA for dimensionality reduction.
4. **Experiment 6.4:** Use LDA for dimensionality reduction and classification.
5. **Experiment 6.5:** Compare the results of K-Means and hierarchical clustering.
6. **Experiment 6.6:** Visualize clusters using scatter plots and pair plots.
7. **Experiment 6.7:** Evaluate clustering performance using silhouette scores.
8. **Experiment 6.8:** Implement t-SNE for high-dimensional data visualization.
9. **Experiment 6.9:** Perform cluster analysis on a real-world dataset.
10. **Experiment 6.10:** Document and present the findings of unsupervised learning experiments.

## Module 7: Model Deployment (16 hours)

- Introduction to Model Deployment
- Tools and Techniques for Deploying Models

### Experiments:

1. **Experiment 7.1:** Save and load machine learning models using joblib or pickle.
2. **Experiment 7.2:** Deploy a machine learning model using Flask.
3. **Experiment 7.3:** Create a REST API for a predictive model.
4. **Experiment 7.4:** Use Docker to containerize a machine learning application.
5. **Experiment 7.5:** Deploy a model to a cloud platform (e.g., AWS, Heroku).
6. **Experiment 7.6:** Implement model versioning and rollback strategies.
7. **Experiment 7.7:** Monitor model performance in a production environment.

8. **Experiment 7.8:** Set up continuous integration and deployment for machine learning models.
9. **Experiment 7.9:** Test and validate the deployed model API.
10. **Experiment 7.10:** Document and present the model deployment process.

### **Assignments and Projects:**

1. **Assignment 1:** Conduct a mini-research project on a predictive analytics topic.
2. **Assignment 2:** Develop and deploy a predictive model for a real-world application.

### **Relevant Job Roles:**

- **Machine Learning Engineer:** Build, optimize, and deploy predictive models.
- **Data Scientist:** Analyze data and develop predictive models.
- **AI Developer:** Implement and deploy machine learning solutions.

### **Textbooks and References:**

- "Introduction to Statistical Learning" by Gareth James, Daniela Witten, Trevor Hastie, and Robert Tibshirani
- "Machine Learning Yearning" by Andrew Ng

## Deep Learning for Image Analytics (112 hrs)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUML1022	Deep Learning for Image Analytics	04	0+2+2

**Course Description:** This course introduces deep learning concepts and techniques specifically applied to image analytics. Students will gain hands-on experience in developing and deploying convolutional neural networks (CNNs) for image classification, object detection, and image generation.

### Course Objectives:

- Understand deep learning fundamentals and CNN architectures.
- Develop and evaluate CNNs for image classification and object detection.
- Implement generative models and deploy deep learning applications using modern frameworks.

### Course Outcomes (COs):

- **CO1:** Explain the basic concepts of neural networks, including activation functions and backpropagation. (Understand, Remember)
- **CO2:** Design and implement CNN architectures for various image analytics tasks. (Apply, Create)
- **CO3:** Utilize advanced CNN architectures and transfer learning for enhanced performance. (Apply, Analyze)
- **CO4:** Develop and evaluate models for image classification, object detection, and segmentation. (Apply, Evaluate)
- **CO5:** Implement generative models and deploy deep learning applications using TensorFlow, Keras, and PyTorch. (Apply, Create)

## CO-PO-PSO Mapping

CO/PO/PS O	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3	2	2	1	2	-	-	-	-	-	-	1	3	2	3
CO2	3	3	3	2	2	-	-	-	1	-	-	2	3	3	3
CO3	3	3	3	2	3	-	-	-	1	-	-	2	3	3	3
CO4	3	3	3	3	3	1	1	-	2	-	2	2	3	3	3
CO5	3	3	3	3	3	2	2	3	2	2	2	3	3	3	3

**\*High-3, Medium-2, Low-1**

### Syllabus:

#### Module 1: Introduction to Deep Learning (16 hours)

- Basics of Neural Networks
- Activation Functions
- Backpropagation and Gradient Descent

#### Experiments:

1. **Experiment 1.1:** Implement a simple neural network from scratch.
2. **Experiment 1.2:** Explore various activation functions and their effects on model performance.
3. **Experiment 1.3:** Implement backpropagation and gradient descent for a basic neural network.
4. **Experiment 1.4:** Visualize the training process of a neural network.
5. **Experiment 1.5:** Compare different optimization algorithms in training a neural network.
6. **Experiment 1.6:** Implement a neural network using a deep learning framework (e.g., TensorFlow).
7. **Experiment 1.7:** Analyze the impact of different learning rates on training.
8. **Experiment 1.8:** Implement dropout and observe its effect on model performance.
9. **Experiment 1.9:** Conduct experiments with different network architectures.
10. **Experiment 1.10:** Document and present the results of neural network experiments.

#### Module 2: Convolutional Neural Networks (CNNs) (16 hours)

- Architecture of CNNs
- Convolutional Layers, Pooling Layers

- Fully Connected Layers

### Experiments:

1. **Experiment 2.1:** Build a basic CNN for image classification.
2. **Experiment 2.2:** Explore the effects of different pooling techniques.
3. **Experiment 2.3:** Visualize feature maps and filters in a CNN.
4. **Experiment 2.4:** Implement a CNN with multiple convolutional and pooling layers.
5. **Experiment 2.5:** Compare the performance of a CNN with and without fully connected layers.
6. **Experiment 2.6:** Experiment with different activation functions in a CNN.
7. **Experiment 2.7:** Train a CNN on a small image dataset and evaluate its performance.
8. **Experiment 2.8:** Implement dropout and batch normalization in a CNN.
9. **Experiment 2.9:** Optimize a CNN for better performance.
10. **Experiment 2.10:** Document and present the results of CNN experiments.

### Module 3: Advanced CNN Architectures (16 hours)

- AlexNet, VGG, ResNet, Inception
- Transfer Learning and Pre-trained Models

### Experiments:

1. **Experiment 3.1:** Implement AlexNet for image classification.
2. **Experiment 3.2:** Implement VGG for image classification.
3. **Experiment 3.3:** Explore ResNet and its residual connections.
4. **Experiment 3.4:** Implement Inception architecture and analyze its performance.
5. **Experiment 3.5:** Apply transfer learning using a pre-trained model.
6. **Experiment 3.6:** Fine-tune a pre-trained model for a specific task.
7. **Experiment 3.7:** Compare the performance of different advanced CNN architectures.
8. **Experiment 3.8:** Visualize and interpret the features learned by advanced CNNs.
9. **Experiment 3.9:** Experiment with combining multiple pre-trained models.
10. **Experiment 3.10:** Document and present the results of advanced CNN experiments.

### Module 4: Image Classification (16 hours)

- Data Augmentation
- Training and Evaluating CNNs for Image Classification

### Experiments:

1. **Experiment 4.1:** Implement data augmentation techniques.
2. **Experiment 4.2:** Train a CNN on augmented data and evaluate its performance.

3. **Experiment 4.3:** Implement a complete pipeline for image classification.
4. **Experiment 4.4:** Evaluate the model using confusion matrix, accuracy, and other metrics.
5. **Experiment 4.5:** Compare the effects of different data augmentation techniques on model performance.
6. **Experiment 4.6:** Experiment with different loss functions and optimization techniques for image classification.
7. **Experiment 4.7:** Implement early stopping and model checkpointing during training.
8. **Experiment 4.8:** Conduct hyperparameter tuning for the image classification model.
9. **Experiment 4.9:** Analyze the model's performance on different subsets of the dataset.
10. **Experiment 4.10:** Document and present the results of image classification experiments.

### Module 5: Object Detection (16 hours)

- R-CNN, Fast R-CNN, Faster R-CNN
- YOLO (You Only Look Once)

#### Experiments:

1. **Experiment 5.1:** Implement R-CNN for object detection.
2. **Experiment 5.2:** Implement Fast R-CNN and compare its performance with R-CNN.
3. **Experiment 5.3:** Implement Faster R-CNN and evaluate its speed and accuracy.
4. **Experiment 5.4:** Implement YOLO for real-time object detection.
5. **Experiment 5.5:** Compare the performance of YOLO with Faster R-CNN.
6. **Experiment 5.6:** Experiment with different object detection datasets and evaluate the models.
7. **Experiment 5.7:** Implement data augmentation for object detection.
8. **Experiment 5.8:** Evaluate the object detection model using precision-recall curves.
9. **Experiment 5.9:** Implement a complete pipeline for object detection.
10. **Experiment 5.10:** Document and present the results of object detection experiments.

### Module 6: Image Segmentation (16 hours)

- Semantic Segmentation
- U-Net Architecture

#### Experiments:

1. **Experiment 6.1:** Implement semantic segmentation using a basic CNN.
2. **Experiment 6.2:** Implement U-Net for image segmentation.
3. **Experiment 6.3:** Train and evaluate a segmentation model on a medical imaging dataset.
4. **Experiment 6.4:** Experiment with different loss functions for image segmentation.
5. **Experiment 6.5:** Compare the performance of semantic segmentation and U-Net.
6. **Experiment 6.6:** Visualize the segmentation results and evaluate their accuracy.

7. **Experiment 6.7:** Implement data augmentation for image segmentation.
8. **Experiment 6.8:** Experiment with different architectures for image segmentation.
9. **Experiment 6.9:** Implement a complete pipeline for image segmentation.
10. **Experiment 6.10:** Document and present the results of image segmentation experiments.

### **Module 7: Generative Models (16 hours)**

- Generative Adversarial Networks (GANs)
- Variational Autoencoders (VAEs)

#### **Experiments:**

1. **Experiment 7.1:** Implement a simple GAN for image generation.
2. **Experiment 7.2:** Train a GAN on a small image dataset and evaluate its performance.
3. **Experiment 7.3:** Implement a VAE for image generation.
4. **Experiment 7.4:** Train and evaluate a VAE on a custom dataset.
5. **Experiment 7.5:** Compare the performance of GANs and VAEs for image generation.
6. **Experiment 7.6:** Experiment with different architectures and loss functions for GANs and VAEs.
7. **Experiment 7.7:** Implement a conditional GAN (cGAN) for image generation.
8. **Experiment 7.8:** Train a cGAN on a labeled dataset and evaluate its performance.
9. **Experiment 7.9:** Experiment with different training techniques for GANs.
10. **Experiment 7.10:** Document and present the results of generative model experiments.

#### **Textbooks and References:**

- "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville
- "Deep Learning with Python" by François Chollet

## Data Analytics using Tableau (112)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUML1023	Data Analytics using Tableau	04	0+2+2

**Course Description:** This course focuses on the use of Tableau for data visualization and business analytics. Students will learn how to create interactive and informative dashboards to effectively communicate insights from data.

### Course Objectives:

- Master the use of Tableau for data visualization.
- Design and create interactive dashboards.
- Analyze and interpret data to derive meaningful insights.

### Course Outcomes (COs):

- **CO1:** Explain the fundamental concepts and principles of data visualization using Tableau. (Understand, Remember)
- **CO2:** Connect to various data sources and prepare data for analysis. (Apply, Analyze)
- **CO3:** Create basic and advanced visualizations to represent data effectively. (Apply, Create)
- **CO4:** Design interactive dashboards and use storytelling techniques to communicate insights. (Apply, Create)
- **CO5:** Share and publish Tableau visualizations and dashboards for collaboration. (Apply, Evaluate)

### CO-PO-PSO Mapping

CO/PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3	2	2	1	2	-	-	1	1	-	-	1	3	2	3
CO2	3	3	3	2	3	-	1	2	1	1	-	2	3	3	3
CO3	3	3	3	3	3	1	1	2	2	1	2	2	3	3	3
CO4	3	3	3	3											

**\*High-3, Medium-2, Low-1**

## Syllabus:

### Module 1: Introduction to Tableau (16 hours)

- Overview of Tableau
- Connecting to Data Sources

#### Experiments:

1. **Experiment 1.1:** Install and set up Tableau.
2. **Experiment 1.2:** Connect Tableau to various data sources (Excel, SQL, etc.).
3. **Experiment 1.3:** Navigate the Tableau interface and understand its features.
4. **Experiment 1.4:** Load and clean data in Tableau.
5. **Experiment 1.5:** Create a simple data connection and explore data.
6. **Experiment 1.6:** Perform basic data transformations.
7. **Experiment 1.7:** Use Tableau Prep for data preparation.
8. **Experiment 1.8:** Combine data from multiple sources.
9. **Experiment 1.9:** Create a data extract and use it in Tableau.
10. **Experiment 1.10:** Document and present data connection and preparation steps.

### Module 2: Data Visualization Principles (16 hours)

- Best Practices in Data Visualization
- Types of Visualizations

#### Experiments:

1. **Experiment 2.1:** Study and apply principles of effective data visualization.
2. **Experiment 2.2:** Compare different types of visualizations for specific data types.
3. **Experiment 2.3:** Create bar charts to visualize categorical data.
4. **Experiment 2.4:** Create line charts to show trends over time.
5. **Experiment 2.5:** Create pie charts to represent parts of a whole.
6. **Experiment 2.6:** Create scatter plots to show relationships between variables.
7. **Experiment 2.7:** Design and use maps for geographical data visualization.
8. **Experiment 2.8:** Apply color theory in data visualization.
9. **Experiment 2.9:** Use annotations and tooltips effectively.
10. **Experiment 2.10:** Document and present best practices in data visualization.

### Module 3: Building Basic Visualizations (16 hours)

- Bar Charts, Line Charts, Pie Charts
- Scatter Plots, Maps

## Experiments:

1. **Experiment 3.1:** Create and customize bar charts.
2. **Experiment 3.2:** Create and customize line charts.
3. **Experiment 3.3:** Create and customize pie charts.
4. **Experiment 3.4:** Create and customize scatter plots.
5. **Experiment 3.5:** Create and customize maps for spatial data.
6. **Experiment 3.6:** Combine multiple basic visualizations in a single worksheet.
7. **Experiment 3.7:** Use filters and highlight actions in basic visualizations.
8. **Experiment 3.8:** Add reference lines and bands to visualizations.
9. **Experiment 3.9:** Create dual-axis charts.
10. **Experiment 3.10:** Document and present basic visualizations.

## Module 4: Advanced Visualizations (16 hours)

- Heat Maps, Tree Maps, Bullet Charts
- Histograms, Box Plots

## Experiments:

1. **Experiment 4.1:** Create and customize heat maps.
2. **Experiment 4.2:** Create and customize tree maps.
3. **Experiment 4.3:** Create and customize bullet charts.
4. **Experiment 4.4:** Create and customize histograms.
5. **Experiment 4.5:** Create and customize box plots.
6. **Experiment 4.6:** Use advanced chart types to uncover insights.
7. **Experiment 4.7:** Combine advanced visualizations in a single dashboard.
8. **Experiment 4.8:** Use advanced calculations in visualizations.
9. **Experiment 4.9:** Implement advanced interactivity in visualizations.
10. **Experiment 4.10:** Document and present advanced visualizations.

## Module 5: Calculations in Tableau (16 hours)

- Calculated Fields
- Table Calculations
- Level of Detail (LOD) Expressions

## Experiments:

1. **Experiment 5.1:** Create and use calculated fields.
2. **Experiment 5.2:** Implement basic table calculations.
3. **Experiment 5.3:** Use running totals and moving averages.
4. **Experiment 5.4:** Apply quick table calculations.

5. **Experiment 5.5:** Create and use LOD expressions.
6. **Experiment 5.6:** Perform cohort analysis using LOD expressions.
7. **Experiment 5.7:** Use advanced table calculations.
8. **Experiment 5.8:** Combine calculated fields and table calculations.
9. **Experiment 5.9:** Use parameter controls with calculations.
10. **Experiment 5.10:** Document and present calculations in Tableau.

## Module 6: Dashboard Design (16 hours)

- Creating Dashboards
- Dashboard Interactivity
- Storytelling with Data

### Experiments:

1. **Experiment 6.1:** Create a basic dashboard.
2. **Experiment 6.2:** Add interactivity to dashboards using actions.
3. **Experiment 6.3:** Use filters and parameters in dashboards.
4. **Experiment 6.4:** Design effective dashboard layouts.
5. **Experiment 6.5:** Use containers for better dashboard organization.
6. **Experiment 6.6:** Create a storytelling narrative with dashboards.
7. **Experiment 6.7:** Implement drill-down functionality.
8. **Experiment 6.8:** Use dashboard extensions for enhanced features.
9. **Experiment 6.9:** Optimize dashboard performance.
10. **Experiment 6.10:** Document and present dashboard design and interactivity.

## Module 7: Data Analysis and Reporting (16 hours)

- Parameters and Filters
- Trend Analysis, Forecasting
- Cohort Analysis

### Experiments:

1. **Experiment 7.1:** Create and use parameters.
2. **Experiment 7.2:** Implement filters in visualizations and dashboards.
3. **Experiment 7.3:** Perform trend analysis using line charts.
4. **Experiment 7.4:** Implement forecasting in Tableau.
5. **Experiment 7.5:** Analyze seasonal trends and patterns.
6. **Experiment 7.6:** Conduct cohort analysis and visualize results.
7. **Experiment 7.7:** Combine multiple analysis techniques in a single report.
8. **Experiment 7.8:** Create custom reports using Tableau.
9. **Experiment 7.9:** Use statistical analysis tools in Tableau.

10. **Experiment 7.10:** Document and present data analysis and reporting techniques.

**Textbooks and References:**

- "Learning Tableau" by Joshua N. Milligan
- "Tableau Your Data!" by Daniel G. Murray

## Project (168 hrs)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUML1025	Project	06	0+0+6

**Course Description:** The major project is a capstone course that allows students to apply the knowledge and skills they have acquired throughout the program to a comprehensive project. This project involves identifying a research question, conducting a thorough analysis, and presenting the findings in both written and oral formats.

### Course Objectives:

- Develop advanced research and analytical skills.
- Apply theoretical knowledge to real-world problems.
- Demonstrate proficiency in project planning, execution, and presentation.

### Course Outcomes (COs):

- CO1: Summarize and integrate knowledge from various sources to define a research question. (Knowledge)
- CO2: Apply appropriate research methods and analytical tools to collect and analyze data. (Application)
- CO3: Evaluate and interpret research findings to draw meaningful conclusions. (Analysis)
- CO4: Develop a comprehensive project report that demonstrates innovation and critical thinking. (Synthesis)
- CO5: Present project outcomes effectively through written reports and oral presentations. (Evaluation)

### CO-PO-PSO Mapping:

CO/PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3	3	3	2	3	-	-	-	2	3	2	2	3	3	3
CO2	3	2	3	3	3	-	-	-	2	3	2	2	3	3	3
CO3	3	2	3	3	3	-	-	-	2	2	2	2	3	3	3
CO4	3	2	3	3	3	-	-	-	3	2	2	2	3	3	3
CO5	3	2	3	3	3	-	-	-	3	3	3	3	3	3	3

**\*High-3, Medium-2, Low-1**

### **Module-wise Breakdown:**

#### **Module 1: Project Proposal (6 hours)**

- **Topics:** Identifying a Research Topic; Defining Objectives and Scope; Project Planning and Timeline.

#### **Module 2: Literature Review and Methodology (8 hours)**

- **Topics:** Comprehensive Literature Survey; Selecting Appropriate Research Methods.

#### **Module 3: Data Collection and Analysis (10 hours)**

- **Topics:** Data Collection Techniques; Data Cleaning and Preprocessing; Analytical Methods and Tools.

#### **Module 4: Implementation (10 hours)**

- **Topics:** Developing Models/Systems; Experimentation and Testing.

#### **Module 5: Results and Discussion (8 hours)**

- **Topics:** Analyzing Results; Discussing Findings and Implications

#### **Module 6: Report Writing (8 hours)**

- **Topics:** Structuring the Final Report; Writing and Revising.

#### **Module 7: Presentation (10 hours)**

- **Topics:** Preparing for the Oral Presentation; Presenting Findings to an Audience.

### **Textbooks and References:**

- "Writing for Computer Science" by Justin Zobel
- "How to Write a Thesis" by Umberto Eco

## Domain Track: Cloud Technology (0+6+6 Credits)

### Course Overview

This 12-credit program is designed to provide comprehensive knowledge and practical skills in AWS Cloud Technology. The program is divided into six subjects, each carrying 3 credits, covering the fundamentals, architecture, services, security, DevOps practices, specialized services, and applications of AWS cloud solutions.

### Advanced Cloud Architecture and Design (84 Hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUCT1031	Advanced Cloud Architecture and Design	03	0+2+1

**Course Description:** This course delves into the architecture and design of AWS solutions, focusing on best practices, advanced services, and architectural patterns.

#### Course Objectives:

- Design scalable and resilient architectures on AWS.
- Implement best practices for high availability and fault tolerance.
- Explore advanced AWS services and architectural patterns.

#### Course Outcomes (COs):

- CO1: Understand advanced cloud computing principles and architecture
- CO2: Design scalable and resilient cloud-based systems
- CO3: Optimize cloud infrastructure for performance and cost-efficiency
- CO4: Implement security measures in cloud environments
- CO5: Leverage automation and DevOps practices in cloud environments

#### 1. CO-PO-PSO Mapping

CO/PO/PS O	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3	3	3	2	3	-	-	-	2	3	2	2	3	3	3
CO2	3	2	3	3	3	-	-	-	2	3	2	2	3	3	3
CO3	3	2	3	3	3	-	-	-	2	2	2	2	3	3	3
CO4	3	2	3	3	3	-	-	-	3	2	2	2	3	3	3
CO5	3	2	3	3	3	-	-	-	3	3	3	3	3	3	3

**\*High-3, Medium-2, Low-1**

### **AWS Well-Architected Framework (12 hours)**

- **Topics:** Overview of the Well-Architected Framework; Pillars of AWS architecture (operational excellence, security, reliability, performance efficiency, cost optimization); Applying the framework to design resilient systems.

#### **Experiments:**

1. **Experiment 1.1:** Evaluate a given architecture using the Well-Architected Framework checklist.
2. **Experiment 1.2:** Design a scalable solution focusing on operational excellence principles.
3. **Experiment 1.3:** Implement security best practices in an AWS architecture.
4. **Experiment 1.4:** Perform cost optimization using AWS Cost Explorer.
5. **Experiment 1.5:** Design for performance efficiency using AWS CloudFront.
6. **Experiment 1.6:** Implement reliability principles with AWS Auto Scaling.
7. **Experiment 1.7:** Implement logging and monitoring using AWS CloudWatch.
8. **Experiment 1.8:** Implement fault tolerance with AWS Multi-AZ deployments.
9. **Experiment 1.9:** Secure data at rest and in transit using AWS KMS.
10. **Experiment 1.10:** Implement disaster recovery using AWS services.

### **Module 2: High Availability and Fault Tolerance (12 hours)**

- **Topics:** Designing for high availability; Implementing fault-tolerant architectures; Using AWS services for disaster recovery.

#### **Experiments:**

1. **Experiment 2.1:** Configure AWS Auto Scaling to handle varying load demands.
2. **Experiment 2.2:** Implement multi-region redundancy using AWS Route 53 and S3.
3. **Experiment 2.3:** Create a disaster recovery plan using AWS CloudFormation.
4. **Experiment 2.4:** Design fault-tolerant architectures using AWS Elastic Load Balancing.
5. **Experiment 2.5:** Implement cross-region failover using AWS Global Accelerator.
6. **Experiment 2.6:** Use AWS CloudWatch alarms for automated scaling.
7. **Experiment 2.7:** Implement high availability with AWS RDS Multi-AZ deployments.
8. **Experiment 2.8:** Design multi-tier architectures with AWS CloudFormation stacks.
9. **Experiment 2.9:** Implement fault tolerance with AWS SQS and SNS.
10. **Experiment 2.10:** Configure health checks and automated responses with AWS CloudWatch Events.



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### Module 3: Advanced Compute Services (12 hours)

- **Topics:** Amazon ECS: Elastic Container Service; Amazon EKS: Elastic Kubernetes Service; AWS Lambda: Serverless computing.

#### Experiments:

1. **Experiment 3.1:**Deploy Docker containers using Amazon ECS.
2. **Experiment 3.2:**Orchestrate Kubernetes clusters with Amazon EKS.
3. **Experiment 3.3:**Develop serverless applications with AWS Lambda.
4. **Experiment 3.4:**Implement batch processing with AWS Batch.
5. **Experiment 3.5:**Configure high-performance computing with AWS ParallelCluster.
6. **Experiment 3.6:**Optimize containerized applications with AWS Fargate.
7. **Experiment 3.7:**Implement serverless APIs using AWS API Gateway.
8. **Experiment 3.8:**Design microservices architecture with AWS Lambda and API Gateway.
9. **Experiment 3.9:**Implement CI/CD pipelines with AWS CodePipeline.
10. **Experiment 3.10:**Monitor and scale applications with AWS App Runner.

### Module 4: Advanced Storage and Database Services (12 hours)

- **Topics:** Amazon DynamoDB: NoSQL database; Amazon Redshift: Data warehousing; Amazon Aurora: High-performance relational database.

#### Experiments:

1. **Experiment 4.1:**Design a schema for high-performance querying using Amazon DynamoDB.
2. **Experiment 4.2:**Optimize data warehousing with Amazon Redshift.
3. **Experiment 4.3:**Implement multi-master replication with Amazon Aurora.
4. **Experiment 4.4:**Configure data lakes with Amazon S3 and AWS Glue.
5. **Experiment 4.5:**Implement real-time analytics with Amazon Kinesis.
6. **Experiment 4.6:**Secure data storage with AWS Encryption SDK.
7. **Experiment 4.7:**Implement versioning and lifecycle policies with Amazon S3.
8. **Experiment 4.8:**Use Amazon DocumentDB for MongoDB compatibility.
9. **Experiment 4.9:**Implement disaster recovery with AWS Backup.
10. **Experiment 4.10:**Optimize cost and performance with Amazon EBS and EFS.

### Module 5: Application Integration and Messaging (12 hours)

- **Topics:** Amazon SQS: Simple Queue Service; Amazon SNS: Simple Notification Service; AWS Step Functions: Coordinating microservices.

## Experiments:

1. **Experiment 5.1:**Coordinate microservices using AWS Step Functions.
2. **Experiment 5.2:**Integrate applications with Amazon SQS for message queuing.
3. **Experiment 5.3:**Implement event-driven architectures using Amazon SNS.
4. **Experiment 5.4:**Orchestrate workflows with AWS Data Pipeline.
5. **Experiment 5.5:**Design event-driven data processing with AWS Lambda.
6. **Experiment 5.6:**Implement pub/sub messaging with AWS IoT Core.
7. **Experiment 5.7:**Configure message filtering with Amazon SNS topics.
8. **Experiment 5.8:**Implement cross-account message delivery with Amazon SNS.
9. **Experiment 5.9:**Monitor and troubleshoot message queues with Amazon SQS.
10. **Experiment 5.10:**Implement message encryption and access controls with AWS KMS.

## Module 6: Security and Compliance (12 hours)

- **Topics:** Advanced security services (AWS KMS, AWS Shield, AWS WAF); Compliance and data protection; Best practices for securing AWS environments.

## Experiments:

1. **Experiment 6.1:**Configure encryption at rest and in transit using AWS KMS.
2. **Experiment 6.2:**Implement DDoS protection using AWS Shield and AWS WAF.
3. **Experiment 6.3:**Conduct a compliance audit of an AWS environment.
4. **Experiment 6.4:**Implement IAM policies for least privilege access.
5. **Experiment 6.5:**Configure VPC peering and security groups.
6. **Experiment 6.6:**Implement network ACLs for traffic control.
7. **Experiment 6.7:**Monitor and analyze security logs with AWS CloudTrail.
8. **Experiment 6.8:**Implement data protection with AWS Secrets Manager.
9. **Experiment 6.9:**Configure AWS Config for compliance monitoring.
10. **Experiment 6.10:**Implement secure application deployments with AWS CodeDeploy.

## Module 7: Cost Management and Optimization (12 hours)

- **Topics:** AWS pricing models and billing; Cost management tools (AWS Budgets, Cost Explorer); Strategies for cost optimization.

## Experiments:

1. **Experiment 7.1:**Analyze AWS billing and cost using Cost Explorer.
2. **Experiment 7.2:**Implement budget alerts and forecasts with AWS Budgets.
3. **Experiment 7.3:**Optimize costs by leveraging Reserved Instances and Spot Instances.
4. **Experiment 7.4:**Implement tagging strategies for cost allocation.
5. **Experiment 7.5:**Use AWS Trusted Advisor for cost optimization recommendations.

6. **Experiment 7.6:**Implement AWS Cost Anomaly Detection for cost monitoring.
7. **Experiment 7.7:**Design cost-effective architectures with AWS Cost Explorer.
8. **Experiment 7.8:**Implement AWS Cost Allocation tags for resource categorization.
9. **Experiment 7.9:**Monitor cost and usage with AWS Cost and Usage Reports.
10. **Experiment 7.10:**Analyze cost breakdowns with AWS Cost Management tools.

## Cloud Development and DevOps (84 Hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUCT1032	Cloud Development and DevOps	03	0+2+1

**Course Description:** This course focuses on developing applications on AWS and implementing DevOps practices using AWS services and tools.

### Course Objectives:

- Develop and deploy applications using AWS services.
- Implement DevOps practices for CI/CD on AWS.
- Gain proficiency in using AWS developer tools.

### Course Outcomes (COs):

- CO1: Utilize AWS development tools to create, manage, and deploy applications. (Apply, Create)
- CO2: Implement CI/CD pipelines using AWS services for automated deployment. (Apply, Create)
- CO3: Apply Infrastructure as Code (IaC) principles using AWS CloudFormation and AWS CDK. (Apply, Create)
- CO4: Monitor and log applications using AWS CloudWatch and AWS X-Ray. (Analyze, Evaluate)
- CO5: Develop containerized and serverless applications on AWS. (Apply, Create)

### CO-PO-PSO Mapping:

CO/PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3	3	3	2	3	-	-	-	-	2	3	3	3	3	3
CO2	3	2	3	2	3	-	-	-	-	2	3	3	3	3	3
CO3	3	2	3	2	3	-	-	-	-	2	3	3	3	3	3
CO4	3	2	3	2	3	-	-	-	-	2	3	3	3	3	3
CO5	3	2	3	2	3	-	-	-	-	2	3	3	3	3	3

**\*High-3, Medium-2, Low-1**

### **Module 1: AWS Development Tools (12 hours)**

- **Topics:** AWS SDKs and CLI; AWS Cloud9: Integrated development environment; AWS CodeCommit: Source control service.

#### **Experiments:**

1. **Experiment 1.1:**Set up AWS CLI and configure access to AWS services.
2. **Experiment 1.2:**Create and manage repositories using AWS CodeCommit.
3. **Experiment 1.3:**Use AWS Cloud9 to develop a sample application.
4. **Experiment 1.4:**Integrate AWS SDKs into a development environment.
5. **Experiment 1.5:**Version control and collaboration with AWS CodeCommit.
6. **Experiment 1.6:**Automate deployments using AWS CLI.
7. **Experiment 1.7:**Debug applications using AWS Cloud9.
8. **Experiment 1.8:**Secure repositories with AWS CodeCommit and IAM policies.
9. **Experiment 1.9:**Implement CI/CD with AWS CodeCommit triggers.
10. **Experiment 1.10:**Document and present the setup and use of AWS development tools.

### **Module 2: Continuous Integration and Continuous Delivery (CI/CD) (12 hours)**

- **Topics:** Overview of CI/CD pipelines; AWS CodePipeline: Continuous integration and delivery; AWS CodeBuild and CodeDeploy: Build and deployment automation.

#### **Experiments:**

1. **Experiment 2.1:**Create a CI/CD pipeline using AWS CodePipeline.
2. **Experiment 2.2:**Configure AWS CodeBuild for automated builds.
3. **Experiment 2.3:**Implement deployment automation with AWS CodeDeploy.
4. **Experiment 2.2:**Integrate AWS CodePipeline with GitHub for source control.
5. **Experiment 2.5:**Set up automated testing in a CI/CD pipeline.
6. **Experiment 2.6:**Implement blue-green deployments using AWS CodeDeploy.
7. **Experiment 2.7:**Monitor pipeline performance with AWS CloudWatch.
8. **Experiment 2.8:**Create custom actions in AWS CodePipeline.
9. **Experiment 2.9:**Implement approval workflows in a CI/CD pipeline.
10. **Experiment 2.10:**Document and present the CI/CD pipeline setup.

### **Module 3: Infrastructure as Code (IaC) (12 hours)**

- **Topics:** AWS CloudFormation: Infrastructure as code; AWS CDK: Cloud Development Kit; Best practices for IaC.

#### **Experiments:**

1. **Experiment 3.1:**Create a CloudFormation template to deploy EC2 instances.
2. **Experiment 3.2:**Use AWS CDK to define infrastructure as code.
3. **Experiment 3.3:**Implement parameterized templates in CloudFormation.
4. **Experiment 3.4:**Manage infrastructure updates with CloudFormation stacks.
5. **Experiment 3.5:**Automate resource provisioning using AWS CDK.
6. **Experiment 3.6:**Implement cross-stack references in CloudFormation.
7. **Experiment 3.7:**Use CloudFormation to deploy a multi-tier application.
8. **Experiment 3.8:**Version control infrastructure as code templates.
9. **Experiment 3.9:**Implement security best practices in CloudFormation.
10. **Experiment 3.10:**Document and present an IaC implementation.

#### **Module 4: Monitoring and Logging (12 hours)**

- **Topics:** AWS X-Ray: Distributed tracing; Amazon CloudWatch Logs and Metrics; Centralized logging solutions.

#### **Experiments:**

1. **Experiment 4.1:**Set up AWS X-Ray for distributed tracing.
2. **Experiment 4.2:**Create CloudWatch Alarms for proactive monitoring.
3. **Experiment 4.3:**Implement centralized logging with CloudWatch Logs.
4. **Experiment 4.4:**Visualize logs and metrics using CloudWatch Dashboards.
5. **Experiment 4.5:**Analyze application logs using CloudWatch Insights.
6. **Experiment 4.6:**Implement custom metrics in CloudWatch.
7. **Experiment 4.7:**Use AWS X-Ray to trace application requests.
8. **Experiment 4.8:**Set up log retention policies in CloudWatch Logs.
9. **Experiment 4.9:**Document and present a monitoring and logging solution.

#### **Module 5: Containerization and Orchestration (12 hours)**

- **Topics:** Docker on AWS; Amazon ECS and EKS for container orchestration; Best practices for containerized applications.

#### **Experiments:**

1. **Experiment 5.1:**Dockerize a sample application.
2. **Experiment 5.2:**Deploy Docker containers using Amazon ECS.
3. **Experiment 5.3:**Set up an Amazon EKS cluster for Kubernetes orchestration.
4. **Experiment 5.4:**Implement container networking in Amazon ECS.
5. **Experiment 5.5:**Manage containerized applications with AWS Fargate.
6. **Experiment 5.6:**Monitor container performance using CloudWatch Container Insights.
7. **Experiment 5.7:**Implement auto-scaling for containerized applications.
8. **Experiment 5.8:**Secure containerized applications using IAM roles.

9. **Experiment 5.9:**Deploy a microservices architecture using ECS and EKS.
10. **Experiment 5.10:**Document and present a containerized application deployment.

### **Module 6: Serverless Development (12 hours)**

- **Topics:** AWS Lambda: Function as a Service; Building serverless applications with Lambda; Event-driven architectures.

#### **Experiments:**

1. **Experiment 6.1:**Create and deploy an AWS Lambda function.
2. **Experiment 6.2:**Build a serverless API using AWS Lambda and API Gateway.
3. **Experiment 6.3:**Implement event-driven processing with AWS Lambda and S3.
4. **Experiment 6.4:**Integrate AWS Lambda with DynamoDB for serverless data processing.
5. **Experiment 6.5:**Monitor serverless applications using CloudWatch Logs.
6. **Experiment 6.6:**Implement retries and error handling in AWS Lambda.
7. **Experiment 6.7:**Use AWS SAM to manage serverless applications.
8. **Experiment 6.8:**Secure serverless applications with IAM policies.
9. **Experiment 6.9:**Optimize AWS Lambda performance and cost.
10. **Experiment 6.10:**Document and present a serverless application.

### **Module 7: Hands-on Lab and Project (12 hours)**

- **Topics:** Build and deploy a CI/CD pipeline using AWS CodePipeline; Develop a serverless application with AWS Lambda; Hands-on lab exercises.

#### **Experiments:**

1. **Experiment 7.1:**Design and implement a CI/CD pipeline for a sample application.
2. **Experiment 7.2:**Develop and deploy a serverless application using AWS Lambda.
3. **Experiment 7.3:**Integrate monitoring and logging into the CI/CD pipeline.
4. **Experiment 7.4:**Optimize the CI/CD pipeline for performance and reliability.
5. **Experiment 7.5:**Test and validate the CI/CD pipeline with automated testing.
6. **Experiment 7.6:**Deploy containerized applications as part of the CI/CD pipeline.
7. **Experiment 7.7:**Document the CI/CD pipeline setup and configuration.
8. **Experiment 7.8:**Present the CI/CD pipeline and serverless application project.
9. **Experiment 7.9:**Receive peer feedback and make improvements.

## Cloud Security and Compliance (84 Hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUCT1033	Cloud Security and Compliance	03	0+2+1

**Course Description:** This course covers the security and compliance aspects of AWS, focusing on best practices, advanced security services, and compliance frameworks.

### Course Objectives:

- Understand AWS security fundamentals.
- Learn to implement advanced security measures on AWS.
- Gain proficiency in ensuring compliance with industry standards.

### Course Outcomes (COs):

- CO1: Explain the shared responsibility model and security best practices on AWS. (Understand, Remember)
- CO2: Implement identity and access management using AWS IAM. (Apply, Create)
- CO3: Apply data protection and encryption techniques using AWS services. (Apply, Analyze)
- CO4: Implement network security best practices using AWS services. (Apply, Create)
- CO5: Ensure compliance with industry standards using AWS compliance tools. (Apply, Evaluate)

### CO-PO-PSO Mapping:

CO/PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	3	-	-	-	1	2	2	2	3	2	3
CO2	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO3	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO4	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO5	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3

**\*High-3, Medium-2, Low-1**

### **Module 1: Security Fundamentals (12 hours)**

- **Topics:** Shared responsibility model; Security best practices; AWS security services overview.

#### **Experiments:**

1. **Experiment 1.1:** Study and explain the shared responsibility model on AWS.
2. **Experiment 1.2:** Identify and document AWS security best practices.
3. **Experiment 1.3:** Explore and summarize AWS security services.
4. **Experiment 1.4:** Implement basic security settings in an AWS account.
5. **Experiment 1.5:** Evaluate the security posture of an AWS environment.
6. **Experiment 1.6:** Set up a secure AWS environment using best practices.
7. **Experiment 1.7:** Conduct a security audit of an AWS environment.
8. **Experiment 1.8:** Implement AWS Identity and Access Management (IAM) for users.
9. **Experiment 1.9.:** Use AWS Trusted Advisor for security recommendations.
10. **Experiment 1.10:** Present findings on AWS security fundamentals.

### **Module 2: Identity and Access Management (12 hours)**

- **Topics:** AWS IAM deep dive; Managing users, groups, and roles; Implementing multi-factor authentication (MFA).

#### **Experiments:**

1. **Experiment 2.1:** Set up AWS IAM users, groups, and roles.
2. **Experiment 2.2:** Implement and manage IAM policies.
3. **Experiment 2.3:** Enable and configure MFA for AWS accounts.
4. **Experiment 2.4:** Audit and review IAM policies for compliance.
5. **Experiment 2.5:** Implement least privilege access using IAM.
6. **Experiment 2.6:** Monitor and log IAM activities using CloudTrail.
7. **Experiment 2.7:** Use IAM roles for cross-account access.
8. **Experiment 2.8:** Implement federated access with IAM.
9. **Experiment 2.9:** Set up AWS Organizations for multi-account management.
10. **Experiment 2.10:** Document and present IAM configurations and best practices.

### **Module 3: Data Protection and Encryption (12 hours)**

- **Topics:** AWS Key Management Service (KMS); AWS CloudHSM: Hardware security module; Data encryption at rest and in transit.

## Experiments:

1. **Experiment 3.1:** Set up and manage AWS KMS keys.
2. **Experiment 3.2:** Encrypt data at rest using AWS KMS.
3. **Experiment 3.3:** Encrypt data in transit using SSL/TLS.
4. **Experiment 3.4:** Configure and use AWS CloudHSM.
5. **Experiment 3.5:** Implement S3 bucket encryption using KMS keys.
6. **Experiment 3.6:** Use KMS with AWS RDS for database encryption.
7. **Experiment 3.7:** Implement EBS volume encryption with KMS.
8. **Experiment 3.8:** Set up and manage customer managed keys (CMKs).
9. **Experiment 3.9:** Implement server-side encryption with S3.
10. **Experiment 3.10:** Document and present data protection strategies.

## Module 4: Network Security (12 hours)

- **Topics:** VPC security best practices; Security groups and network ACLs; AWS WAF and Shield: Web application firewall and DDoS protection.

## Experiments:

1. **Experiment 4.1:** Configure VPC security groups and network ACLs.
2. **Experiment 4.2:** Implement best practices for securing VPCs.
3. **Experiment 4.3:** Set up AWS WAF for a web application.
4. **Experiment 4.4:** Configure AWS Shield for DDoS protection.
5. **Experiment 4.5:** Monitor VPC traffic using VPC Flow Logs.
6. **Experiment 4.6:** Implement private subnets with NAT gateways.
7. **Experiment 4.7:** Secure VPC endpoints for S3 and DynamoDB.
8. **Experiment 4.8:** Use AWS Network Firewall for network traffic control.
9. **Experiment 4.9:** Implement a bastion host for secure access.
10. **Experiment 4.10:** Document and present network security configurations.

## Module 5: Monitoring and Logging for Security (12 hours)

- **Topics:** AWS CloudTrail: Security auditing; Amazon GuardDuty: Threat detection; AWS Security Hub: Centralized security view.

## Experiments:

1. **Experiment 5.1:** Set up and configure AWS CloudTrail.
2. **Experiment 5.2:** Use CloudTrail to monitor API activity
3. **Experiment 5.3:** Configure Amazon GuardDuty for threat detection.

4. **Experiment 5.4:**Analyze GuardDuty findings and alerts.
5. **Experiment 5.5:**Set up AWS Security Hub for centralized security management.
6. **Experiment 5.6:**Integrate Security Hub with other AWS services.
7. **Experiment 5.7:**Use CloudWatch to monitor security metrics.
8. **Experiment 5.8:**Implement AWS Config for security compliance.
9. **Experiment 5.9:**Set up AWS Inspector for vulnerability assessments.
10. **Experiment 5.10:**Document and present security monitoring configurations.

## **Module 6: Compliance and Governance (12 hours)**

- **Topics:** AWS compliance programs and certifications; Implementing governance frameworks (CIS, NIST, ISO); Using AWS Config for continuous compliance.

### **Experiments:**

1. **Experiment 6.1:**Study and summarize AWS compliance programs.
2. **Experiment 6.2:**Implement AWS Config rules for continuous compliance.
3. **Experiment 6.3:**Configure AWS CloudFormation for compliance automation.
4. **Experiment 6.4:**Set up AWS Control Tower for governance.
5. **Experiment 6.5:**Use AWS Artifact to access compliance reports.
6. **Experiment 6.6:**Implement a governance framework using AWS services.
7. **Experiment 6.7:**Audit AWS environments for compliance with CIS benchmarks.
8. **Experiment 6.8:**Use AWS Service Catalog for compliant resource provisioning.
9. **Experiment 6.9:**Conduct a gap analysis against NIST standards.
10. **Experiment 6.10:**Document and present compliance strategies.

## **Module 7: Incident Response and Forensics (12 hours)**

- **Topics:** AWS best practices for incident response; Setting up an incident response plan; Conducting forensics on AWS.

### **Experiments:**

1. **Experiment 7.1:**Develop an incident response plan for AWS environments.
2. **Experiment 7.2:**Set up AWS IAM roles for incident response.
3. **Experiment 7.3:**Implement automated incident response with AWS Lambda.
4. **Experiment 7.4:**Use AWS CloudFormation to deploy incident response resources.
5. **Experiment 7.5:**Conduct a simulated security incident and response.
6. **Experiment 7.6:**Collect and analyze forensic data using AWS services.
7. **Experiment 7.7:**Use AWS Config and CloudTrail for forensic investigations.
8. **Experiment 7.8:**Implement AWS Systems Manager for incident response automation.
9. **Experiment 7.9:**Create a runbook for security incident response.
10. **Experiment 7.10:**Document and present incident response and forensic strategies.

## .Capstone Project (84 Hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUCT1034	Capstone Project	03	0+0+3

**Course Description:** This capstone course allows students to apply their AWS knowledge and skills to solve a real-world problem or develop a comprehensive solution using multiple AWS services.

### Course Objectives:

- Develop a comprehensive AWS-based solution.
- Apply best practices and advanced AWS services.
- Demonstrate proficiency in AWS architecture, development, and security.

### Course Outcomes (COs):

- CO1: Identify and scope a real-world problem or project idea suitable for an AWS-based solution. (Understand, Remember)
- CO2: Develop a comprehensive project plan and timeline, defining clear objectives and deliverables. (Apply, Create)
- CO3: Implement the project using AWS services, adhering to best practices for architecture, security, and DevOps. (Apply, Create)
- CO4: Perform thorough testing and validation of the AWS-based solution. (Analyze, Evaluate)
- CO5: Present and demonstrate the final project, showcasing the solution's effectiveness and alignment with the defined objectives. (Evaluate, Create)

### CO-PO-PSO Mapping:

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CO1	3	2	2	2	3	-	-	-	1	2	2	2	3	2	3
CO2	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO3	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO4	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO5	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3

## **\*High-3, Medium-2, Low-1**

### **Module 1: Project Proposal and Planning (12 hours)**

- **Topics:** Identify a real-world problem or project idea; Define project scope, objectives, and deliverables; Develop a project plan and timeline.

### **Module 2: Project Development (12 hours)**

- **Topics:** Implement the project using AWS services; Apply best practices for architecture, security, and DevOps; Regular progress reviews and feedback.

### **Module 3: Project Testing and Validation (12 hours)**

- **Topics:** Perform testing and validation.

### **Module 4: Project Documentation (12 hours)**

- **Topics:** Prepare project documentation.

### **Module 5: Project Presentation and Demonstration (12 hours)**

- **Topics:** Final presentation and demonstration of the project.

### **Evaluation and Grading:**

- Assignments and Quizzes: 20%
- Projects (excluding Capstone): 30%
- Capstone Project: 40%
- Participation and Attendance: 10%

### **Recommended Textbooks and Resources:**

- **AWS Cloud:**
  - "AWS Certified Solutions Architect Official Study Guide" by Joe Baron, Hisham Baz, and Tim Bixler.
  - "Amazon Web Services in Action" by Andreas Wittig and Michael Wittig.
- **Cloud Computing:**
  - "Architecting the Cloud" by Michael J. Kavis.
  - "Cloud Native Transformation" by Pini Reznik, Jamie Dobson, and Michelle Gienow.
- **DevOps:**
  - "The DevOps Handbook" by Gene Kim, Patrick Debois, and John Willis.
  - "Infrastructure as Code" by Kief Morris.

- **Additional Resources:**

- AWS online documentation and whitepapers.
- AWS training and certification courses.
- GitHub repositories for sample projects and code.
- Community forums and study groups.

**Domain Track: Drone Imaging and Spectral Analysis (0+6+6 Credits)**

**Drone Image Processing using Pix4D(84hours)**

Course Code	Course Title	Credits	Type (T+P+Pj)
CUDS1041	Drone Image Processing using Pix4D	03	0+2+1

**Course Description:** This course provides an in-depth understanding of drone image processing using Pix4D. Students will learn how to process aerial images to generate various outputs like orthomosaics, 3D models, and digital surface models (DSMs).

**Course Objectives:**

- Understand the fundamentals of drone imaging and Pix4D software.
- Learn to plan drone missions and acquire high-quality data.
- Develop proficiency in processing drone images to generate various outputs.

**Course Outcomes (COs):**

- CO1: Explain the fundamentals of drone imaging and Pix4D software. (Understand, Remember)
- CO2: Plan and execute drone missions for data acquisition. (Apply, Create)
- CO3: Process drone images using Pix4D to generate point clouds and align images. (Apply, Analyze)
- CO4: Create orthomosaics, 3D models, and DSMs using Pix4D. (Apply, Create)
- CO5: Implement advanced processing techniques including multi-spectral and thermal image processing. (Apply, Evaluate)

**CO-PO-PSO Mapping:**

CO/PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
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CO2	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO3	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3

CO4	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO5	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3

**\*High-3, Medium-2, Low-1**

## Module Breakdown:

### Module 1: Introduction to Drone Imaging (6 hours)

- **Topics:** Overview of Drone Technology; Applications of Drone Imaging.

#### Experiments:

- **Experiment 1.1:** Study and summarize drone technology and its components.
- **Experiment 1.2:** Explore and document various applications of drone imaging.
- **Experiment 1.3:** Research and present the evolution of drone technology.
- **Experiment 1.4:** Compare different types of drones used in imaging.
- **Experiment 1.5:** Understand the regulatory aspects of drone usage.
- **Experiment 1.6:** Explore the role of drones in different industries.
- **Experiment 1.7:** Analyze case studies of successful drone imaging projects.
- **Experiment 1.8:** Identify challenges and solutions in drone imaging.
- **Experiment 1.9:** Conduct a seminar on future trends in drone technology.
- **Experiment 1.10:** Present findings on the applications of drone imaging.

### Module 2: Introduction to Pix4D (6 hours)

- **Topics:** Overview of Pix4D Software; Installing and Setting up Pix4D.

#### Experiments:

- **Experiment 2.1:** Install Pix4D software on a computer.
- **Experiment 2.2:** Set up a Pix4D project workspace.
- **Experiment 2.3:** Navigate the Pix4D interface and explore its features.
- **Experiment 2.4:** Import sample data into Pix4D.
- **Experiment 2.5:** Explore the various modules and tools in Pix4D.
- **Experiment 2.6:** Set up project parameters in Pix4D.
- **Experiment 2.7:** Troubleshoot common installation issues.
- **Experiment 2.8:** Understand the licensing and subscription options for Pix4D.
- **Experiment 2.9:** Conduct a hands-on session on Pix4D setup.
- **Experiment 2.10:** Document and present the Pix4D installation and setup process.

### Module 3: Flight Planning and Data Acquisition (6 hours)

- **Topics:** Mission Planning; Best Practices for Data Collection; Data Quality Considerations.

#### Experiments:

- **Experiment 3.1:** Plan a drone mission using Pix4D.
- **Experiment 3.2:** Set up flight parameters for data acquisition.
- **Experiment 3.3:** Execute a drone flight mission and collect data.
- **Experiment 3.4:** Evaluate the quality of collected data.
- **Experiment 3.5:** Implement best practices for drone flight safety.
- **Experiment 3.6:** Use Pix4D Capture app for mission planning.
- **Experiment 3.7:** Analyze factors affecting data quality.
- **Experiment 3.8:** Conduct a field survey for data collection.
- **Experiment 3.9:** Document flight planning and data acquisition process.
- **Experiment 3.10:** Present findings on data quality considerations.

### Module 4: Image Processing in Pix4D (6 hours)

- **Topics:** Importing Images and Initial Setup; Image Alignment and Calibration; Point Cloud Generation.

#### Experiments:

- **Experiment 4.1:** Import drone images into Pix4D.
- **Experiment 4.2:** Set up initial project parameters for image processing.
- **Experiment 4.3:** Align images using Pix4D's calibration tools.
- **Experiment 4.4:** Generate a point cloud from imported images.
- **Experiment 4.5:** Analyze the accuracy of image alignment.
- **Experiment 4.6:** Adjust processing parameters to improve results.
- **Experiment 4.7:** Conduct quality checks on generated point clouds.
- **Experiment 4.8:** Explore different calibration techniques in Pix4D.
- **Experiment 4.9:** Document the image processing workflow.
- **Experiment 4.10:** Present a processed point cloud and its analysis.

### Module 5: Creating Outputs (6 hours)

- **Topics:** Generating Orthomosaics; Creating 3D Models and Meshes; Generating DSMs and DTMs.

#### Experiments:

- **Experiment 5.1:**Generate an orthomosaic using Pix4D.
- **Experiment 5.2:**Create a 3D model from drone images.
- **Experiment 5.3:**Develop meshes for 3D visualization.
- **Experiment 5.4:**Generate DSMs and DTMs from processed images.
- **Experiment 5.5:**Analyze the quality of generated outputs.
- **Experiment 5.6:**Compare different output formats and their uses.
- **Experiment 5.7:**Conduct a project to create multiple outputs from a dataset.
- **Experiment 5.8:**Implement techniques to enhance output quality.
- **Experiment 5.9:**Document the process of creating outputs in Pix4D.
- **Experiment 5.10:**Present and evaluate generated outputs.

### **Module 6: Advanced Processing Techniques (6 hours)**

- **Topics:** Multi-spectral and Thermal Image Processing; Integrating Ground Control Points (GCPs); Quality Assessment and Improvement.

#### **Experiments:**

- **Experiment 6.1:**Process multi-spectral images using Pix4D.
- **Experiment 6.2:**Implement thermal image processing techniques.
- **Experiment 6.3:**Integrate GCPs into a Pix4D project.
- **Experiment 6.4:**Conduct a quality assessment of processed images.
- **Experiment 6.5:**Apply techniques to improve image processing results.
- **Experiment 6.6:**Analyze the benefits of using GCPs.
- **Experiment 6.7:**Compare multi-spectral and thermal image outputs.
- **Experiment 6.8:**Conduct a project using advanced processing techniques.
- **Experiment 6.9:**Document advanced processing workflows.
- **Experiment 6.10:**Present findings on quality assessment and improvement.

### **Module 7: Case Studies and Applications (6 hours)**

- **Topics:** Real-World Applications and Case Studies; Hands-on Projects with Pix4D.

#### **Experiments:**

- **Experiment 7.1:**Study and present real-world applications of drone imaging.
- **Experiment 7.2:**Analyze case studies of Pix4D projects.
- **Experiment 7.3:**Conduct a hands-on project using Pix4D.
- **Experiment 7.4:**Implement a real-world application using Pix4D.
- **Experiment 7.5:**Evaluate the success and challenges of case studies.
- **Experiment 7.6:**Develop a project plan for a real-world application.

- **Experiment 7.7:** Document the project implementation process.
- **Experiment 7.8:** Present a case study analysis.
- **Experiment 7.9:** Conduct a peer review of project implementations.
- **Experiment 7.10:** Submit and present the final project.

**Textbooks and References:**

- "Introduction to Drone Imaging" by Douglas Spotted Eagle
- Pix4D Documentation and Tutorials

## Multispectral Image Analytics for Agriculture(84hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUDS1042	Multispectral Image Analytics for Agriculture	03	0+2+1

**Course Description:** This course explores the use of drone imaging and multispectral sensors for agricultural applications. Students will learn how to capture and analyze multispectral data to monitor crop health, detect diseases, and optimize agricultural practices.

### Course Objectives:

- Understand the application of drone imaging and multispectral sensors in agriculture.
- Learn to process and analyze multispectral data for agricultural insights.
- Apply advanced analytical methods to improve agricultural practices.

### Course Outcomes (COs):

- CO1: Explain the benefits and applications of drones and multispectral imaging in agriculture. (Understand, Remember)
- CO2: Acquire and calibrate multispectral data using appropriate sensors. (Apply, Create)
- CO3: Process multispectral data and calculate vegetation indices. (Apply, Analyze)
- CO4: Analyze vegetation indices to monitor crop health and predict yield. (Apply, Evaluate)
- CO5: Implement precision agriculture techniques and advanced analytical methods. (Apply, Create)

### CO-PO-PSO Mapping:

CO/PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	3	-	-	-	1	2	2	2	3	2	3
CO2	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO3	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO4	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO5	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3

**\*High-3, Medium-2, Low-1**

## **Module Breakdown:**

### **Module 1: Introduction to Agricultural Drone Imaging (6 hours)**

- **Topics:** Overview of Drones in Agriculture; Benefits of Multispectral Imaging.

#### **Experiments:**

- **Experiment 1.1:** Research and the role of drones in modern agriculture.
- **Experiment 1.2:** Explore and document the benefits of using multispectral imaging in agriculture.
- **Experiment 1.3:** Compare different types of drones used in agricultural imaging.
- **Experiment 1.4:** Study and present case studies of successful agricultural drone projects.
- **Experiment 1.5:** Identify the challenges and solutions in agricultural drone imaging.
- **Experiment 1.6:** Conduct a seminar on the future trends in agricultural drone technology.
- **Experiment 1.7:** Analyze the economic impact of using drones in agriculture.
- **Experiment 1.8:** Present findings on the applications of multispectral imaging in agriculture.
- **Experiment 1.9:** Research the legal and regulatory aspects of using drones in agriculture.
- **Experiment 1.10:** Document and present the overall benefits of drones and multispectral imaging.

### **Module 2: Multispectral Sensors and Data Acquisition (6 hours)**

- **Topics:** Types of Multispectral Sensors; Calibration and Data Collection.

#### **Experiments:**

- **Experiment 2.1:** Study different types of multispectral sensors used in agriculture.
- **Experiment 2.2:** Calibrate a multispectral sensor for data collection.
- **Experiment 2.3:** Set up a drone for multispectral imaging.
- **Experiment 2.4:** Plan and execute a data acquisition mission using a multispectral sensor.
- **Experiment 2.5:** Evaluate the quality of collected multispectral data.
- **Experiment 2.6:** Implement best practices for data collection in agriculture.
- **Experiment 2.7:** Analyze the factors affecting multispectral data quality.
- **Experiment 2.8:** Conduct a field survey for multispectral data collection.
- **Experiment 2.9:** Document the process of sensor calibration and data acquisition.
- **Experiment 2.10:** Present findings on multispectral sensors and data collection techniques.

### **Module 3: Image Processing for Agriculture (6 hours)**

- **Topics:** Pre-processing Multispectral Data; Reflectance Calculation and Vegetation Indices.

#### **Experiments:**

- **Experiment 3.1:**Pre-process raw multispectral data for analysis.
- **Experiment 3.2:**Calculate reflectance values from multispectral data.
- **Experiment 3.3:**Generate NDVI maps using multispectral data.
- **Experiment 3.4:**Explore different vegetation indices and their calculation.
- **Experiment 3.5:**Implement data normalization techniques for accurate analysis.
- **Experiment 3.6:**Conduct quality checks on pre-processed data.
- **Experiment 3.7:**Use software tools for multispectral image processing.
- **Experiment 3.8:**Analyze the accuracy of vegetation indices.
- **Experiment 3.9:**Document the image processing workflow for agriculture.
- **Experiment 3.10:**Present findings on pre-processing and reflectance calculation.

#### **Module 4: Vegetation Indices and Analysis (6 hours)**

- **Topics:** NDVI (Normalized Difference Vegetation Index); Other Indices (EVI, SAVI, etc.); Analyzing Vegetation Indices.

#### **Experiments:**

- **Experiment 4.1:**Calculate NDVI from multispectral data.
- **Experiment 4.2:**Generate Enhanced Vegetation Index (EVI) maps.
- **Experiment 4.3:**Calculate Soil-Adjusted Vegetation Index (SAVI).
- **Experiment 4.4:**Compare different vegetation indices for crop analysis.
- **Experiment 4.5:**Implement methods for analyzing vegetation indices.
- **Experiment 4.6:**Conduct a case study on vegetation indices for crop health monitoring.
- **Experiment 4.7:**Use software tools for vegetation index calculation.
- **Experiment 4.8:**Analyze the temporal changes in vegetation indices.
- **Experiment 4.9:**Document the process of calculating and analyzing vegetation indices.
- **Experiment 4.10:**Present findings on the use of vegetation indices in agriculture.

#### **Module 5: Crop Health Monitoring (6 hours)**

- **Topics:** Identifying Stress and Disease; Yield Prediction and Assessment.

#### **Experiments:**

- **Experiment 5.1:**Identify crop stress using multispectral data.
- **Experiment 5.2:**Detect plant diseases using vegetation indices.

- **Experiment 5.3:** Implement methods for yield prediction using multispectral data.
- **Experiment 5.4:** Conduct a case study on crop health monitoring.
- **Experiment 5.5:** Analyze the effectiveness of multispectral imaging for disease detection.
- **Experiment 5.6:** Use software tools for crop health assessment.
- **Experiment 5.7:** Implement advanced algorithms for yield prediction.
- **Experiment 5.8:** Conduct field validation of crop health monitoring results.
- **Experiment 5.9:** Document the process of crop health monitoring and yield prediction.
- **Experiment 5.10:** Present findings on the use of multispectral data for crop health monitoring.

### **Module 6: Precision Agriculture Techniques (6 hours)**

- **Topics:** Variable Rate Application; Field Mapping and Zoning.

#### **Experiments:**

- **Experiment 6.1:** Implement variable rate application techniques using multispectral data.
- **Experiment 6.2:** Conduct field mapping for precision agriculture.
- **Experiment 6.3:** Generate zoning maps for targeted interventions.
- **Experiment 6.4:** Use software tools for precision agriculture mapping.
- **Experiment 6.5:** Analyze the benefits of variable rate application.
- **Experiment 6.6:** Conduct a case study on precision agriculture techniques.
- **Experiment 6.7:** Implement methods for optimizing field inputs.
- **Experiment 6.8:** Evaluate the economic impact of precision agriculture.
- **Experiment 6.8:** Document the process of field mapping and zoning.
- **Experiment 6.10:** Present findings on the use of precision agriculture techniques.

### **Module 7: Advanced Analytical Methods (6 hours)**

- **Topics:** Machine Learning for Crop Analysis; Time-Series Analysis of Crop Data.

#### **Experiments:**

- **Experiment 7.1:** Implement machine learning algorithms for crop analysis.
- **Experiment 7.2:** Conduct time-series analysis of multispectral crop data.
- **Experiment 7.3:** Use software tools for machine learning in agriculture.
- **Experiment 7.4:** Analyze the effectiveness of machine learning for crop health prediction.
- **Experiment 7.5:** Conduct a case study on advanced analytical methods.
- **Experiment 7.6:** Implement methods for integrating multispectral data with other datasets.
- **Experiment 7.7:** Evaluate the benefits of using machine learning in agriculture.
- **Experiment 7.8:** Document the process of applying advanced analytical methods.

- **Experiment 7.9:** Present findings on machine learning and time-series analysis for agriculture.
- **Experiment 7.10:** Submit a project report on advanced analytical methods for crop analysis.

### Textbooks and References:

- "Precision Agriculture Technology for Crop Farming" by Qin Zhang
- Research Papers and Case Studies on Agricultural Drone Imaging

### Drone Imaging Applications(56hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUDS1043	Drone Imaging Applications	02	0+2+0

**Course Description:** This course covers various applications of drone imaging across different industries. Students will learn about the diverse uses of drone data in areas such as environmental monitoring, construction, mining, and disaster management.

### Course Objectives:

- Understand the diverse applications of drone imaging across various industries.
- Learn to implement drone imaging techniques for specific industry needs.
- Analyze and interpret drone data for practical applications.

### Course Outcomes (COs):

- CO1: Explain the regulatory considerations and best practices for drone applications in different industries. (Understand, Remember)
- CO2: Implement drone imaging techniques for environmental monitoring. (Apply, Create)
- CO3: Apply drone imaging for construction and infrastructure projects. (Apply, Analyze)
- CO4: Utilize drone imaging in mining and resource management. (Apply, Evaluate)
- CO5: Implement advanced imaging techniques and integrate various data types for comprehensive analysis. (Apply, Create)

### CO-PO-PSO Mapping:

CO/PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	3	-	-	-	1	2	2	2	3	2	3
CO2	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO3	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO4	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO5	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3

**\*High-3, Medium-2, Low-1**

#### Module Breakdown:

##### Module 1: Introduction to Drone Applications (4 hours)

- **Topics:** Overview of Industry Applications; Regulatory Considerations and Best Practices.

#### Experiments:

- **Experiment 1.1:** Research and present the various industry applications of drone imaging.
- **Experiment 1.2:** Explore and document regulatory considerations for drone usage.
- **Experiment 1.3:** Study best practices for drone operations in different industries.
- **Experiment 1.4:** Analyze case studies of successful drone applications.
- **Experiment 1.5:** Identify challenges and solutions in implementing drone projects.
- **Experiment 1.6:** Conduct a seminar on future trends in drone applications.
- **Experiment 1.7:** Explore the economic impact of drone technology in various sectors.
- **Experiment 1.8:** Present findings on regulatory and best practice guidelines.
- **Experiment 1.9:** Research the ethical considerations of using drones.
- **Experiment 1.10:** Document and present an overview of drone applications.

##### Module 2: Environmental Monitoring (4 hours)

- **Topics:** Habitat Mapping and Conservation; Forest Health and Wildlife Monitoring; Water Quality Assessment.

#### Experiments:

- **Experiment 2.1:** Implement drone-based habitat mapping techniques.
- **Experiment 2.2:** Monitor forest health using drone imaging.

- **Experiment 2.3:** Assess wildlife populations using drone data.
- **Experiment 2.4:** Conduct a water quality assessment with drone sensors.
- **Experiment 2.5:** Analyze the effectiveness of drones in conservation projects.
- **Experiment 2.6:** Use software tools for environmental data analysis.
- **Experiment 2.7:** Conduct a case study on drone applications in environmental monitoring.
- **Experiment 2.8:** Implement best practices for environmental data collection.
- **Experiment 2.9:** Document the process of environmental monitoring with drones.
- **Experiment 2.10:** Present findings on the impact of drones in environmental conservation.

### **Module 3: Construction and Infrastructure (4 hours)**

- **Topics:** Site Surveying and Progress Monitoring; Structural Inspections and 3D Modeling; Safety and Compliance Monitoring.

#### **Experiments:**

- **Experiment 3.1:** Conduct a site survey using drone imaging.
- **Experiment 3.2:** Monitor construction progress with drone data.
- **Experiment 3.3:** Perform structural inspections using drones.
- **Experiment 3.4:** Create 3D models of infrastructure projects.
- **Experiment 3.5:** Implement safety and compliance monitoring techniques.
- **Experiment 3.6:** Analyze the benefits of drones in construction projects.
- **Experiment 3.7:** Use software tools for construction data analysis.
- **Experiment 3.8:** Conduct a case study on drone applications in construction.
- **Experiment 3.9:** Document the process of using drones in infrastructure projects.
- **Experiment 3.10:** Present findings on the effectiveness of drones in construction.

### **Module 4: Mining and Resources (4 hours)**

- **Topics:** Site Mapping and Resource Estimation; Stockpile Measurement and Management; Environmental Impact Assessment.

#### **Experiments:**

- **Experiment 4.1:** Map a mining site using drone imaging.
- **Experiment 4.2:** Estimate resources with drone data.
- **Experiment 4.3:** Measure and manage stockpiles using drones.
- **Experiment 4.4:** Conduct an environmental impact assessment with drone sensors.
- **Experiment 4.5:** Analyze the benefits of drones in resource management.
- **Experiment 4.6:** Use software tools for mining data analysis.
- **Experiment 4.7:** Conduct a case study on drone applications in mining.
- **Experiment 4.8:** Implement best practices for resource estimation with drones.

- **Experiment 4.9:** Document the process of using drones in mining projects.
- **Experiment 4.10:** Present findings on the impact of drones in the mining industry.

### **Module 5: Disaster Management (4 hours)**

- **Topics:** Disaster Response and Damage Assessment; Search and Rescue Operations; Post-Disaster Recovery Planning.

#### **Experiments:**

- **Experiment 5.1:** Implement drone-based disaster response techniques.
- **Experiment 5.2:** Assess damage using drone imaging.
- **Experiment 5.3:** Conduct search and rescue operations with drones.
- **Experiment 5.4:** Plan post-disaster recovery using drone data.
- **Experiment 5.5:** Analyze the effectiveness of drones in disaster management.
- **Experiment 5.6:** Use software tools for disaster data analysis.
- **Experiment 5.7:** Conduct a case study on drone applications in disaster response.
- **Experiment 5.8:** Implement best practices for disaster management with drones.
- **Experiment 5.9:** Document the process of using drones in disaster scenarios.
- **Experiment 5.10:** Present findings on the role of drones in disaster management.

### **Module 6: Urban Planning and Development (4 hours)**

- **Topics:** Urban Mapping and Analysis; Smart City Applications; Infrastructure Planning and Monitoring.

#### **Experiments:**

- **Experiment 6.1:** Map urban areas using drone imaging.
- **Experiment 6.2:** Analyze urban development with drone data.
- **Experiment 6.3:** Implement smart city applications with drones.
- **Experiment 6.4:** Monitor urban infrastructure using drones.
- **Experiment 6.5:** Analyze the benefits of drones in urban planning.
- **Experiment 6.6:** Use software tools for urban data analysis.
- **Experiment 6.7:** Conduct a case study on drone applications in urban planning.
- **Experiment 6.8:** Implement best practices for urban mapping with drones.
- **Experiment 6.9:** Document the process of using drones in urban development projects.
- **Experiment 6.10:** Present findings on the impact of drones in urban planning.

## Module 7: Advanced Imaging Techniques (4 hours)

- **Topics:** Thermal Imaging Applications; Hyperspectral Imaging; LiDAR and Photogrammetry Integration.

### Experiments:

- **Experiment 7.1:** Implement thermal imaging techniques with drones.
- **Experiment 7.2:** Conduct hyperspectral imaging with drone sensors.
- **Experiment 7.3:** Integrate LiDAR and photogrammetry data.
- **Experiment 7.4:** Analyze the effectiveness of advanced imaging techniques.
- **Experiment 7.5:** Use software tools for advanced imaging analysis.
- **Experiment 7.6:** Conduct a case study on advanced drone imaging applications.
- **Experiment 7.7:** Implement best practices for integrating multiple data types.
- **Experiment 7.8:** Document the process of using advanced imaging techniques.
- **Experiment 7.9:** Present findings on the benefits of advanced imaging in various industries.
- **Experiment 7.10:** Submit a project report on advanced imaging techniques.

### Textbooks and References:

- "Drones for Dummies" by Mark LaFay and Chase Guttman
- Industry Reports and Case Studies

### Project(224hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUDS1044	Project	04	0+0+4

**Course Description:** The project course allows students to apply the knowledge and skills they have acquired in drone imaging and spectral analysis to a comprehensive, real-world project. This involves planning, data collection, processing, analysis, and presentation of findings.

**Course Objectives:**

- Develop and execute a comprehensive project in drone imaging and spectral analysis.
- Apply advanced data collection, processing, and analysis techniques.
- Present findings effectively through written reports and oral presentations.

**Course Outcomes (COs):**

- CO1: Identify and scope a research topic or industry problem relevant to drone imaging and spectral analysis. (Understand, Remember)
- CO2: Develop a project plan and timeline, defining clear objectives and scope. (Apply, Create)
- CO3: Conduct data collection using drones and ensure data quality and accuracy. (Apply, Analyze)
- CO4: Process and analyze data using advanced tools and techniques. (Apply, Evaluate)
- CO5: Present project findings through structured reports and oral presentations. (Evaluate, Create)

**CO-PO-PSO Mapping:**

CO/PO/PS O	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	3	-	-	-	1	2	2	2	3	2	3
CO2	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO3	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO4	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO5	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3

**\*High-3, Medium-2, Low-1**

**Module Breakdown:**

**Module 1: Project Proposal (6 hours)**

- **Topics:** Identifying a Research Topic or Industry Problem; Defining Objectives and Scope; Project Planning and Timeline.

**Module 2: Literature Review and Methodology (6 hours)**

- **Topics:** Conducting a Literature Review; Selecting Appropriate Research Methods.

### **Module 3: Data Collection (6 hours)**

- **Topics:** Planning and Executing Drone Flights; Ensuring Data Quality and Accuracy.

### **Module 4: Data Processing (6 hours)**

- **Topics:** Using Pix4D and Other Tools for Image Processing; Generating Relevant Outputs (Orthomosaics, 3D Models, etc.).

### **Module 5: Data Analysis (6 hours)**

- **Topics:** Applying Analytical Techniques; Interpreting Results.

### **Module 6: Report Writing (6 hours)**

- **Topics:** Structuring the Final Report; Writing and Revising the Report.

### **Module 7: Presentation (6 hours)**

- **Topics:** Preparing for the Oral Presentation; Presenting Findings to an Audience.

### **Textbooks and References:**

- "Research Design: Qualitative, Quantitative, and Mixed Methods Approaches" by John W. Creswell
- Project Management and Technical Documentation Resources

**Domain Track: Software Technology (18 Credits)**

**Advanced Java(112hours)**

Course Code	Course Title	Credits	Type (T+P+Pj)
CUST1051	Advanced Java	4	0+2+2

**Course Description:** This course delves into advanced topics in Java programming, including multithreading, networking, database connectivity, and Java frameworks. Students will gain a deep understanding of Java's capabilities and how to apply them in real-world applications.

**Course Objectives:**

- Master advanced Java programming concepts and techniques.
- Implement Java-based solutions for web, and database applications.
- Apply Java frameworks and best practices in real-world scenarios.

**Course Outcomes (COs):**

- CO1: Understand and apply advanced object-oriented programming concepts in Java. (Understand, Apply)
- CO2: Implement servlet to control web applications. (Apply, Analyse)
- CO3: Develop dynamic web pages using Java Server Page. (Apply, Create)
- CO4: Integrate Java applications with databases using JDBC and manage transactions. (Apply, Evaluate)
- CO5: Utilize Java EE and frameworks to build robust enterprise applications. (Apply, Create)

**CO-PO-PSO Mapping:**

CO/PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	3	-	-	-	1	2	2	2	3	2	3
CO2	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO3	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO4	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO5	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3

**\*High-3, Medium-2, Low-1**

## Module Breakdown:

### Module 1: Introduction to Web Architecture (6 hours)

- Overview of Web Architecture, Client-Server Model, HTTP Protocol Basics, Web Servers and Application Servers, Introduction to MVC Architecture.

#### Experiments:

- Set up a simple HTTP server and client.
- Create a basic web page and deploy it on a web server.
- Implement a simple MVC pattern in a web application.
- Analyze HTTP request and response headers using browser tools.
- Configure and deploy an application on an Apache Tomcat server..

### Module 2: Introduction to GitHub (6 hours)

- **Topics:** Version Control Basics, Git Commands and Workflow, GitHub Repository Management, Branching and Merging, Collaborating with GitHub.

#### Experiments:

- Initialize a Git repository and commit changes.
- Push local repository to GitHub and manage remote repositories.
- Create and merge branches.
- Resolve merge conflicts.
- Collaborate with others using pull requests and issues on GitHub.

### Module 3: Java Database Connectivity (JDBC) (10 hours)

- **Topics:** Introduction to Java Database Connectivity (JDBC), JDBC Architecture and Drivers, Establishing Database Connections, Executing SQL Queries and Updates, Handling ResultSets, Prepared Statements and Callable Statements, Batch Processing in JDBC, Transaction Management, Connection Pooling

#### Experiments:

- Set up a database and connect to it using JDBC.
- Execute SQL SELECT queries and process the results.
- Perform INSERT, UPDATE, and DELETE operations using JDBC.
- Handle SQL exceptions and errors.
- Develop a simple CRUD application using JDBC.
- Use prepared statements and callable statements

- Implement batch processing in JDBC
- Manage transactions effectively
- Utilize connection pooling for efficient database access.

#### **Module 4: Introduction to Servlets (6 hours)**

- **Topics:** Introduction to Servlets, Servlet Lifecycle, Handling Requests and Responses, Servlet Configuration and Context, Session Management.

#### **Experiments:**

- Create and deploy a simple servlet.
- Handle GET and POST requests in a servlet.
- Implement session tracking using cookies and HTTP sessions.
- Use servlet context and configuration for initialization parameters.
- Develop a login system using servlets and session management.

#### **Module 5: Advanced Servlet Concepts (6 hours)**

- **Topics:** Request Dispatching and Redirecting, Servlet Filters, Servlet Listener, Asynchronous Servlets, Error Handling in Servlets, Security and Authentication in Servlets

#### **Experiments:**

- Implement request forwarding and redirection.
- Create and configure a servlet filter.
- Develop an asynchronous servlet for long-running tasks.
- Implement custom error pages for handling different HTTP errors.
- Secure a servlet using basic authentication and HTTPS.

#### **Module 6: Introduction to JSP (8 hours)**

- **Topics:** Basics of JavaServer Pages (JSP), JSP Lifecycle, JSP Directives, Scriptlets, and Expressions, JSP Implicit Objects, Using JavaBeans in JSP, JSP Tag Libraries (JSTL), Custom Tags in JSP, Expression Language (EL), JSP and MVC Architecture, Error Handling in JSP
- **Experiments:**
  - Create a basic JSP page and deploy it.
  - Use JSP scriptlets to embed Java code in HTML.

- Access JSP implicit objects to handle requests and responses.
- Integrate a JavaBean in a JSP page.
- Create a simple form processing application using JSP and JavaBeans.
- Use JSTL core tags to manage control flow and iteration.
- Create and use custom JSP tags.
- Utilize EL to access Java objects and properties.
- Implement MVC architecture with JSP as the view.
- Develop error handling mechanisms in JSP

### **Module 7: Introduction to Hibernate (8 hours)**

- **Topics:** Basics of Hibernate ORM, Hibernate Architecture, Configuring Hibernate, Mapping Entities to Tables, CRUD Operations with Hibernate

#### **Experiments:**

- Set up Hibernate in a Java project.
- Map a Java class to a database table using annotations.
- Perform CRUD operations with Hibernate.
- Configure Hibernate using XML.
- Implement relationships (one-to-many, many-to-many) in Hibernate

#### **Textbooks and References:**

- "Core Servlets and JavaServer Pages" by Marty Hall and Larry Brown

## Angular(112hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUST1052	Angular	4	0+2+2

**Course Description:** This course provides a comprehensive understanding of Angular, focusing on advanced concepts and techniques required to build dynamic, responsive, and efficient web applications. Students will gain hands-on experience in developing and deploying Angular applications.

### Course Objectives:

- Master the fundamentals and advanced concepts of Angular.
- Develop and optimize complex Angular applications.
- Implement best practices and deploy Angular applications.

### Course Outcomes (COs):

- CO1: Understand the core concepts and architecture of Angular applications. (Understand, Remember)
- CO2: Develop Angular applications using TypeScript and advanced Angular features. (Apply, Create)
- CO3: Implement data binding, directives, and component communication in Angular. (Apply, Analyze)
- CO4: Utilize Angular services, dependency injection, and HTTP client for dynamic applications. (Apply, Evaluate)
- CO5: Optimize, test, and deploy Angular applications following best practices. (Apply, Create)

### CO-PO-PSO Mapping:

CO/PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	3	-	-	-	1	2	2	2	3	2	3
CO2	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO3	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO4	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO5	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3

**\*High-3, Medium-2, Low-1**

## **Module Breakdown:**

### **Module 1: Introduction to Angular and TypeScript Basics (8 hours)**

#### **Theory**

Overview of Angular framework; Setting up the development environment (Node.js, Angular CLI); Creating a new Angular project with Angular CLI; Introduction to TypeScript; TypeScript features and syntax; Variables, types, and functions; Classes and interfaces; TypeScript in Angular.

#### **Practice**

- Experiment 1.1: Install Node.js and Angular CLI.
- Experiment 1.2: Create a new Angular project using Angular CLI.
- Experiment 1.3: Explore the Angular project structure.
- Experiment 1.4: Configure the Angular development environment.
- Experiment 1.5: Implement a simple Angular application.
- Experiment 1.6: Conduct a seminar on the evolution of Angular.
- Experiment 1.7: Present case studies of successful Angular applications.
- Experiment 1.8: Install and set up TypeScript.
- Experiment 1.9: Implement basic TypeScript syntax (variables, types, functions).
- Experiment 1.10: Create and use classes and interfaces in TypeScript.

### **Module 2: Angular Architecture (8 hours)**

#### **Theory**

Components, templates, and modules; Component lifecycle hooks; Creating and using Angular modules; Angular application structure and best practices.

#### **Practice**

- Experiment 2.1: Create and use Angular components.
- Experiment 2.2: Implement component lifecycle hooks.
- Experiment 2.3: Create and manage Angular modules.
- Experiment 2.4: Structure an Angular application following best practices.
- Experiment 2.5: Document and present the Angular component lifecycle.
- Experiment 2.6: Compare different approaches to structuring Angular applications.
- Experiment 2.7: Conduct a seminar on Angular architecture.
- Experiment 2.8: Implement a modular Angular application.
- Experiment 2.9: Present case studies of Angular application architectures.
- Experiment 2.10: Research and present advanced Angular architectural patterns.

### **Module 3: Data Binding and Directives (8 hours)**

#### **Theory**

Property binding and event binding; Two-way data binding with ngModel; Built-in directives (ngIf, ngFor, ngClass, ngStyle); Custom directives.

## Practice

- Experiment 3.1: Implement property binding in an Angular application.
- Experiment 3.2: Use event binding to handle user interactions.
- Experiment 3.3: Implement two-way data binding with ngModel.
- Experiment 3.4: Use built-in directives (ngIf, ngFor, ngClass, ngStyle).
- Experiment 3.5: Create and use custom directives.
- Experiment 3.6: and present the use of data binding in Angular.
- Experiment 3.7: Compare different data binding techniques.
- Experiment 3.8: Conduct a seminar on Angular directives.
- Experiment 3.9: Implement a directive-based project.
- Experiment 3.10: Present case studies of data binding and directives in Angular applications.

## Module 4: Component Communication (8 hours)

### Theory

Input and output decorators; Event emitters; Parent-child component communication; ViewChild and ContentChild decorators.

### Practice

- Experiment 4.1: Implement component communication using input and output decorators.
- Experiment 4.2: Use event emitters for component interaction.
- Experiment 4.3: Implement parent-child communication in Angular.
- Experiment 4.4: Use ViewChild and ContentChild decorators.
- Experiment 4.5: Document and present component communication techniques.
- Experiment 4.6: Compare different approaches to component communication.
- Experiment 4.7: Conduct a seminar on advanced component communication.
- Experiment 4.8: Implement a project involving complex component interaction.
- Experiment 4.9: Present case studies of component communication in Angular applications.
- Experiment 4.10: Research and present advanced component communication patterns.

## Module 5: Services, Dependency Injection and HTTP Client (8 hours)

- **Theory:** Creating and using services; Dependency injection in Angular; Hierarchical injectors; Managing application-wide services; Introduction to Angular HttpClient; Performing GET,POST,PUT,DELETE requests

### Practice

- Experiment 5.1: Creating and Injecting a Simple Service in Angular
- Experiment 5.2: Exploring Angular Dependency Injection: Singleton Services
- Experiment 5.3: Hierarchical Dependency Injection: Providing Services in Modules
- Experiment 5.4: Managing Application-Wide Services in Angular
- Experiment 5.5: Introduction to Angular HttpClient: Performing GET Requests.
- Experiment 5.6: Performing POST Requests with Angular HttpClient
- Experiment 5.7: Updating Data with PUT Requests in Angular HttpClient

- Experiment 5.8: Deleting Data with DELETE Requests in Angular HttpClient
- Experiment 5.9: Handling HTTP Errors and Responses in Angular HttpClient
- Experiment 5.10: Interceptors in Angular HttpClient: Modifying Requests and Responses

### **Module 6: Routing and Navigation (8 hours)**

**Theory:** Configuring routes; RouterLink and router-outlet; Route guards and lazy loading; Child routes and nested routing.

#### **Practice**

- Experiment 6.1: Configure routes in an Angular application.
- Experiment 6.2: Use RouterLink and router-outlet for navigation.
- Experiment 6.3: Implement route guards for security.
- Experiment 6.4: Implement lazy loading for performance optimization.
- Experiment 6.5: Create and use child routes and nested routing.
- Experiment 6.6: Document and present routing and navigation techniques.
- Experiment 6.7: Compare different approaches to routing in Angular.
- Experiment 6.8: Conduct a seminar on advanced routing techniques.
- Experiment 6.9: Implement a project involving complex routing and navigation.
- Experiment 6.10: Present case studies of routing and navigation in Angular applications.

### **Module 7: RxJS, Testing and Deployment (8 hours)**

#### **Theory**

Introduction to RxJS; Using observables with Angular HttpClient; Introduction to testing in Angular; Deployment options(Firebase,AWS).

#### **Practice**

- Experiment 7.1: Creating and Subscribing to Observables in RxJS
- Experiment 7.2: Using RxJS Operators for Data Transformation
- Experiment 7.3: Combining Observables Using RxJS Operators
- Experiment 7.4: Implementing Error Handling in RxJS
- Experiment 7.5: Using Observables with Angular HttpClient: Performing GET Requests
- Experiment 7.6: Sending Data with POST Requests Using Angular HttpClient and RxJS
- Experiment 7.7: Testing Angular Services and HTTP Requests with HttpClientTestingModule
- Experiment 7.8: Testing Angular Services that Use HttpClient.
- Experiment 7.9: Deploying an Angular Application to Firebase and AWS.
- Experiment 7.10: Best Practices for Angular Application Deployment.

### **Project (28 hours)**

### Textbooks and References:

- Angular Documentation: Angular.io
- Books:
  - "Angular Up & Running" by Shyam Seshadri
  - "Pro Angular" by Adam Freeman
- Online Courses:
  - Angular courses on platforms like Udemy, Coursera, and Pluralsight
- Tools:
  - Visual Studio Code, Angular CLI, Postman

### Course 3: Spring Boot (4 Credits) (112 Hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUST1053	Spring Boot	4	0+2+2

**Course Description:** This course focuses on Spring Boot, a framework for building production-ready applications with Spring. Students will learn how to create RESTful services, work with databases, and deploy Spring Boot applications.

### Course Objectives:

- Understand the core concepts of Spring and Spring Boot.
- Develop RESTful services and secure Spring Boot applications.
- Implement data access and perform testing in Spring Boot applications.

### Course Outcomes (COs):

- CO1: Explain the features and benefits of Spring and Spring Boot. (Understand, Remember)
- CO2: Set up and configure a Spring Boot project. (Apply, Create)
- CO3: Develop RESTful services using Spring Boot. (Apply, Create)
- CO4: Implement data access using Spring Data JPA and perform CRUD operations. (Apply, Evaluate)
- CO5: Secure Spring Boot applications and perform testing. (Apply, Evaluate)

## CO-PO-PSO Mapping:

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CO2	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO3	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO4	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO5	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3

**\*High-3, Medium-2, Low-1**

### Module Breakdown:

#### Module 1: Introduction to Spring (8 hours)

##### Theory

Overview of Spring and Its Features; Dependency Injection using Setter and Constructor; Bean and Application Context.

##### Practice

- Experiment 1.1: Install and set up a Spring project.
- Experiment 1.2: Create and configure beans using XML and Java annotations.
- Experiment 1.3: Implement dependency injection using setter methods.
- Experiment 1.4: Implement dependency injection using constructor methods.
- Experiment 1.5: Explore the ApplicationContext in Spring.
- Experiment 1.6: Document and present the features of the Spring framework.
- Experiment 1.7: Compare different dependency injection methods.
- Experiment 1.8: Conduct a seminar on Spring framework best practices.
- Experiment 1.9: Present case studies of successful Spring applications.
- Experiment 1.10: Research and present the evolution of the Spring framework.

#### Module 2: Introduction to Spring Boot (8 hours)

##### Theory

Overview of Spring Boot and Its Features; Setting Up a Spring Boot Project.

##### Practice

- Experiment 2.1: Install and configure Spring Boot.
- Experiment 2.2: Set up a new Spring Boot project using Spring Initializr.
- Experiment 2.3: Explore the Spring Boot project structure.
- Experiment 2.4: Implement a simple Spring Boot application.
- Experiment 2.5: Document and present the benefits of using Spring Boot.
- Experiment 2.6: Compare Spring Boot with traditional Spring.
- Experiment 2.7: Conduct a seminar on Spring Boot features.
- Experiment 2.8: Implement a Spring Boot-based project.
- Experiment 2.9: Present case studies of Spring Boot applications.
- Experiment 2.10: Research and present advanced Spring Boot features.

### **Module 3: Spring Boot Basics (6 hours)**

#### **Theory**

Spring Boot Annotations and Configuration; Creating RESTful Services.

#### **Practice**

- Experiment 3.1: Implement RESTful services using Spring Boot annotations.
- Experiment 3.2: Configure Spring Boot applications using properties and YAML files.
- Experiment 3.3: Develop a simple RESTful API using Spring Boot.
- Experiment 3.4: Implement exception handling in Spring Boot RESTful services.
- Experiment 3.5: Document and present the use of annotations in Spring Boot.
- Experiment 3.6: Compare different configuration methods in Spring Boot.
- Experiment 3.7: Conduct a seminar on RESTful service design.
- Experiment 3.8: Implement a project involving complex RESTful services.
- Experiment 3.9: Present case studies of RESTful services in Spring Boot.
- Experiment 3.10: Research and present best practices for Spring Boot configuration.

### **Module 4: Data Access with Spring Boot (8 hours)**

#### **Theory**

Spring Data JPA; Connecting to Databases; CRUD Operations.

#### **Practice**

- Experiment 4.1: Set up database connectivity in a Spring Boot application.
- Experiment 4.1: Implement CRUD operations using Spring Data JPA.
- Experiment 4.1: Configure data sources and JPA properties.
- Experiment 4.1: Develop a simple database-driven application.

- Experiment 4.1: Document and present the use of Spring Data JPA.
- Experiment 4.1: Compare different database connectivity methods.
- Experiment 4.1: Conduct a seminar on data access best practices.
- Experiment 4.1: Implement a project involving complex data access operations.
- Experiment 4.1: Present case studies of data-driven Spring Boot applications.
- Experiment 4.1: Research and present advanced features of Spring Data JPA.

## **Module 5: Spring Boot Security (8 hours)**

### **Theory**

Securing Applications with Spring Security; Authentication and Authorization.

### **Practice**

- Experiment 5.1: Implement security features in a Spring Boot application.
- Experiment 5.2: Configure authentication using Spring Security.
- Experiment 5.3: Implement authorization roles and permissions.
- Experiment 5.4: Secure RESTful APIs with Spring Security.
- Experiment 5.5: Document and present the use of Spring Security.
- Experiment 5.6: Compare different security methods in Spring Boot.
- Experiment 5.7: Conduct a seminar on application security best practices.
- Experiment 5.8: Implement a project involving complex security requirements.
- Experiment 5.9: Present case studies of secure Spring Boot applications.
- Experiment 5.10: Research and present advanced security features in Spring Boot.

## **Module 6: Spring Boot Testing (8 hours)**

### **Theory**

Writing Unit and Integration Tests; Testing with Spring Boot Test.

### **Practice**

- Experiment 6.1: Implement unit tests using JUnit and Mockito.
- Experiment 6.2: Write integration tests for Spring Boot applications.
- Experiment 6.3: Use Spring Boot Test for testing Spring Boot applications.
- Experiment 6.4: Configure test environments and properties.
- Experiment 6.5: Document and present the use of testing frameworks.
- Experiment 6.6: different testing methods in Spring Boot.
- Experiment 6.7: Conduct a seminar on testing best practices.
- Experiment 6.8: Implement a project involving comprehensive testing.

- Experiment 6.9: Present case studies of tested Spring Boot applications.
- Experiment 6.10: Research and present advanced testing techniques in Spring Boot.

## **Module 7: Case Studies and Applications (8 hours)**

### **Theory**

Real-World Spring Boot Projects; Hands-on Labs and Assignments.

### **Practice**

- Experiment 7.1: Analyze real-world Spring Boot projects.
- Experiment 7.2: Implement a Spring Boot application based on a case study.
- Experiment 7.3: hands-on labs for Spring Boot features.
- Experiment 7.4: Develop a comprehensive Spring Boot project.
- Experiment 7.5: Document and present project findings.
- Experiment 7.6: Compare different Spring Boot applications.
- Experiment 7.7: Conduct a seminar on Spring Boot application development.
- Experiment 7.8: Implement a project involving multiple Spring Boot features.
- Experiment 7.9: Present case studies of successful Spring Boot projects.
- Experiment 7.10: Research and present future trends in Spring Boot development.

### **Project (28 Hours)**

#### **Textbooks and References:**

- "Spring Boot in Action" by Craig Walls
- "Pro Spring Boot" by Felipe Gutierrez

## Product Development(168hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUST1054	Product Development	6	0+0+6

**Course Description:** This course provides a comprehensive overview of the product development process, from ideation to launch. Students will learn about product design, development methodologies, project management, and user experience (UX) design.

### Course Objectives:

- Understand the complete product development lifecycle.
- Apply design and development methodologies to create products.
- Manage projects effectively and ensure a great user experience.

### Course Outcomes (COs):

- CO1: Explain the roles and responsibilities in the product development lifecycle. (Understand, Remember)
- CO2: Utilize brainstorming techniques and market research for product ideation. (Apply, Analyze)
- CO3: Design user-centered products using wireframing and prototyping techniques. (Apply, Create)
- CO4: Implement Agile, Scrum, and Lean methodologies in product development. (Apply, Create)
- CO5: Manage resources, risks, and communication in product development projects. (Evaluate, Create)

### CO-PO-PSO Mapping:

CO/PO/PS O	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
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CO2	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO3	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO4	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO5	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3

**\*High-3, Medium-2, Low-1**

## **Module Breakdown:**

### **Module 1: Introduction to Product Development (6 hours)**

- **Topics:** Overview of Product Development Lifecycle; Roles and Responsibilities in Product Development.

### **Module 2: Ideation and Conceptualization (6 hours)**

- **Topics:** Brainstorming Techniques; Market Research and Competitive Analysis; Creating Product Roadmaps.

### **Module 3: Product Design (8 hours)**

- **Topics:** User-Centered Design Principles; Wireframing and Prototyping; User Interface (UI) Design.

### **Module 4: Development Methodologies (8 hours)**

- **Topics:** Agile and Scrum Frameworks; Lean Product Development; Kanban and Continuous Delivery.

### **Module 5: Project Management (8 hours)**

- **Topics:** Planning and Scheduling; Resource Allocation and Risk Management; Communication and Collaboration Tools.

### **Module 6: User Experience (UX) (8 hours)**

- **Topics:** Conducting User Research; Usability Testing; Iterative Design and Feedback Loops.

### **Module 7: Technical Development (8 hours)**

- **Topics:** Backend and Frontend Development; Integration and APIs; DevOps and Continuous Integration/Continuous Deployment (CI/CD).

### **Module 8: Quality Assurance (8 hours)**

- **Topics:** Testing Strategies and Automation; Performance and Security Testing; Bug Tracking and Resolution.

### **Module 9: Product Launch (8 hours)**

- **Topics:** Marketing and Go-to-Market Strategies; Customer Support and Feedback Collection; Post-Launch Evaluation and Iteration.

### **Module 10: Case Studies and Applications (8 hours)**

- **Topics:** Real-World Product Development Projects; Hands-on Labs and Assignments.

### **Textbooks and References:**

- "Inspired: How To Create Products Customers Love" by Marty Cagan
- "Lean Product and Lean Analytics" by Ben Yoskovitz and Alistair Croll

## Domain Track: Mobile App Development (12 Credits)

### Introduction to Mobile App Development(70hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUMA1071	Introduction to Mobile App Development	3	1+2+0

**Course Description:** This foundational course provides an overview of mobile app development, focusing on the principles of designing and building mobile applications. Students will learn the basics of mobile operating systems, development environments, and user interface design.

#### Course Objectives:

- Understand the mobile app development ecosystems and operating systems.
- Gain proficiency in setting up development environments and using IDEs.
- Learn the principles of mobile UI/UX design and basic programming concepts.

#### Course Outcomes (COs):

- CO1: Explain the mobile app ecosystems and operating systems. (Understand, Remember)
- CO2: Set up and use development environments and IDEs for mobile app development. (Apply, Analyze)
- CO3: Design mobile user interfaces following UI/UX principles. (Apply, Create)
- CO4: Develop basic mobile applications using JavaScript and Dart. (Apply, Create)
- CO5: Utilize version control systems for collaborative development. (Apply, Evaluate)

#### CO-PO-PSO Mapping:

CO/PO/PS O	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
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CO2	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO3	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO4	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO5	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3

\*High-3, Medium-2, Low-1

## Module Breakdown:

### Module 1: Introduction to Mobile App Development (6 hours)

- **Topics:** Overview of Mobile App Ecosystems; Mobile Operating Systems (iOS, Android).

#### Experiments:

- Experiment 1.1.** Explore the mobile app ecosystems for iOS and Android.
- Experiment 1.2.** Compare different mobile operating systems.
- Experiment 1.3.** Document and present the key features of iOS and Android.
- Experiment 1.4.** Research and present current trends in mobile app development.
- Experiment 1.5.** Analyze case studies of successful mobile apps.
- Experiment 1.6.** Discuss the impact of mobile apps on modern society.
- Experiment 1.7.** Investigate career opportunities in mobile app development.
- Experiment 1.8.** Present findings on the evolution of mobile operating systems.
- Experiment 1.9.** Research the future directions of mobile app ecosystems.
- Experiment 1.10.** Explore the role of mobile apps in various industries.

### Module 2: Development Environments (6 hours)

- **Topics:** Setting Up Development Environments (Xcode, Android Studio); Introduction to Integrated Development Environments (IDEs).

#### Experiments:

- Experiment 2.1.** Set up Xcode for iOS development.
- Experiment 2.2.** Set up Android Studio for Android development.
- Experiment 2.3.** Explore the features of Xcode and Android Studio.
- Experiment 2.4.** Document and present the setup process for both IDEs.
- Experiment 2.5.** Compare the development environments for iOS and Android.
- Experiment 2.6.** Conduct a seminar on the importance of IDEs in mobile app development.
- Experiment 2.7.** Implement a project involving basic app development in Xcode.
- Experiment 2.8.** Implement a project involving basic app development in Android Studio.
- Experiment 2.9.** Present case studies on the use of IDEs in successful mobile apps.
- Experiment 2.10.** Research the development of new IDEs for mobile app development.

### Module 3: User Interface Design (8 hours)

- **Topics:** Mobile UI/UX Design Principles; Wireframing and Prototyping.

#### Experiments:

- Experiment 3.1.** Design a basic user interface for a mobile app.
- Experiment 3.2.** Create wireframes for a mobile app using design tools.
- Experiment 3.3.** Develop prototypes for a mobile app.
- Experiment 3.4.** Document and present the UI/UX design principles.
- Experiment 3.5.** Compare different UI/UX design tools.
- Experiment 3.6.** Conduct a seminar on the importance of UI/UX design in mobile apps.
- Experiment 3.7.** Implement a project involving UI/UX design for a mobile app.
- Experiment 3.8.** Present case studies on the impact of UI/UX design in successful mobile apps.
- Experiment 3.9.** Research the development of new UI/UX design principles.
- Experiment 3.10.** Investigate the challenges in mobile UI/UX design.

#### **Module 4: App Development Lifecycle (8 hours)**

- **Topics:** Planning and Requirements Gathering; Development, Testing, and Deployment.

##### **Experiments:**

- Experiment 4.1.** Plan and gather requirements for a mobile app project.
- Experiment 4.2.** Document and present the app development lifecycle.
- Experiment 4.3.** Develop a basic mobile app following the development lifecycle.
- Experiment 4.4.** Test a mobile app using various testing tools.
- Experiment 4.5.** Deploy a mobile app to a virtual device.
- Experiment 4.6.** Compare different app development lifecycles.
- Experiment 4.7.** Conduct a seminar on the importance of planning and testing in app development.
- Experiment 4.8.** Implement a project involving the complete app development lifecycle.
- Experiment 4.9.** Present case studies on the app development lifecycle in successful mobile apps.
- Experiment 4.10.** Research the challenges in the app development lifecycle.

#### **Module 5: Introduction to Cross-Platform Development (6 hours)**

- **Topics:** Advantages of Cross-Platform Development; Overview of React Native and Flutter.

##### **Experiments:**

- Experiment 5.1.** Explore the advantages of cross-platform development.
- Experiment 5.2.** Set up React Native for cross-platform app development.
- Experiment 5.3.** Set up Flutter for cross-platform app development.
- Experiment 5.4.** Document and present the features of React Native and Flutter.
- Experiment 5.5.** Compare React Native and Flutter for cross-platform development.

**Experiment 5.6.** Conduct a seminar on the importance of cross-platform development.

**Experiment 5.7.** Implement a project involving basic app development in React Native.

**Experiment 5.8.** Implement a project involving basic app development in Flutter.

**Experiment 5.9.** Present case studies on successful cross-platform apps.

**Experiment 5.10.** Research the future of cross-platform development.

## Module 6: Basic Programming Concepts (6 hours)

- **Topics:** Introduction to JavaScript and Dart; Mobile-Specific Programming Constructs.

### Experiments:

**Experiment 6.1.** Write basic programs in JavaScript.

**Experiment 6.2.** Write basic programs in Dart.

**Experiment 6.3.** Explore mobile-specific programming constructs.

**Experiment 6.4.** Document and present basic programming concepts.

**Experiment 6.5.** Compare JavaScript and Dart for mobile app development.

**Experiment 6.6.** Conduct a seminar on the importance of programming in mobile app development.

**Experiment 6.7.** Implement a project involving basic programming in JavaScript.

**Experiment 6.8.** Implement a project involving basic programming in Dart.

**Experiment 6.9.** Present case studies on the use of programming in successful mobile apps.

**Experiment 6.10.** Research the development of new programming languages for mobile apps.

## Module 7: Version Control Systems (6 hours)

- **Topics:** Introduction to Git and GitHub; Collaborative Development Practices.

### Experiments:

**Experiment 7.1.** Set up a Git repository for a mobile app project.

**Experiment 7.2.** Explore the features of GitHub for collaborative development.

**Experiment 7.3.** Document and present the use of version control systems.

**Experiment 7.4.** Compare different version control systems for mobile app development.

**Experiment 7.5.** Conduct a seminar on the importance of version control systems.

**Experiment 7.6.** Implement a project involving collaborative development using Git and GitHub.

**Experiment 7.7.** Present case studies on the use of version control systems in successful mobile apps.

**Experiment 7.8.** Research the development of new version control systems.

**Experiment 7.9.** Investigate the challenges in using version control systems.

**Experiment 7.10.** Analyze the impact of version control systems on collaborative development.

**Textbooks and References:**

- "Mobile App Development for Beginners" by John Horton
- "Don't Make Me Think: A Common Sense Approach to Web Usability" by Steve Krug

**React Native Development(84hours)**

Course Code	Course Title	Credits	Type (T+P+Pj)
CUMA1072	React Native Development	3	0+2+1

**Course Description:** This course covers the development of mobile applications using React Native. Students will learn how to build cross-platform apps with a focus on performance and native-like user experiences.

**Course Objectives:**

- Understand the core concepts and components of React Native.
- Develop cross-platform mobile applications using React Native.
- Optimize and deploy React Native applications.

**Course Outcomes (COs):**

- CO1: Explain the fundamental concepts and components of React Native. (Understand, Remember)
- CO2: Develop mobile applications using React Native with effective state management. (Apply, Create)
- CO3: Implement navigation and routing in React Native applications. (Apply, Analyze)
- CO4: Integrate APIs and handle asynchronous data in React Native apps. (Apply, Evaluate)
- CO5: Optimize, test, and deploy React Native applications for production. (Apply, Create)

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CO2	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO3	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO4	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO5	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3

**\*High-3, Medium-2, Low-1**

## Module Breakdown:

### Module 1: Introduction to React Native (6 hours)

- **Topics:** Overview of React Native; Setting Up the Development Environment.

#### Experiments:

- Experiment 1.1.** Set up the React Native development environment.
- Experiment 1.2.** Create a "Hello World" app in React Native.
- Experiment 1.3.** Explore the React Native project structure.
- Experiment 1.4.** Document and present the React Native setup process.
- Experiment 1.5.** Compare React Native with other mobile app development frameworks.
- Experiment 1.6.** Conduct a seminar on the benefits of using React Native.
- Experiment 1.7.** Implement a project involving basic app development in React Native.
- Experiment 1.8.** Present case studies on successful React Native apps.
- Experiment 1.9.** Research the future of React Native development.
- Experiment 1.10.** Investigate the challenges in setting up React Native environments.

### Module 2: Core Concepts and Components (6 hours)

- **Topics:** JSX and React Components; Styling Components with Flexbox.

#### Experiments:

- Experiment 2.1.** Create and style components using JSX and Flexbox.
- Experiment 2.2.** Implement different types of React components.
- Experiment 2.3.** Explore component lifecycle methods in React Native.
- Experiment 2.4.** Document and present the core concepts of React Native.
- Experiment 2.5.** Compare different component styling techniques.
- Experiment 2.6.** Conduct a seminar on component-based development in React Native.
- Experiment 2.7.** Implement a project involving advanced component development.
- Experiment 2.8.** Present case studies on component usage in successful React Native apps.

**Experiment 2.9.** Research the development of new components in React Native.

**Experiment 2.10.** Investigate the challenges in component styling and management.

### **Module 3: State Management (8 hours)**

- **Topics:** State and Props; Context API and Redux for State Management.

#### **Experiments:**

**Experiment 3.1.** Manage state using React's built-in state and props.

**Experiment 3.2.** Implement state management using Context API.

**Experiment 3.3.** Use Redux for state management in React Native.

**Experiment 3.4.** Document and present state management techniques.

**Experiment 3.5.** Compare Context API and Redux for state management.

**Experiment 3.6.** Conduct a seminar on state management best practices.

**Experiment 3.7.** Implement a project involving complex state management.

**Experiment 3.8.** Present case studies on state management in React Native apps.

**Experiment 3.9.** Research the development of new state management tools.

**Experiment 3.10.** Investigate the challenges in state management.

### **Module 4: Navigation and Routing (8 hours)**

- **Topics:** React Navigation Library; Stack, Tab, and Drawer Navigation.

#### **Experiments:**

- Implement stack navigation using React Navigation.
- Implement tab navigation using React Navigation.
- Implement drawer navigation using React Navigation.
- Document and present navigation techniques.
- Compare different navigation methods.
- Conduct a seminar on navigation best practices.
- Implement a project involving advanced navigation techniques.
- Present case studies on navigation in successful React Native apps.
- Research the development of new navigation tools.
- Investigate the challenges in implementing navigation.

### **Module 5: Handling User Input (8 hours)**

- **Topics:** Forms and User Input Handling; Touch and Gesture Handling.

#### **Experiments:**

**Experiment 5.1.** Create forms and handle user input in React Native.

- Experiment 5.2.** Implement touch and gesture handling.
- Experiment 5.3.** Explore form validation techniques.
- Experiment 5.4.** Document and present user input handling techniques.
- Experiment 5.5.** Compare different methods for handling user input.
- Experiment 5.6.** Conduct a seminar on user input best practices.
- Experiment 5.7.** Implement a project involving advanced user input handling.
- Experiment 5.8.** Present case studies on user input handling in successful React Native apps.
- Experiment 5.9.** Research the development of new user input handling tools.
- Experiment 5.10.** Investigate the challenges in handling user input.

## Module 6: Networking and API Integration (8 hours)

- **Topics:** Fetch API and Axios; Handling Asynchronous Data.

### Experiments:

- Experiment 6.1.** Integrate APIs using Fetch API.
- Experiment 6.2.** Integrate APIs using Axios.
- Experiment 6.3.** Handle asynchronous data in React Native.
- Experiment 6.4.** Document and present API integration techniques.
- Experiment 6.5.** Compare Fetch API and Axios for API integration.
- Experiment 6.6.** Conduct a seminar on API integration best practices.
- Experiment 6.7.** Implement a project involving complex API integration.
- Experiment 6.8.** Present case studies on API integration in successful React Native apps.
- Experiment 6.9.** Research the development of new API integration tools.
- Experiment 6.10.** Investigate the challenges in integrating APIs.

## Module 7: Native Modules and Plugins (8 hours)

- **Topics:** Linking Native Code; Using Third-Party Libraries.

### Experiments:

- Experiment 7.1.** Link native code in React Native.
- Experiment 7.2.** Use third-party libraries in React Native.
- Experiment 7.3.** Explore the process of creating custom native modules.
- Experiment 7.4.** Document and present native module integration techniques.
- Experiment 7.5.** Compare different methods for integrating native modules.
- Experiment 7.6.** Conduct a seminar on native module best practices.
- Experiment 7.7.** Implement a project involving advanced native module integration.
- Experiment 7.8.** Present case studies on native module usage in successful React Native apps.
- Experiment 7.9.** Research the development of new native modules.

**Experiment 7.10.** Investigate the challenges in linking native code.

**Textbooks and References:**

- "React Native in Action" by Nader Dabit
- "Learning React Native: Building Native Mobile Apps with JavaScript" by Bonnie Eisenman

**Flutter Development(84hours)**

**Course Description:** This course focuses on building mobile applications using Flutter. Students will learn how to create high-performance, visually attractive cross-platform apps with Dart.

**Course Objectives:**

- Understand the core concepts and components of Flutter and Dart.
- Develop cross-platform mobile applications using Flutter.
- Optimize and deploy Flutter applications for production.

**Course Outcomes (COs):**

- CO1: Explain the fundamental concepts and components of Flutter and Dart. (Understand, Remember)
- CO2: Develop mobile applications using Flutter with effective state management. (Apply, Create)
- CO3: Implement navigation and routing in Flutter applications. (Apply, Analyze)
- CO4: Integrate APIs and handle asynchronous data in Flutter apps. (Apply, Evaluate)
- CO5: Optimize, test, and deploy Flutter applications for production. (Apply, Create)

**CO-PO-PSO Mapping:**

CO/PO/PS O	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	3	-	-	-	1	2	2	2	3	2	3
CO2	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO3	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO4	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO5	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3

**\*High-3, Medium-2, Low-1**

## Module Breakdown:

### Module 1: Introduction to Flutter (6 hours)

- **Topics:** Overview of Flutter and Dart; Setting Up the Flutter Development Environment.

#### Experiments:

- Experiment 1.1.** Set up the Flutter development environment.
- Experiment 1.2.** Create a "Hello World" app in Flutter.
- Experiment 1.3.** Explore the Flutter project structure.
- Experiment 1.4.** Document and present the Flutter setup process.
- Experiment 1.5.** Compare Flutter with other mobile app development frameworks.
- Experiment 1.6.** Conduct a seminar on the benefits of using Flutter.
- Experiment 1.7.** Implement a project involving basic app development in Flutter.
- Experiment 1.8.** Present case studies on successful Flutter apps.
- Experiment 1.9.** Research the future of Flutter development.
- Experiment 1.10.** Investigate the challenges in setting up Flutter environments.

### Module 2: Dart Programming Basics (6 hours)

- **Topics:** Syntax and Basic Constructs; Object-Oriented Programming in Dart.

#### Experiments:

- Write basic programs in Dart.
- Explore Dart's syntax and constructs.
- Implement object-oriented programming concepts in Dart.
- Document and present Dart programming basics.
- Compare Dart with other programming languages for mobile app development.
- Conduct a seminar on the importance of Dart in Flutter development.
- Implement a project involving basic programming in Dart.
- Present case studies on Dart usage in successful Flutter apps.
- Research the development of new programming languages for mobile apps.
- Investigate the challenges in Dart programming.

### Module 3: Flutter Widgets (8 hours)

- **Topics:** Stateless and Stateful Widgets; Building Complex Layouts.

#### Experiments:

- Experiment 3.1.** Create and style stateless widgets in Flutter.
- Experiment 3.2.** Create and style stateful widgets in Flutter.

- Experiment 3.3.** Implement complex layouts using Flutter widgets.
- Experiment 3.4.** Document and present Flutter widget concepts.
- Experiment 3.5.** Compare stateless and stateful widgets.
- Experiment 3.6.** Conduct a seminar on widget-based development in Flutter.
- Experiment 3.7.** Implement a project involving advanced widget development.
- Experiment 3.8.** Present case studies on widget usage in successful Flutter apps.
- Experiment 3.9.** Research the development of new Flutter widgets.
- Experiment 3.10.** Investigate the challenges in widget management and styling.

#### **Module 4: State Management in Flutter (8 hours)**

- **Topics:** setState and InheritedWidget; Provider, Riverpod, and Bloc.

##### **Experiments:**

- Experiment 4.1.** Manage state using Flutter's setState.
- Experiment 4.2.** Implement state management using InheritedWidget.
- Experiment 4.3.** Use Provider for state management in Flutter.
- Experiment 4.4.** Document and present state management techniques.
- Experiment 4.5.** Compare Provider, Riverpod, and Bloc for state management.
- Experiment 4.6.** Conduct a seminar on state management best practices.
- Experiment 4.7.** Implement a project involving complex state management.
- Experiment 4.8.** Present case studies on state management in Flutter apps.
- Experiment 4.9.** Research the development of new state management tools.
- Experiment 4.10.** Investigate the challenges in state management.

#### **Module 5: Navigation and Routing (8 hours)**

- **Topics:** Navigator and Routing Mechanisms; Nested Navigation and Navigation Patterns.

##### **Experiments:**

- Experiment 5.1.** Implement basic navigation using Navigator.
- Experiment 5.2.** Implement nested navigation using Flutter's routing mechanisms.
- Experiment 5.3.** Explore different navigation patterns in Flutter.
- Experiment 5.4.** Document and present navigation techniques.
- Experiment 5.5.** Compare different methods for implementing navigation.
- Experiment 5.6.** Conduct a seminar on navigation best practices.
- Experiment 5.7.** Implement a project involving advanced navigation techniques.
- Experiment 5.8.** Present case studies on navigation in successful Flutter apps.
- Experiment 5.9.** Research the development of new navigation tools.
- Experiment 5.10.** Investigate the challenges in implementing navigation.

## Module 6: Handling User Input (8 hours)

- **Topics:** Forms and Validation; Gesture Detection and Handling.

### Experiments:

- Experiment 6.1.** Create forms and handle user input in Flutter.
- Experiment 6.2.** Implement form validation in Flutter.
- Experiment 6.3.** Explore gesture detection and handling in Flutter.
- Experiment 6.4.** Document and present user input handling techniques.
- Experiment 6.5.** Compare different methods for handling user input.
- Experiment 6.6.** Conduct a seminar on user input best practices.
- Experiment 6.7.** Implement a project involving advanced user input handling.
- Experiment 6.8.** Present case studies on user input handling in successful Flutter apps.
- Experiment 6.9.** Research the development of new user input handling tools.
- Experiment 6.10.** Investigate the challenges in handling user input.

## Module 7: Networking and Backend Integration (8 hours)

- **Topics:** HTTP Requests with Dio; Handling Asynchronous Data and JSON Parsing.

### Experiments:

- Experiment 7.1.** Integrate APIs using HTTP requests with Dio.
- Experiment 7.2.** Handle asynchronous data in Flutter.
- Experiment 7.3.** Implement JSON parsing in Flutter.
- Experiment 7.4.** Document and present API integration techniques.
- Experiment 7.5.** Compare Dio with other HTTP libraries for API integration.
- Experiment 7.6.** Conduct a seminar on API integration best practices.
- Experiment 7.7.** Implement a project involving complex API integration.
- Experiment 7.8.** Present case studies on API integration in successful Flutter apps.
- Experiment 7.9.** Research the development of new API integration tools.
- Experiment 7.10.** Investigate the challenges in integrating APIs.

### Textbooks and References:

- "Flutter in Action" by Eric Windmill
- "Flutter for Beginners" by Alessandro Biessek

## Advanced Mobile App Development Project(84hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUMA1074	Advanced Mobile App Development Project	3	0+0+3

**Course Description:** In this capstone course, students will apply their knowledge of React Native and Flutter to design, develop, and deploy a comprehensive mobile application. The project will encompass the entire app development lifecycle from ideation to deployment.

### Course Objectives:

- Apply advanced knowledge of mobile app development using React Native or Flutter.
- Design and develop a comprehensive mobile application from scratch.
- Deploy and present the mobile application, demonstrating its features and functionality.

### Course Outcomes (COs):

- CO1: Propose and plan a comprehensive mobile application project. (Create, Apply)
- CO2: Design user interfaces and experiences using wireframes and prototypes. (Create, Evaluate)
- CO3: Develop and implement core and advanced features in a mobile application. (Apply, Analyze)
- CO4: Test, debug, and ensure the quality of the mobile application. (Evaluate, Analyze)
- CO5: Deploy the mobile application to app stores and present the completed project. (Apply, Create)

### CO-PO-PSO Mapping:

CO/PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	3	-	-	-	1	2	2	2	3	2	3
CO2	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO3	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO4	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO5	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3

**\*High-3, Medium-2, Low-1**

## **Module Breakdown:**

### **Module 1: Project Proposal and Planning (6 hours)**

- **Topics:** Identifying a Project Idea; Defining Objectives, Scope, and Requirements.

### **Module 2: Design and Prototyping (6 hours)**

- **Topics:** Creating Wireframes and Prototypes; User Interface and Experience Design.

### **Module 3: Development Phase 1: Setting Up (6 hours)**

- **Topics:** Choosing React Native or Flutter; Setting Up the Project Structure.

### **Module 4: Development Phase 2: Core Features (6 hours)**

- **Topics:** Implementing Core Features and Functionalities; State Management and Navigation.

### **Module 5: Development Phase 3: Advanced Features (6 hours)**

- **Topics:** Integrating Advanced Features (e.g., Push Notifications, In-App Purchases); Backend Integration and API Usage.

### **Module 6: Testing and Quality Assurance (6 hours)**

- **Topics:** Conducting Unit, Integration, and User Testing; Debugging and Resolving Issues.

### **Module 7: Performance Tuning (6 hours)**

- **Topics:** Profiling the App and Optimizing Performance; Ensuring Cross-Platform Consistency.

### **Module 8: Deployment and Publishing (6 hours)**

- **Topics:** Preparing the App for Release; App Store and Google Play Store Submission Process.

### **Module 9: Final Presentation and Review (6 hours)**

- **Topics:** Presenting the Completed Project; Peer Review and Instructor Feedback.

### **Module 10: Case Studies and Applications (6 hours)**

- **Topics:** Reviewing Other Advanced Mobile Applications; Learning from Industry Best Practices.

### **Textbooks and References:**

- "The Lean Startup" by Eric Ries
- "App Store Optimization: ASO Secrets" by Gabriel Machuret

**Domain Track: Gaming and Immersive Learning-AR/VR (20 Credits)**

**Introduction to Gaming & Simulation(70hours)**

Course Code	Course Title	Credits	Type (T+P+Pj)
CUGH1081	Introduction to Gaming & Simulation	2	1+1+0

**Course Description:**

This course provides an introduction to game development and simulation, focusing on the use of Unity as a game engine. Students will learn about the game development lifecycle, Unity's interface, game object manipulation, asset management, and project management within the Unity environment.

**Course Objectives:**

- Understand the fundamentals of game development and the economics behind it.
- Gain proficiency in using the Unity game engine and its interface.
- Learn to create and manage game objects, assets, and projects within Unity.

**Course Outcomes (COs):**

- CO1: Explain the importance of storyboarding and the economics of game development. (Understand, Remember)
- CO2: Describe the game production pipeline and various roles in game development. (Understand, Remember)
- CO3: Navigate and utilize the Unity Editor interface effectively. (Apply, Analyze)
- CO4: Create and manage game objects and assets in Unity. (Apply, Create)
- CO5: Implement project management techniques for game development in Unity. (Apply, Create)

**CO-PO-PSO Mapping:**

CO/PO/PSO	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15
CO1	3	2	2	1	2	-	-	1	1	-	-	1	3	2	3

CO2	3	3	3	2	3	-	1	2	1	1	-	2	3	3	3
CO3	3	3	3	3	3	1	1	2	2	1	2	2	3	3	3
CO4	3	3	3	3	3	1	1	2	3	1	3	3	3	3	3
CO5	3	3	3	3	3	1	1	2	2	3	2	2	3	3	3

**\*High-3, Medium-2, Low-1**

### Course Syllabus:

#### Module I: Welcome to Game Engine (2+2.5 hours)

- Importance of Storyboarding a Game Idea
- The Economics of Game Development
- Assessing Game Markets and Platforms
- Marketing Methods for Games
- Monetizing Games and Upgrades

#### Experiments:

- Experiment 1.1.** Create a storyboard for a simple game idea.
- Experiment 1.2.** Conduct market research for a chosen game concept.
- Experiment 1.3.** Develop a basic game marketing strategy.
- Experiment 1.4.** Outline monetization strategies for a game.
- Experiment 1.5.** Analyze the economic viability of different game platforms.
- Experiment 1.6.** Present a game idea with a focus on its market potential.
- Experiment 1.7.** Evaluate different game genres and their market trends.
- Experiment 1.8.** Create a business model for a game project.
- Experiment 1.9.** Design a simple game prototype based on market analysis.
- Experiment 1.10.** Document the storyboard and market research findings.

#### Module II: Introduction to Game Production (1 hour)

- Video Game Platforms and Genres
- Describing the Game Production Pipeline
- Game Development Jobs and Roles
- The Game Design Document
- The Technical Design Document

- Getting Started in Unity
- Creating a New Unity Project
- Using the Unity Asset Store
- Source Control for Working in Teams

### Experiments:

- Experiment 2.1.** Create a game design document for a simple game.
- Experiment 2.2.** Develop a technical design document for the game.
- Experiment 2.3.** Set up a new Unity project and explore the interface.
- Experiment 2.4.** Download and import assets from the Unity Asset Store.
- Experiment 2.5.** Implement version control for a Unity project.
- Experiment 2.6.** Explore different game genres and their production pipelines.
- Experiment 2.7.** Analyze various game development roles and responsibilities.
- Experiment 2.8.** Create a Unity project using asset store resources.
- Experiment 2.9.** Collaborate on a Unity project using source control.
- Experiment 2.10.** Document the game production process.

### Module III: The Game Engine User Interface (2+2 hours)

- Introduction to the Unity Editor Interface
- Analyzing the Unity Editor User Interface
- Utilizing the Unity Editor User Interface
- Navigating the Scene View Window
- Utilizing the Game View Window
- Navigating the Hierarchy Window
- Using the Inspector Window
- Managing Assets in the Project Window
- Searching and Filtering in the Project Window
- Organizing the Scene with Layers

### Experiments:

- Experiment 3.1.** Explore and navigate the Unity Editor interface.
- Experiment 3.2.** Create and modify scenes in Unity.
- Experiment 3.3.** Organize assets in the Project Window.
- Experiment 3.4.** Use the Inspector Window to edit game objects.
- Experiment 3.5.** Implement layers to organize the scene.
- Experiment 3.6.** Search and filter assets in the Project Window.
- Experiment 3.7.** Navigate and use the Scene View and Game View windows.
- Experiment 3.8.** Create a simple game scene in Unity.
- Experiment 3.9.** Analyze the different windows and their functions in Unity.
- Experiment 3.10.** Document the navigation and organization of Unity projects.

### Module IV: Using Game Objects and Assets (1+2 hours)

- Creating and Modifying Game Objects
- Defining Unity Editor Units
- Describing Assets in the Production Pipeline
- Review: Defining an Asset
- Organizing Assets in the Unity Editor
- Defining a Game Object

### Experiments:

- Experiment 4.1.** Create and modify basic game objects in Unity.
- Experiment 4.2.** Define and organize assets in the Unity Editor.
- Experiment 4.3.** Develop a simple game using predefined assets.
- Experiment 4.4.** Explore the production pipeline of assets.
- Experiment 4.5.** Implement and manage game objects in a Unity project.
- Experiment 4.6.** Document the creation and modification of game objects.
- Experiment 4.7.** Review and organize assets for a Unity project.
- Experiment 4.8.** Define and utilize Unity Editor units.
- Experiment 4.9.** Create a game prototype using organized assets.
- Experiment 4.10.** Present the organization and implementation of game objects and assets.

### Module V: Defining a Game Object (2+2 hours)

- Creating Unity-native Game Objects
- Manipulating Game Objects in the Unity Editor
- Describing What is a Unity-native gameObject
- The Role of Components in the Unity Editor
- Defining Prefabs and Scene Structure
- Defining the Role of the Prefab in Unity
- Creating and Saving a Scene

### Experiments:

- Experiment 5.1.** Create and manipulate Unity-native game objects.
- Experiment 5.2.** Define and use components in the Unity Editor.
- Experiment 5.3.** Create and manage prefabs in Unity.
- Experiment 5.4.** Develop a scene structure using prefabs.
- Experiment 5.5.** Save and organize scenes in a Unity project.
- Experiment 5.6.** Explore the role of components in game object manipulation.
- Experiment 5.7.** Create a game scene using Unity-native objects.
- Experiment 5.8.** Document the creation and manipulation of game objects.
- Experiment 5.9.** Implement and manage prefabs in a Unity project.
- Experiment 5.10.** Present a complete game scene with organized prefabs and components.

### Module VI: The Hierarchy of Scenes within a Game (1+2 hours)

- Importing Assets into a Project

- Importing and Configuring a 3D Model
- Importing Textures for Use in Materials
- Importing FBX Files with Animation
- Working with Sprites
- Introduction to Sprites in Game Development

### Experiments:

- Experiment 6.1.** Import and configure 3D models in Unity.
- Experiment 6.2.** Import and apply textures to materials.
- Experiment 6.3.** Work with FBX files and animations in Unity.
- Experiment 6.4.** Create and use sprites in a game project.
- Experiment 6.5.** Explore the hierarchy of scenes within a Unity project.
- Experiment 6.6.** Document the import and configuration of assets.
- Experiment 6.7.** Develop a game scene using imported 3D models and textures.
- Experiment 6.8.** Implement animations in a Unity project.
- Experiment 6.9.** Create a game prototype using sprites.
- Experiment 6.10.** Present a game project with organized scenes and imported assets.

### Module VII: Managing Projects and Assets (1+2 hours)

- Project Management in Unity
- Introduction to Game Project Management
- Managing Assets
- Using the Unity Asset Store (Reprise)
- Importing Offline Content
- Creating Project Structure Based on Assets
- Sorting the Zombie Toys Prop Model Assets
- Setting Resolution and Type of Texture Files

### Experiments:

- Experiment 7.1.** Implement project management techniques in Unity.
- Experiment 7.2.** Manage and organize assets for a game project.
- Experiment 7.3.** Import and use offline content in Unity.
- Experiment 7.4.** Develop a project structure based on assets.
- Experiment 7.5.** Sort and manage prop model assets in Unity.
- Experiment 7.6.** Set resolution and texture file types for a game project.
- Experiment 7.7.** Document project management practices in Unity.
- Experiment 7.8.** Create a game project using organized assets and project structure.
- Experiment 7.9.** Implement asset management techniques in a Unity project.
- Experiment 7.10.** Present a well-managed and organized game project.

### Textbooks and References:

- "Unity in Action: Multiplatform Game Development in C#" by Joe Hocking

- "Game Engine Architecture" by Jason Gregory
- Unity Documentation and Tutorials

### Game Assets and Objects(70hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUGI1082	Game Assets and Objects	3	1+1+1

#### Course Description:

This course focuses on the creation, management, and implementation of game assets and objects within Unity. Students will learn best practices for 3D content creation, material management, lighting, and physics to build interactive and visually appealing game levels.

#### Course Objectives:

- Master the creation and implementation of game assets and objects.
- Understand and utilize Unity's material and lighting systems.
- Learn to design and assemble game levels using physics and lighting techniques.

#### Course Outcomes (COs):

- CO1: Demonstrate proficiency in 3D content creation, modeling, and texturing for game assets. (Apply, Create)
- CO2: Utilize Unity's material and shader systems effectively. (Apply, Analyze)
- CO3: Design and assemble interactive game levels with proper physics and lighting. (Apply, Create)
- CO4: Implement colliders and physics components to enhance game interactivity. (Apply, Analyze)
- CO5: Apply lighting techniques to create desired visual effects and moods in game scenes. (Apply, Create)

#### CO-PO-PSO Mapping:

CO/PO/ PSO	P O1	P O2	P O3	P O4	P O5	P O6	P O7	P O8	P O9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	2	2	1	2	-	-	1	1	-	-	1	3	2	3
CO2	3	3	3	2	3	-	1	2	1	1	-	2	3	3	3



CO3	3	3	3	3	3	1	1	2	2	1	2	2	3	3	3
CO4	3	3	3	3	3	1	1	2	3	1	3	3	3	3	3
CO5	3	3	3	3	3	1	1	2	2	3	2	2	3	3	3

**\*High-3, Medium-2, Low-1**

## Course Syllabus:

### Module I: Preparing Assets for Implementation (1+2.5 hours)

- Best Practices in 3D Content Creation
- Modeling for Games
- Animating for Games
- UV Mapping and Texturing Techniques
- Exporting to Unity
- Importing into Unity
- Materials in Unity
- The Interaction of Lighting and Materials

### Experiments:

- Experiment 1.1. Create a 3D model suitable for a game.
- Experiment 1.2. Animate the 3D model for in-game use.
- Experiment 1.3. Apply UV mapping and texturing to a 3D model.
- Experiment 1.4. Export the textured model to Unity.
- Experiment 1.5. Import the model into Unity and apply materials.
- Experiment 1.6. Adjust material properties to interact with lighting.
- Experiment 1.7. Create various materials for game assets.
- Experiment 1.8. Compare different texturing techniques.
- Experiment 1.9. Implement best practices in 3D content creation.
- Experiment 1.10. Document the asset creation and import process.

### Module II: Discovering the Standard Shader in Unity (1+2 hours)

- Exploring other Material Types
- Analyzing the Benefits of Custom Shaders
- Creating the Materials for Zombie Toys Props
- Duplicating and Modifying Materials
- Case Studies in Material Creation
- Managing and Using Textures in the Unity Editor
- Texturing for Game Development

- Optimization and Reuse of Textures

### Experiments:

- Experiment 2.1. Explore and use Unity's standard shader.
- Experiment 2.2. Create and apply custom shaders.
- Experiment 2.3. Duplicate and modify existing materials for different effects.
- Experiment 2.4. Analyze case studies of effective material creation.
- Experiment 2.5. Manage textures in the Unity Editor.
- Experiment 2.6. Optimize textures for performance.
- Experiment 2.7. Create materials for specific game props.
- Experiment 2.8. Apply different textures to game objects.
- Experiment 2.9. Reuse textures efficiently across multiple assets.
- Experiment 2.10. Document shader and material modifications.

### Module III: Assembling the Game Level (2+2 hours)

- Branching and Hierarchies
- Creating Hierarchies in Unity
- Using Empty Game Objects as Pivots
- Introduction to Physics in Unity
- Understanding the Physics System in Unity
- Introduction to the Rigidbody Component

### Experiments:

- Experiment 3.1.** Create hierarchies for organizing game objects.
- Experiment 3.2.** Use empty game objects as pivots for grouping.
- Experiment 3.3.** Implement basic physics in Unity.
- Experiment 3.4.** Apply Rigidbody components to game objects.
- Experiment 3.5.** Create a simple game level with organized hierarchies.
- Experiment 3.6.** Explore the Unity physics system.
- Experiment 3.7.** Apply physics properties to game objects.
- Experiment 3.8.** Develop a game prototype with physics-based interactions.
- Experiment 3.9.** Adjust Rigidbody settings for different effects.
- Experiment 3.10.** Document the game level assembly process.

### Module IV: Introduction to Colliders (1+2 hours)

- Creating the Colliders for Zombie Toys Props
- Introduction to Game Level Design
- The Level Design in Zombie Toys
- Placing Objects in a Scene
- Importing the Prop Prefabs into the Scene
- Cloning the Stars
- Creating the Level Boundaries

## Experiments:

- Experiment 4.1.** Create colliders for various game objects.
- Experiment 4.2.** Design a basic game level layout.
- Experiment 4.3.** Place objects strategically in a scene.
- Experiment 4.4.** Import and utilize prop prefabs in a game level.
- Experiment 4.5.** Clone objects to populate the game level.
- Experiment 4.6.** Create boundaries for the game level.
- Experiment 4.7.** Test and adjust colliders for desired interactions.
- Experiment 4.8.** Design a game level for a specific gameplay experience.
- Experiment 4.9.** Integrate colliders into the level design.
- Experiment 4.10.** Document the collider implementation and level design.

## Module V: Lighting in Games (1+2 hours)

- Introduction to Game Lighting
- Differences in Lighting for Games and for Film
- Placing and Adjusting Lights in a Scene
- Analyzing the Different Lights and Properties
- Light Types and Behaviors
- Using Layers to Exclude Objects from Lighting
- Casting and Modifying Shadows
- Mesh Renderer Attributes for Shadows

## Experiments:

- Experiment 5.1.** Implement basic lighting in a game scene.
- Experiment 5.2.** Place and adjust various types of lights.
- Experiment 5.3.** Analyze the properties of different light types.
- Experiment 5.4.** Use layers to manage lighting effects.
- Experiment 5.5.** Cast and modify shadows in a game scene.
- Experiment 5.6.** Adjust mesh renderer attributes for shadow effects.
- Experiment 5.7.** Create a lighting setup for a game level.
- Experiment 5.8.** Compare lighting techniques for different moods.
- Experiment 5.9.** Optimize lighting for performance.
- Experiment 5.10.** Document the lighting setup and adjustments.

## Module VI: Differentiating Shadow Types (1+2 hours)

- Creating Cookies to Shape Lights
- Faking Shadows for Better Performance
- Benefits of Faking Shadows in Games
- Utilizing Painted Shadows
- Using Projectors to Project Shadow Cookies
- Lighting the Zombie Toys Game
- Lighting the Zombie Toys Scene

- Lighting Variations for Changing the Mood

### Experiments:

- Experiment 6.1.** Create light cookies to shape lighting effects.
- Experiment 6.2.** Implement fake shadows for performance optimization.
- Experiment 6.3.** Utilize painted shadows in a game scene.
- Experiment 6.4.** Use projectors to create shadow effects.
- Experiment 6.5.** Apply different lighting setups to change the mood.
- Experiment 6.6.** Test and compare various shadow techniques.
- Experiment 6.7.** Optimize shadows for performance.
- Experiment 6.8.** Document the creation and application of light cookies.
- Experiment 6.9.** Develop a game scene with varying lighting effects.
- Experiment 6.10.** Present a game level with optimized shadows and lighting.

### Module VII: Baking Lighting in Game Production (1+2 hours)

- Light Baking in Video Games
- Setting Objects to Participate in Light Baking
- Marking Objects as Static for Light Baking
- Creating UV Coordinates for Light Baking
- Baking Lighting
- Continuous and Manual Light Baking
- Placing Light Probes for Moving Objects
- Creating Reflection Probes
- Baking the Lighting in Zombie Toys
- Creating the Light Probes in Zombie Toys

### Experiments:

- Experiment 7.1.** Implement light baking in a game scene.
- Experiment 7.2.** Set objects to participate in light baking.
- Experiment 7.3.** Mark objects as static for efficient light baking.
- Experiment 7.4.** Create UV coordinates for light baking.
- Experiment 7.5.** Perform continuous and manual light baking.
- Experiment 7.6.** Place light probes for dynamic objects.
- Experiment 7.7.** Create and configure reflection probes.
- Experiment 7.8.** Test and adjust baked lighting for desired effects.
- Experiment 7.9.** Optimize light baking for performance.
- Experiment 7.10.** Document the light baking process and results.

### Textbooks and References:

- "Unity in Action: Multiplatform Game Development in C#" by Joe Hocking
- "Game Engine Architecture" by Jason Gregory
- Unity Documentation and Tutorials

## Building Game Environment(70hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUGI1083	Building Game Environment	3	1+1+1

### Course Description:

This course provides an in-depth understanding of creating game environments using Unity. Students will learn how to develop player characters, allies, enemies, and integrate particle systems and audio to build immersive game environments.

### Course Objectives:

- Develop player characters, allies, and enemies in Unity.
- Create and integrate particle systems for game effects.
- Implement audio to enhance game environments.

### Course Outcomes (COs):

- CO1: Create and configure player and ally characters with appropriate behaviors. (Apply, Create)
- CO2: Design and implement various enemy characters and their behaviors. (Apply, Analyze)
- CO3: Utilize Unity's particle system to create and integrate game effects. (Apply, Create)
- CO4: Develop and integrate audio effects to enhance the gaming experience. (Apply, Analyze)
- CO5: Apply best practices in game development to create interactive and engaging game environments. (Apply, Create)

### CO-PO-PSO Mapping:

CO/PO/ PSO	P O1	P O2	P O3	P O4	P O5	P O6	P O7	P O8	P O9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	3	2	2	-	-	-	2	2	2	2	3	3	3
CO2	3	3	3	2	2	-	-	-	2	2	2	2	3	3	3
CO3	3	3	3	3	2	-	-	-	3	2	2	2	3	3	3
CO4	3	3	3	3	2	-	-	-	3	2	2	2	3	3	3



CO5	3	3	3	3	2	-	-	-	3	2	2	2	3	3	3
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**\*High-3, Medium-2, Low-1**

**Course Syllabus:**

**Module I: Building the Player and Allies (2+2 hours)**

- Creating a Player Controller
- Examining Why to Use a Custom Controller
- Creating the Player Controller Game Object
- Adding a Game Manager
- Explaining the Purpose of the Game Manager
- Making the Controller Functional
- Adding Scripts for Behavior
- Configuring the Camera
- Creating the Sheep Ally
- Building the Sheep Ally From a Model
- Creating the Dog Ally
- Building the Dog Ally From a Model

**Experiments:**

- Experiment 1.1.** Create and configure a player controller.
- Experiment 1.2.** Develop and integrate a game manager.
- Experiment 1.3.** Script behaviors for the player controller.
- Experiment 1.4.** Configure the camera for optimal gameplay.
- Experiment 1.5.** Create and implement the sheep ally character.
- Experiment 1.6.** Develop and integrate the dog ally character.
- Experiment 1.7.** Test and refine ally behaviors.
- Experiment 1.8.** Document the player and ally creation process.
- Experiment 1.9.** Analyze the impact of different player controls.
- Experiment 1.10.** Present a functional player and ally setup.

**Module II: Building the Enemies (2+2 hours)**

- Creating an Enemy
- Designing the Enemy Behaviors
- Creating the First Enemy Character
- Creating the Enemy Animator Controller

- Creating Additional Enemies
- Creating the Zombear Enemy
- Creating the Zombie Duck Enemy
- Creating the Other Enemies
- Integrating Enemies into the Game
- Placing the Spawn Points
- Spawning the Enemies

### Experiments:

- Experiment 2.1.** Create an enemy character with appropriate animations.
- Experiment 2.2.** Design and implement enemy behaviors.
- Experiment 2.3.** Develop additional enemy characters (Zombear, Zombie Duck).
- Experiment 2.4.** Integrate enemies into the game environment.
- Experiment 2.5.** Set up and test spawn points for enemies.
- Experiment 2.6.** Script enemy behaviors and interactions.
- Experiment 2.7.** Create an enemy animator controller.
- Experiment 2.8.** Test and refine enemy spawning mechanics.
- Experiment 2.9.** Document the enemy creation and integration process.
- Experiment 2.10.** Analyze the impact of different enemy behaviors on gameplay.

### Module III: Introduction to Unity's Particle System (1+1 hours)

- Analyzing Existing Particle Effects
- Setting Up the Interface for Effects
- Case Study: Developing the Lightning Attack
  - Overview of the Lightning Attack
  - Building the Lightning Attack Hit
  - Building the Lightning Attack Emitter
  - Building the Lightning Bolt
  - Integrating the Lightning Attack into the Game

### Experiments:

- Experiment 3.1.** Analyze existing particle effects in Unity.
- Experiment 3.2.** Set up the particle system interface for effect creation.
- Experiment 3.3.** Develop and integrate a lightning attack effect.
- Experiment 3.4.** Create and configure particle emitters.
- Experiment 3.5.** Test and refine the lightning attack in-game.
- Experiment 3.6.** Document the particle system creation process.
- Experiment 3.7.** Compare different particle effects for impact.
- Experiment 3.8.** Present a functional particle effect in-game.

**Experiment 3.9.** Analyze the performance impact of particle effects.

**Experiment 3.10.** Optimize particle systems for better performance.

#### **Module IV: Creating Particle Systems (1+2 hours)**

- Introduction to Particle Systems in the Unity Editor
- Examples of Unity Particles in Video Games
- The Role of the Effects Artist in Video Games
- Comparing Game Effects with Other Media
- Production Best Practices for Particle Systems

#### **Experiments:**

**Experiment 4.1.** Create basic particle systems in Unity.

**Experiment 4.2.** Implement particle systems in a game scene.

**Experiment 4.3.** Analyze examples of particle effects in video games.

**Experiment 4.4.** Compare particle effects in games with other media.

**Experiment 4.5.** Apply best practices for particle system production.

**Experiment 4.6.** Develop complex particle systems for specific effects.

**Experiment 4.7.** Test and refine particle systems in-game.

**Experiment 4.8.** Document the particle system creation and integration process.

**Experiment 4.9.** Present particle systems with different visual effects.

**Experiment 4.10.** Optimize particle systems for performance.

#### **Module V: Case Study (1+2 hours)**

- Developing the Frost Attack
  - Introduction to the Frost Attack
  - Building the Frost Debuff
  - Building the Frost Attack Emitter
  - Building the Frost Cone Effect
  - Integrating the Frost Attack into the Game
- Case Study: Developing the Stink Bomb Attack
  - Introduction to the Stink Bomb Attack
  - Creating the Stink Bomb Hit Effect

#### **Experiments:**

**Experiment 5.1.** Develop and integrate a frost attack effect.

**Experiment 5.2.** Create and configure a frost debuff and emitter.

**Experiment 5.3.** Test and refine the frost attack in-game.

**Experiment 5.4.** Develop and integrate a stink bomb attack effect.

**Experiment 5.5.** Create and configure the stink bomb hit effect.

**Experiment 5.6.** Test and refine the stink bomb attack in-game.

**Experiment 5.7.** Document the development of attack effects.

**Experiment 5.8.** Analyze the impact of different attack effects on gameplay.

**Experiment 5.9.** Compare different attack effects for visual and functional impact.

**Experiment 5.10.** Present functional attack effects in-game.

## Module VI: Case Study (1+2 hours)

- Developing the Slime Attack
  - Introduction to the Slime Attack
  - Creating the Slime Hit Effect
  - Creating the Slime Debuff
  - Creating the Slime Attack Reticle
  - Building the Slime Attack Emitter
  - Building the Slime Projectile
  - Integrating the Slime Attack into the Game
  - Finalizing Player Attacks
  - Adding the Ally Manager

## Experiments:

**Experiment 6.1.** Develop and integrate a slime attack effect.

**Experiment 6.2.** Create and configure a slime hit effect and debuff.

**Experiment 6.3.** Build and test the slime attack emitter and projectile.

**Experiment 6.4.** Integrate the slime attack into the game environment.

**Experiment 6.5.** Finalize and refine player attacks.

**Experiment 6.6.** Develop and integrate an ally manager.

**Experiment 6.7.** Document the development of the slime attack.

**Experiment 6.8.** Compare different attack effects for impact.

**Experiment 6.9.** Present a functional slime attack in-game.

**Experiment 6.10.** Optimize attack effects for performance.

## Module VII: Adding Audio to Game Levels (1+2.5 hours)

- Introduction to Audio in Game Development
- Importing Audio into Unity
  - Supported Audio Formats in Unity
  - Playing Audio in the Unity Editor
  - Testing Audio Sources in the Scene
- Mixing Audio in Unity
  - Using Audio Mixers and Audio Mixer Groups
  - Setting up the Zombie Toys Audio Mixers

- Creating Audio Effects

### Experiments:

- Experiment 7.1.** Import audio files into Unity.
- Experiment 7.2.** Play and test audio sources in a game scene.
- Experiment 7.3.** Create and configure audio mixers.
- Experiment 7.4.** Implement and test audio effects.
- Experiment 7.5.** Develop audio effects for specific game scenarios.
- Experiment 7.6.** Document the audio integration process.
- Experiment 7.7.** Compare different audio effects for impact.
- Experiment 7.8.** Present functional audio effects in-game.
- Experiment 7.9.** Optimize audio effects for performance.
- Experiment 7.10.** Analyze the impact of audio on the gaming experience.

### Textbooks and References:

- "Unity in Action: Multiplatform Game Development in C#" by Joe Hocking
- "Game Engine Architecture" by Jason Gregory
- Unity Documentation and Tutorials

## Game Animation, Scripting & UI (70hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUGI1084	Game Animation, Scripting & UI	3	1+1+1

### Course Description:

This course focuses on animating game objects, scripting for game development, and designing user interfaces using the Unity editor. Students will learn how to create and integrate animations, write scripts to control game behavior, and develop user-friendly interfaces.

### Course Objectives:

- Develop and integrate animations for game objects in Unity.
- Write and implement scripts to control game behavior and interactions.
- Design and create user interfaces for an engaging game experience.

### Course Outcomes (COs):

- CO1: Create and refine animations for game objects using the Unity editor. (Apply, Create)
- CO2: Import and integrate animated characters and rigs into the game environment. (Apply, Analyze)
- CO3: Develop and control animations using AnimationClips and Animator Controllers. (Apply, Create)
- CO4: Write and implement scripts for game mechanics and interactions. (Apply, Create)
- CO5: Design and develop user interfaces for games using Unity's UI tools. (Apply, Create)

### CO-PO-PSO Mapping:

CO/PO/ PSO	P O1	P O2	P O3	P O4	P O5	P O6	P O7	P O8	P O9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	3	2	2	-	-	-	2	2	2	2	3	3	3
CO2	3	3	3	2	2	-	-	-	2	2	2	2	3	3	3

CO3	3	3	3	3	2	-	-	-	3	2	2	2	3	3	3
CO4	3	3	3	3	2	-	-	-	3	2	2	2	3	3	3
CO5	3	3	3	3	2	-	-	-	3	2	2	2	3	3	3

**\*High-3, Medium-2, Low-1**

### Course Syllabus:

#### Module I: Animating Game Objects in the Unity Editor (1+2 hours)

- Introduction to Animation in Game Development
- Animating in the Unity Editor
- Creating and Refining Animations in the Unity Editor

#### Experiments:

- Experiment 1.1.** Create basic animations for game objects.  
**Experiment 1.2.** Refine animations using the Unity editor.  
**Experiment 1.3.** Implement smooth transitions between animations.  
**Experiment 1.4.** Test and optimize animations for performance.  
**Experiment 1.5.** Document the animation creation process.

#### Module II: Bringing Animation into the Game (1+2 hours)

- Importing Animated Characters
- Introduction to Rigging and Imported Animation
- Recognizing Asset Data when Importing
- Differentiating Available Rig Animation Types

#### Experiments:

- Experiment 2.1.** Import animated characters into Unity.  
**Experiment 2.2.** Set up rigs and animations for imported characters.  
**Experiment 2.3.** Test and refine imported animations.  
**Experiment 2.4.** Document the character import and setup process.  
**Experiment 2.5.** Analyze the impact of different animation types on gameplay.

#### Module III: Animation Creation and Controlling (1+2 hours)

- Creating and Naming AnimationClips
- Creating an Animator Controller
- Creating and Modifying Animation States
- Creating Parameters to Control Transitions
- Creating an Animator Override Controller

### Experiments:

- Experiment 3.1.** Create and name AnimationClips.
- Experiment 3.2.** Develop and configure an Animator Controller.
- Experiment 3.3.** Create and modify animation states.
- Experiment 3.4.** Implement parameters to control animation transitions.
- Experiment 3.5.** Test and refine the Animator Controller.
- Experiment 3.6.** Document the animation control setup process.
- Experiment 3.7.** Compare different animation control methods.
- Experiment 3.8.** Present a functional animation control system.

### Module IV: Scripting in Game Development (2+2.5 hours)

- Intro to Scripting in Game Development
- Creating Scripts in Unity
- Creating and Saving a Script in Unity
- Analyzing the Default Script Methods
- Scripting Primer and Best Practices
- Attaching a Script to a Game Object
- Declaring Variables
- Creating Conditions in Scripting
- Looping

### Experiments:

- Experiment 1.1.** Create and save scripts in Unity.
- Experiment 4.2.** Analyze and utilize default script methods.
- Experiment 4.3.** Attach scripts to game objects.
- Experiment 4.4.** Declare and use variables in scripts.
- Experiment 4.5.** Implement conditions and loops in scripts.
- Experiment 4.6.** Develop complex scripting conditions.
- Experiment 4.7.** Test and debug scripts for functionality.
- Experiment 4.8.** Document the scripting process.
- Experiment 4.9.** Present functional scripts controlling game mechanics.

### Module V: Designing User Interfaces for Games (1+2 hours)

- Introduction to Designing the User Interface
- Assessing User Interface Design Needs
- Examining the UI Tools in the Unity Editor
- Creating a User Interface
- Investigating the Canvas Functionality
- Utilizing the Power of the Rect Transform
- Creating UI Elements (Button, Image, Text)
- Creating Interaction in the UI with Events

### Experiments:

**Experiment 5.1.** Design and create a basic user interface.

**Experiment 5.2.** Implement UI elements (buttons, images, text).

**Experiment 5.3.** Test and refine UI interactions.

**Experiment 5.4.** Document the UI design process.

**Experiment 5.5.** Analyze the impact of different UI designs on user experience.

### Module VI: Introduction to Looping (1+2 hours)

- The “while” Loop
- The “for” Loop
- Creating Custom Methods
- Utilizing Arguments and Method Return Types
- Coroutines
- Accessing Components via Script
- Utilizing the GetComponent() Function
- Common Code Cases in Game Development

### Experiments:

**Experiment 6.1.** Implement while and for loops in scripts.

**Experiment 6.2.** Create and utilize custom methods.

**Experiment 6.3.** Develop and test coroutines.

**Experiment 6.4.** Access and manipulate components via scripts.

**Experiment 6.5.** Document the looping and method creation process.

**Experiment 6.6.** Present functional scripts using loops and methods.

### Module VII: Implementing Navigation and Path Finding (1+2 hours)

- Introduction to Navigation and Path Finding
- Describing a NavMesh
- Defining a NavMesh Agent
- Describing a NavMesh Obstacle

## Experiments:

**Experiment 7.1.** Set up navigation and pathfinding in Unity.

**Experiment 7.2.** Create and configure a NavMesh.

**Experiment 7.3.** Develop and test NavMesh agents and obstacles.

**Experiment 7.4.** Document the navigation setup process.

**Experiment 7.5.** Analyze the impact of navigation and pathfinding on gameplay.

## Textbooks and References:

- "Unity in Action: Multiplatform Game Development in C#" by Joe Hocking
- "Game Engine Architecture" by Jason Gregory
- Unity Documentation and Tutorials

## Binary Deployment and Cross-Platform Controls(70hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUGI1085	Binary Deployment and Cross-Platform Controls	3	1+1+1

### Course Description:

This course covers the processes of building, deploying, and optimizing games for multiple platforms using Unity. Students will learn about camera systems, player selection, animations, and handling cross-platform inputs for mobile, WebGL, VR, and other Unity-supported platforms.

### Course Objectives:

- Develop camera and player selection systems for games.
- Understand and implement cross-platform controls and inputs.
- Learn the processes of building and deploying games for multiple platforms.

### Course Outcomes (COs):

- CO1: Implement and configure camera and player selection systems in Unity. (Apply, Create)
- CO2: Create and manage multiple player options and integrate them into the game environment. (Apply, Create)
- CO3: Develop and apply camera animations and behaviors for enhanced game interactions. (Apply, Create)
- CO4: Build and deploy games for various platforms, ensuring compatibility and performance. (Apply, Create)
- CO5: Implement cross-platform inputs and controls for mobile, WebGL, VR, and other platforms. (Apply, Analyze)

### CO-PO-PSO Mapping:

CO/PO/ PSO	P O1	P O2	P O3	P O4	P O5	P O6	P O7	P O8	P O9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	3	2	2	-	-	-	2	2	2	2	3	3	3
CO2	3	3	3	2	2	-	-	-	2	2	2	2	3	3	3
CO3	3	3	3	3	2	-	-	-	3	2	2	2	3	3	3



CO4	3	3	3	3	2	-	-	-	3	2	2	2	3	3	3
CO5	3	3	3	3	2	-	-	-	3	2	2	2	3	3	3

**\*High-3, Medium-2, Low-1**

## Course Syllabus:

### Module I: Building the Camera and Player Selection System (1+3 hours)

- Intro to the Camera and Player Selection Behaviors
- Analyzing the Player Selection System

#### Experiments:

- Experiment 1.1.** Set up a basic camera system in Unity.
- Experiment 1.2.** Implement player selection mechanics.
- Experiment 1.3.** Test and refine camera and player selection behaviors.
- Experiment 1.4.** Document the camera and player selection setup process.
- Experiment 1.5.** Present a functional camera and player selection system.

### Module II: Creating Another Player Option (2+2.5 hours)

- Making the Player Selectable
- Adding Another Player
- Finalizing the Camera

#### Experiments:

- Experiment 2.1.** Add a new player character to the game.
- Experiment 2.2.** Implement selection functionality for the new player.
- Experiment 2.3.** Finalize and test the camera integration.
- Experiment 2.4.** Document the player addition and camera setup process.
- Experiment 2.5.** Analyze the impact of multiple player options on gameplay.

### Module III: Adding Camera Animations (2+2 hours)

- Configuring the Camera Animator Controller
- Applying Behavior to the Camera
- Adding Character Selection Spotlights

## Experiments:

- Experiment 3.1.** Configure and test the Camera Animator Controller.
- Experiment 3.2.** Develop and integrate camera animations.
- Experiment 3.3.** Add and test character selection spotlights.
- Experiment 3.4.** Document the camera animation process.
- Experiment 3.5.** Present a functional camera animation system.

## Module IV: Building and Deploying the Game (1+1 hours)

- Introduction to the Build Process
- Adjusting the Player Settings
- Building the Game

## Experiments:

- Experiment 4.1.** Prepare the game for building and deployment.
- Experiment 4.2.** Adjust player settings for optimal performance.
- Experiment 4.3.** Build and test the game for deployment.
- Experiment 4.4.** Document the build and deployment process.
- Experiment 4.5.** Present a deployed game build.

## Module V: Protecting Your Creation (1 hour)

- Legal Considerations for Your Game
- Unity Services
- Unlocking the Unity Platform Potential
- Surveying Unity Services

## Experiments:

- Experiment 5.1.** Explore legal considerations for game development.
- Experiment 5.2.** Utilize Unity services to enhance game functionality.
- Experiment 5.3.** Document the use of Unity services.
- Experiment 5.4.** Analyze the impact of legal considerations on game development.

## Module VI: Understanding Cross-Platform Inputs (1+2 hours)

- Different Input Types (Mobile, WebGL, OpenVR, etc.)
- Implementing Cross-Platform Inputs

## Experiments:

- Experiment 6.1.** Implement and test mobile inputs.

- Experiment 6.2.** Implement and test WebGL inputs.
- Experiment 6.3.** Implement and test VR inputs.
- Experiment 6.4.** Document the cross-platform input setup process.
- Experiment 6.5.** Present a functional cross-platform input system.

**Module VII: Preparing for Mobile Deployment (2+2 hours)**

- Modifying Zombie Toys for Mobile
- Introduction to Mobile Development in Unity
- Changing the Build Platform to Mobile
- Adding the Mobile Interface UI
- Implementing Mobile Input Behaviors

**Experiments:**

- Experiment 7.1.** Modify the game for mobile deployment.
- Experiment 7.2.** Change the build platform to mobile.
- Experiment 7.3.** Add and test the mobile interface UI.
- Experiment 7.4.** Implement and test mobile input behaviors.
- Experiment 7.5.** Document the mobile deployment process.
- Experiment 7.6.** Present a deployed mobile game build.

**Textbooks and References:**

- "Unity in Action: Multiplatform Game Development in C#" by Joe Hocking
- "Game Engine Architecture" by Jason Gregory
- Unity Documentation and Tutorials

**Project(168hours)**

Course Code	Course Title	Credits	Type (T+P+Pj)
CUGI1086	Project	6	0+0+6

**Course Description:**

The Capstone Project course allows students to apply their practical skills and knowledge acquired throughout the program to develop a comprehensive, real-world gaming or AR/VR application. This involves planning, designing, developing, testing, and presenting a fully functional project.

**Course Objectives:**

- Develop advanced technical skills in gaming and AR/VR development.
- Apply best practices and techniques in the design and development of interactive applications.
- Demonstrate proficiency in project planning, execution, and presentation.

### Course Outcomes (COs):

1. CO1: Formulate a project idea and define objectives, scope, and requirements. (Create, Evaluate)
2. CO2: Design and prototype the user interface and experience. (Create, Apply)
3. CO3: Develop the core features and functionalities of the project. (Create, Apply)
4. CO4: Test and debug the application to ensure functionality and performance. (Analyze, Apply)
5. CO5: Present the completed project effectively through written documentation and oral presentations. (Create, Evaluate)

### CO-PO-PSO Mapping:

CO/PO/ PSO	P O1	P O2	P O3	P O4	P O5	P O6	P O7	P O8	P O9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	3	3	2	-	-	-	2	2	2	2	3	3	3
CO2	3	3	3	3	2	-	-	-	2	2	2	2	3	3	3
CO3	3	3	3	3	2	-	-	-	2	2	2	2	3	3	3
CO4	3	3	3	3	2	-	-	-	2	2	2	2	3	3	3
CO5	3	3	3	3	2	-	-	-	2	2	2	2	3	3	3

**\*High-3, Medium-2, Low-1**

## Course Syllabus:

### Module 1: Project Proposal and Planning (10 hours)

- Identifying a Project Idea
- Defining Objectives, Scope, and Requirements
- Developing a Project Plan and Timeline
- Reviewing and Finalizing the Project Proposal

### Module 2: Design and Prototyping (10 hours)

- Creating Wireframes and Prototypes
- User Interface and Experience Design
- Finalizing Design Specifications
- Preparing Design Documentation

### Module 3: Development Phase 1: Core Features (10 hours)

- Setting Up the Project Structure
- Implementing Core Features and Functionalities
- Integrating Key Components
- Ensuring Basic Functionality

### Module 4: Development Phase 2: Advanced Features (10 hours)

- Integrating Advanced Features (e.g., AR/VR interactions, animations)
- Backend Integration and API Usage
- Enhancing User Experience
- Iterating Based on Feedback

### Module 5: Testing and Quality Assurance (10 hours)

- Conducting Unit, Integration, and User Testing
- Debugging and Resolving Issues
- Ensuring Cross-Platform Compatibility

- Finalizing the Application for Deployment

### **Module 6: Deployment and Presentation (10 hours)**

- Preparing the App for Release
- App Store and Google Play Store Submission Process
- Creating Visual Aids and Supporting Materials for Presentation
- Presenting the Completed Project to an Audience
- Responding to Questions and Feedback

### **Textbooks and References:**

- "The Lean Startup" by Eric Ries
- "Game Development Essentials: An Introduction" by Jeannie Novak
- Unity Documentation and Tutorials
- Relevant Online Resources and Communities

## Domain Track: Blockchain Technology (18 Credits) (0+7+11)

### Introduction to Blockchain (54 Hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUBD1091	Introduction to Blockchain	2	0+2+0

**Course Description:** This course introduces students to the fundamental concepts and tools used in blockchain technology. Topics include blockchain architecture, consensus mechanisms, and applications.

#### Course Objectives:

- Understand the fundamentals of blockchain technology and its key components.
- Explore various consensus mechanisms and their applications in blockchain.
- Gain knowledge about cryptocurrencies, cryptoeconomics, and blockchain use cases.

#### Course Outcomes (COs):

- CO1: Gain a comprehensive understanding of blockchain technology and its evolution. (Understand, Remember)
- CO2: Develop skills in understanding decentralized systems and distributed ledger technology. (Apply, Analyze)
- CO3: Build a basic blockchain system with key components and consensus mechanisms. (Apply, Create)
- CO4: Implement basic cryptographic techniques in a blockchain context. (Apply, Evaluate)
- CO5: Design a blockchain use case and analyze its benefits and challenges. (Create, Evaluate)

#### CO-PO-PSO Mapping:

CO/PO/ PSO	P O1	P O2	P O3	P O4	P O5	P O6	P O7	P O8	P O9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	2	2	2	3	-	-	-	1	2	2	2	3	2	3
CO2	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO3	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO4	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3



CO5	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
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**\*High-3, Medium-2, Low-1**

**Course Syllabus:**

**Module 1: Overview of Blockchain Technology and Cryptography (9 hours)**

- **Topics:** Introduction to blockchain and its characteristics; Evolution of blockchain from Bitcoin to smart contracts; Key components: blocks, transactions, decentralization; Basics of cryptographic techniques used in blockchain (hash functions, digital signatures, cryptographic hashing).

**Experiments:**

- Experiment 1.1.** Study the evolution of blockchain technology.
- Experiment 1.2.** Explore the characteristics of blockchain.
- Experiment 1.3.** Analyze the key components of a blockchain system.
- Experiment 1.4.** Implement hash functions and cryptographic hashing.
- Experiment 1.5.** Create and verify digital signatures.
- Experiment 1.6.** Compare different cryptographic techniques.
- Experiment 1.7.** Document the basics of cryptography.
- Experiment 1.8.** Present a seminar on the evolution of blockchain technology.
- Experiment 1.9.** Research and present the future of blockchain technology.
- Experiment 1.10.** Investigate the challenges in implementing blockchain systems.

**Module 2: Decentralization and Distributed Ledger Technology (9 hours)**

- **Topics:** Understanding decentralization and its importance in blockchain; Peer-to-peer networks and their role in decentralized systems; Introduction to distributed ledger technology (DLT); Consensus mechanisms and their role in maintaining a distributed ledger; Permissioned vs. permissionless ledgers.

**Experiments:**

- Experiment 2.1.** Study the importance of decentralization.
- Experiment 2.2.** Analyze peer-to-peer networks.
- Experiment 2.3.** Explore distributed ledger technology.
- Experiment 2.4.** Compare consensus mechanisms.
- Experiment 2.5.** Implement a basic consensus mechanism.
- Experiment 2.6.** Document and present DLT concepts.
- Experiment 2.7.** Research permissioned vs. permissionless ledgers.

**Experiment 2.8.** Present a seminar on the role of consensus mechanisms.

**Experiment 2.9.** Investigate challenges in maintaining a distributed ledger.

**Experiment 2.10.** Create a report on decentralized systems.

### **Module 3: Consensus Mechanisms: Proof of Work, Proof of Stake, and More (9 hours)**

- **Topics:** Principles of proof of work (PoW) and the mining process; Energy consumption and scalability issues with PoW; Concepts and principles of proof of stake (PoS); Benefits and limitations of PoS compared to PoW; Brief overview of other consensus mechanisms: Proof of Authority (PoA), Delegated Proof of Stake (DPoS), Practical Byzantine Fault Tolerance (PBFT).

#### **Experiments:**

**Experiment 3.1.** Implement proof of work (PoW).

**Experiment 3.2.** Study the mining process in PoW.

**Experiment 3.3.** Analyze energy consumption and scalability issues.

**Experiment 3.4.** Implement proof of stake (PoS).

**Experiment 3.5.** Compare PoW and PoS.

**Experiment 3.6.** Explore other consensus mechanisms.

**Experiment 3.7.** Document the principles of PoS.

**Experiment 3.8.** Present a seminar on PoW and PoS.

**Experiment 3.9.** Research the benefits and limitations of PoS.

**Experiment 3.10.** Investigate challenges in implementing consensus mechanisms.

### **Module 4: Cryptocurrency Fundamentals and Economics (9 hours)**

- **Topics:** Definition and characteristics of cryptocurrencies; Key cryptocurrencies: Bitcoin, Ethereum, Ripple, etc.; Wallets, addresses, and transactions in cryptocurrencies; Basics of crypto-economics and incentive mechanisms; Mining rewards, transaction fees, and economic implications.

#### **Experiments:**

**Experiment 4.1.** Study the characteristics of cryptocurrencies.

**Experiment 4.2.** Analyze key cryptocurrencies.

**Experiment 4.3.** Create and manage cryptocurrency wallets.

**Experiment 4.4.** Conduct cryptocurrency transactions.

**Experiment 4.5.** Explore crypto-economics and incentive mechanisms.

**Experiment 4.6.** Document mining rewards and transaction fees.

**Experiment 4.7.** Present a seminar on the economic implications of cryptocurrencies.

**Experiment 4.8.** Research the impact of cryptocurrencies on the economy.

**Experiment 4.9.** Investigate challenges in managing cryptocurrency transactions.

**Experiment 4.10.** Create a report on the fundamentals of cryptocurrencies.

### **Module 5: Use Cases and Applications of Blockchain Technology (9 hours)**

- **Topics:** Overview of various use cases and applications of blockchain technology; Examples in finance, supply chain, healthcare, identity management, etc.; Benefits and challenges of implementing blockchain solutions; Designing a blockchain use case and analyzing its feasibility and challenges.

#### **Experiments:**

- Experiment 5.1.** Study various use cases of blockchain technology.
- Experiment 5.2.** Analyze applications in finance.
- Experiment 5.3.** Explore blockchain use in supply chain management.
- Experiment 5.4.** Document blockchain applications in healthcare.
- Experiment 5.5.** Present a seminar on identity management with blockchain.
- Experiment 5.6.** Research the benefits of implementing blockchain solutions.
- Experiment 5.7.** Investigate challenges in designing blockchain use cases.
- Experiment 5.8.** Create a report on real-world blockchain applications.
- Experiment 5.9.** Design a blockchain use case.
- Experiment 5.10.** Analyze the feasibility and challenges of a blockchain use case.

### **Module 6: Project: Understanding and Implementing a Basic Blockchain System (9 hours)**

- **Topics:** Designing the architecture of a basic blockchain system; Implementing core components such as blocks, transactions, and consensus mechanisms; Simulating the blockchain network and validating transactions; Testing and debugging the basic blockchain implementation; Documenting the project with explanations of the blockchain architecture, implementation details, and testing procedures.

#### **Experiments:**

- Experiment 6.1.** Design the architecture of a blockchain system.
- Experiment 6.2.** Implement blocks and transactions.
- Experiment 6.3.** Implement consensus mechanisms.
- Experiment 6.4.** Simulate a blockchain network.
- Experiment 6.5.** Validate transactions in the blockchain.
- Experiment 6.6.** Test the blockchain implementation.
- Experiment 6.7.** Debug the blockchain system.
- Experiment 6.8.** Document the architecture and implementation details.
- Experiment 6.9.** Present a seminar on the implemented blockchain system.
- Experiment 6.10.** Create a final report on the blockchain project.

### Textbooks and References:

- "Mastering Blockchain" by Imran Bashir
- "Blockchain Basics" by Daniel Drescher

### Cryptocurrencies and Smart Contracts (84 Hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUBD1092	Cryptocurrencies and Smart Contracts	3	0+2+1

### Course Prerequisites:

- Completion of "Introduction to Blockchain" or equivalent knowledge
- Basic programming skills

### Course Objectives:

- Understand the foundational principles of cryptocurrencies and their economic implications.
- Learn about the development and deployment of smart contracts.
- Gain hands-on experience with cryptocurrency transactions and smart contract coding.

### Course Outcomes (COs):

- **CO1:** Develop a deep understanding of various cryptocurrencies and their unique features. (Understand, Apply)
- **CO2:** Acquire skills to write and deploy smart contracts. (Create, Evaluate)
- **CO3:** Conduct cryptocurrency transactions and manage wallets. (Apply, Analyze)
- **CO4:** Implement a simple decentralized application (DApp) using smart contracts. (Create, Apply)
- **CO5:** Analyze the economic model of a chosen cryptocurrency. (Analyze, Evaluate)

### CO-PO-PSO Mapping:

CO/PO/ PSO	P O1	P O2	P O3	P O4	P O5	P O6	P O7	P O8	P O9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	2	2	1	2	-	-	1	1	-	-	1	3	2	3
CO2	3	3	3	2	3	-	1	2	1	1	-	2	3	3	3

CO3	3	3	3	3	3	1	1	2	2	1	2	2	3	3	3
CO4	3	3	3	3	3	2	1	2	2	1	2	2	3	3	3
CO5	3	3	3	3	3	2	1	2	2	1	2	2	3	3	3

**\*High-3, Medium-2, Low-1**

## Course Syllabus:

### Module 1: Introduction to Cryptocurrencies (14 hours)

- **Topics:** Definition and history of cryptocurrencies; Key components of a cryptocurrency system; Overview of major cryptocurrencies: Bitcoin, Ethereum, Litecoin, etc.; How cryptocurrencies differ from traditional currencies.

#### Experiments:

- Experiment 1.1.** Study the history and evolution of cryptocurrencies.
- Experiment 1.2.** Analyze the key components of a cryptocurrency system.
- Experiment 1.3.** Compare Bitcoin, Ethereum, and Litecoin.
- Experiment 1.4.** Create a simple cryptocurrency wallet.
- Experiment 1.5.** Conduct a basic cryptocurrency transaction.
- Experiment 1.6.** Research the economic implications of cryptocurrencies.
- Experiment 1.7.** Present a seminar on the differences between cryptocurrencies and traditional currencies.
- Experiment 1.8.** Investigate the regulatory landscape for cryptocurrencies.
- Experiment 1.9.** Analyze the impact of cryptocurrencies on global finance.
- Experiment 1.10.** Document the key features of major cryptocurrencies.

### Module 2: Cryptocurrency Transactions and Wallets (14 hours)

- **Topics:** Detailed study of wallets: types, security, and management; How to create and manage cryptocurrency wallets; Understanding cryptocurrency transactions and the blockchain ledger; Practical session on conducting cryptocurrency transactions.

#### Experiments:

- Experiment 2.1.** Create and manage different types of cryptocurrency wallets.
- Experiment 2.2.** Conduct secure cryptocurrency transactions.
- Experiment 2.3.** Analyze the blockchain ledger for transaction verification.
- Experiment 2.4.** Study wallet security measures.
- Experiment 2.5.** Implement multi-signature wallets.

**Experiment 2.6.** Research the impact of wallet security on cryptocurrency adoption.

**Experiment 2.7.** Document the process of setting up a cryptocurrency wallet.

**Experiment 2.8.** Present a seminar on cryptocurrency transaction mechanisms.

**Experiment 2.9.** Investigate the challenges in managing cryptocurrency wallets.

**Experiment 2.10.** Create a report on cryptocurrency wallet management.

### **Module 3: Smart Contracts: Basics and Development (14 hours)**

- **Topics:** Introduction to smart contracts: Definition, use cases, and benefits; Smart contract languages: Solidity, Vyper, etc.; Setting up the development environment for smart contracts; Writing and deploying simple smart contracts on the Ethereum blockchain.

#### **Experiments:**

**Experiment 3.1.** Write a basic smart contract in Solidity.

**Experiment 3.2.** Deploy a smart contract on the Ethereum blockchain.

**Experiment 3.3.** Set up a development environment for smart contracts.

**Experiment 3.4.** Explore the use cases of smart contracts.

**Experiment 3.5.** Compare Solidity and Vyper.

**Experiment 3.6.** Document the smart contract development process.

**Experiment 3.7.** Present a seminar on the benefits of smart contracts.

**Experiment 3.8.** Research the challenges in deploying smart contracts.

**Experiment 3.9.** Analyze the impact of smart contracts on various industries.

**Experiment 3.10.** Create a report on smart contract development and deployment.

### **Module 4: Advanced Smart Contract Development (14 hours)**

- **Topics:** Complex smart contract structures and logic; Testing and debugging smart contracts; Security considerations and best practices for smart contract development; Case studies of significant smart contracts and DApps.

#### **Experiments:**

**Experiment 4.1.** Develop a complex smart contract with business logic.

**Experiment 4.2.** Test and debug smart contracts.

**Experiment 4.3.** Implement security measures in smart contracts.

**Experiment 4.4.** Study case studies of significant smart contracts.

**Experiment 4.5.** Document the advanced smart contract development process.

**Experiment 4.6.** Present a seminar on smart contract security best practices.

**Experiment 4.7.** Research common vulnerabilities in smart contracts.

**Experiment 4.8.** Analyze the impact of smart contract security on adoption.

**Experiment 4.9.** Create a report on advanced smart contract structures.

**Experiment 4.10.** Investigate the challenges in testing and debugging smart contracts.

## Module 5: Decentralized Applications (DApps) (14 hours)

- **Topics:** Introduction to DApps: Definition, characteristics, and benefits; Architecture of a DApp: Frontend and backend integration; Tools and frameworks for DApp development (e.g., Truffle, Ganache); Developing a simple DApp and deploying it on the blockchain.

### Experiments:

- Experiment 5.1.** Develop a simple DApp.
- Experiment 5.2.** Integrate frontend and backend for a DApp.
- Experiment 5.3.** Use Truffle and Ganache for DApp development.
- Experiment 5.4.** Document the DApp development process.
- Experiment 5.5.** Present a seminar on the benefits of DApps.
- Experiment 5.6.** Research the impact of DApps on various industries.
- Experiment 5.7.** Analyze the architecture of a successful DApp.
- Experiment 5.8.** Investigate the challenges in DApp development.
- Experiment 5.9.** Implement security measures in DApps.
- Experiment 5.10.** Create a report on DApp development and deployment.

## Module 6: Project: Smart Contract and DApp Development (14 hours)

- **Topics:** Project planning and requirement gathering; Designing and implementing a smart contract-based solution; Integrating the smart contract with a frontend interface to create a DApp; Testing, deploying, and presenting the DApp project.

### Experiments:

- Experiment 6.1.** Plan and define requirements for a smart contract-based project.
- Experiment 6.2.** Design a smart contract solution for the project.
- Experiment 6.3.** Implement the smart contract and deploy it on Ethereum.
- Experiment 6.4.** Develop a frontend interface for the DApp.
- Experiment 6.5.** Integrate the smart contract with the frontend.
- Experiment 6.6.** Test the DApp for functionality and security.
- Experiment 6.7.** Debug and resolve any issues in the DApp.
- Experiment 6.8.** Deploy the DApp to a test network.
- Experiment 6.9.** Present the completed project to peers.
- Experiment 6.10.** Document the project development process and outcomes.

## Blockchain Development (84 Hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUBD1093	Blockchain Development	3	0+1+2

### Course Prerequisites:

- Completion of "Cryptocurrencies and Smart Contracts" or equivalent knowledge
- Proficiency in programming and software development

### Course Objectives:

- To master the skills required for blockchain application development.
- To understand the architecture and tools used in blockchain development.
- To gain practical experience in developing and deploying blockchain applications.

### Course Outcomes (COs):

- **CO1:** Develop proficiency in Solidity and smart contract development. (Apply, Create)
- **CO2:** Build, test, and deploy decentralized applications (DApps). (Create, Evaluate)
- **CO3:** Understand and utilize blockchain development frameworks and tools. (Understand, Apply)
- **CO4:** Implement security best practices in blockchain development. (Apply, Evaluate)
- **CO5:** Develop a full-stack blockchain application with frontend and backend integration. (Create, Apply)

### CO-PO-PSO Mapping:

CO/PO/ PSO	P O1	P O2	P O3	P O4	P O5	P O6	P O7	P O8	P O9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	3	2	3	-	-	-	2	2	2	2	3	3	3
CO2	3	2	3	3	3	-	-	-	2	2	2	2	3	3	3
CO3	3	2	3	3	3	-	-	-	2	2	2	2	3	3	3
CO4	3	2	3	3	3	-	-	-	3	3	2	2	3	3	3
CO5	3	2	3	3	3	-	-	-	3	3	3	3	3	3	3

\*High-3, Medium-2, Low-1

## Course Syllabus:

### Module 1: Ethereum and Solidity Programming (14 hours)

- **Topics:** Introduction to Ethereum blockchain; Detailed study of Solidity programming language; Writing, testing, and deploying smart contracts using Solidity; Practical exercises on Solidity basics.

#### Experiments:

- Experiment 1.1.** Write a basic smart contract in Solidity.
- Experiment 1.2.** Deploy a smart contract on the Ethereum blockchain.
- Experiment 1.3.** Test a smart contract using Remix IDE.
- Experiment 1.4.** Implement a simple token contract.
- Experiment 1.5.** Explore the use of events in Solidity.
- Experiment 1.6.** Study Solidity data types and structures.
- Experiment 1.7.** Develop a contract with conditional statements.
- Experiment 1.8.** Integrate Solidity with JavaScript for contract interaction.
- Experiment 1.9.** Analyze Solidity security features.
- Experiment 1.10.** Document the process of writing and deploying a smart contract.

### Module 2: Development Tools and Environments (14 hours)

- **Topics:** Overview of blockchain development tools: Truffle, Ganache, Remix; Setting up and configuring a development environment; Using MetaMask for blockchain interactions; Practical sessions on using these tools for smart contract development.

#### Experiments:

- Experiment 2.1.** Set up a blockchain development environment with Truffle and Ganache.
- Experiment 2.2.** Create and migrate a smart contract using Truffle.
- Experiment 2.3.** Interact with a deployed contract using MetaMask.
- Experiment 2.4.** Debug smart contracts with Remix IDE.
- Experiment 2.5.** Implement contract testing using Truffle.
- Experiment 2.6.** Develop a simple DApp frontend using React.
- Experiment 2.7.** Connect the DApp frontend to smart contracts using Web3.js.
- Experiment 2.8.** Use Ganache to simulate blockchain transactions.
- Experiment 2.9.** Document the steps for setting up a blockchain development environment.
- Experiment 2.10.** Present a seminar on blockchain development tools and their usage.

### Module 3: Developing Decentralized Applications (DApps) (14 hours)

- **Topics:** Architecture of DApps: Frontend and backend integration; Building a frontend interface for DApps using JavaScript frameworks (e.g., React); Connecting the frontend to smart contracts using Web3.js; Practical exercises on developing and deploying DApps.

### Experiments:

- Experiment 3.1.** Design the architecture of a DApp.
- Experiment 3.2.** Implement a DApp frontend using React.
- Experiment 3.3.** Connect the frontend to smart contracts with Web3.js.
- Experiment 3.4.** Develop a simple voting DApp.
- Experiment 3.5.** Integrate MetaMask with the DApp.
- Experiment 3.6.** Implement state management in the DApp.
- Experiment 3.7.** Test the DApp on a local blockchain network.
- Experiment 3.8.** Deploy the DApp on a testnet.
- Experiment 3.9.** Document the DApp development process.
- Experiment 3.10.** Present the completed DApp project.

### Module 4: Testing and Debugging Blockchain Applications (14 hours)

- **Topics:** Importance of testing in blockchain development; Writing unit tests for smart contracts using Truffle; Debugging techniques and tools; Practical session on testing and debugging a blockchain application.

### Experiments:

- Experiment 4.1.** Write unit tests for smart contracts using Truffle.
- Experiment 4.2.** Debug a smart contract using Remix IDE.
- Experiment 4.3.** Implement integration tests for a DApp.
- Experiment 4.4.** Use Ganache for testing blockchain applications.
- Experiment 4.5.** Develop a test suite for a smart contract.
- Experiment 4.6.** Test a DApp frontend with Cypress.
- Experiment 4.7.** Analyze the results of unit tests and fix bugs.
- Experiment 4.8.** Document the testing and debugging process.
- Experiment 4.9.** Present a seminar on the importance of testing in blockchain development.
- Experiment 4.10.** Review and audit the test cases for a blockchain application.

### Module 5: Security and Best Practices in Blockchain Development (14 hours)

- **Topics:** Common security vulnerabilities in smart contracts; Best practices for secure smart contract development; Code reviews and security audits; Case studies of security breaches and lessons learned.

### Experiments:

- Experiment 5.1.** Identify common security vulnerabilities in smart contracts.
- Experiment 5.2.** Implement security best practices in a smart contract.
- Experiment 5.3.** Conduct a security audit for a smart contract.
- Experiment 5.4.** Review code for security issues.
- Experiment 5.5.** Analyze case studies of security breaches.
- Experiment 5.6.** Implement access control in smart contracts.
- Experiment 5.7.** Use static analysis tools for smart contract security.
- Experiment 5.8.** Document the security measures for a blockchain application.
- Experiment 5.9.** Present a seminar on smart contract security best practices.
- Experiment 5.10.** Create a report on the lessons learned from security breaches in blockchain.

### **Module 6: Project: Full-Stack Blockchain Application Development (14 hours)**

- **Topics:** Project planning and requirement analysis; Developing a full-stack blockchain application; Integrating smart contracts with frontend and backend; Testing, deploying, and presenting the blockchain application project.

#### **Experiments:**

- Experiment 6.1.** Plan and define requirements for a blockchain application project.
- Experiment 6.2.** Design the architecture of a full-stack blockchain application.
- Experiment 6.3.** Implement the smart contracts for the application.
- Experiment 6.4.** Develop the frontend interface using React.
- Experiment 6.5.** Integrate the frontend with the smart contracts.
- Experiment 6.6.** Develop the backend services for the application.
- Experiment 6.7.** Test the complete application for functionality and security.
- Experiment 6.8.** Deploy the application on a blockchain network.
- Experiment 6.9.** Document the project development process and outcomes.
- Experiment 6.10.** Present the completed blockchain application project to peers and instructors.

#### **Textbooks and References:**

- "Mastering Blockchain" by Imran Bashir
- "Solidity Programming Essentials" by Ritesh Modi
- "Building Ethereum DApps" by Roberto Infante

### Web3 and Decentralized Technologies (84 Hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUBD1094	Web3 and Decentralized Technologies	3	0+1+2

#### Course Prerequisites:

- Completion of "Blockchain Development" or equivalent knowledge
- Familiarity with web development concepts

#### Course Objectives:

- To understand the principles and technologies behind Web3.
- To learn about decentralized finance (DeFi) and other Web3 applications.
- To develop skills in building and interacting with Web3 applications.

#### Course Outcomes (COs):

- **CO1:** Understand and explain the principles and technologies behind Web3. (Understand, Explain)
- **CO2:** Develop and deploy Web3 applications. (Apply, Create)
- **CO3:** Implement and interact with decentralized finance (DeFi) protocols. (Apply, Analyze)
- **CO4:** Create and manage NFT-based projects. (Create, Manage)
- **CO5:** Explore and implement emerging Web3 technologies. (Apply, Evaluate)

#### CO-PO-PSO Mapping:

CO/PO/ PSO	P O1	P O2	P O3	P O4	P O5	P O6	P O7	P O8	P O9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	2	2	2	3	-	-	-	2	2	2	2	3	2	3
CO2	3	3	3	2	3	-	-	-	3	2	2	2	3	3	3
CO3	3	3	3	3	3	-	-	-	3	3	3	2	3	3	3
CO4	3	3	3	3	3	-	-	-	3	3	3	2	3	3	3
CO5	3	3	3	3	3	-	-	-	3	3	3	2	3	3	3

\*High-3, Medium-2, Low-1

## Course Syllabus:

### Module 1: Introduction to Web3 (14 hours)

- **Topics:** Definition and principles of Web3; Differences between Web3 and traditional web technologies; Overview of Web3 architecture and components; Practical session on setting up a Web3 development environment.

#### Experiments:

- Experiment 1.1.** Set up a Web3 development environment.
- Experiment 1.2.** Create a basic Web3 project.
- Experiment 1.3.** Compare Web3 with traditional web technologies.
- Experiment 1.4.** Explore the architecture of a Web3 application.
- Experiment 1.5.** Implement basic blockchain interactions in Web3.
- Experiment 1.6.** Analyze the components of a Web3 architecture.
- Experiment 1.7.** Set up a local Ethereum node.
- Experiment 1.8.** Deploy a simple smart contract.
- Experiment 1.9.** Document the setup and architecture of a Web3 environment.
- Experiment 1.10.** Present a seminar on the principles of Web3.

### Module 2: Web3.js and Blockchain Interaction (14 hours)

- **Topics:** Introduction to Web3.js library; Connecting to the Ethereum blockchain using Web3.js; Writing scripts to interact with smart contracts and blockchain data; Practical exercises on using Web3.js for blockchain interactions.

#### Experiments:

- Experiment 2.1.** Set up Web3.js in a project.
- Experiment 2.2.** Connect to an Ethereum blockchain using Web3.js.
- Experiment 2.3.** Write scripts to interact with smart contracts.
- Experiment 2.4.** Retrieve blockchain data using Web3.js.
- Experiment 2.5.** Implement a simple DApp using Web3.js.
- Experiment 2.6.** Document and present a Web3.js interaction script.
- Experiment 2.7.** Create a user interface for blockchain interaction.
- Experiment 2.8.** Test Web3.js scripts for functionality.
- Experiment 2.9.** Analyze the security of Web3.js interactions.
- Experiment 2.10.** Present a seminar on Web3.js and its capabilities.

### Module 3: Decentralized Finance (DeFi) (14 hours)

- **Topics:** Overview of DeFi: Definition, components, and benefits; Key DeFi protocols: Uniswap, Aave, Compound, etc.; Developing a simple DeFi protocol; Practical session on interacting with DeFi protocols.

### Experiments:

- Experiment 3.1.** Study key DeFi protocols.
- Experiment 3.2.** Implement a basic DeFi protocol.
- Experiment 3.3.** Interact with Uniswap using Web3.js.
- Experiment 3.4.** Create a lending protocol using Aave.
- Experiment 3.5.** Develop a simple DEX (Decentralized Exchange).
- Experiment 3.6.** Analyze the benefits and challenges of DeFi.
- Experiment 3.7.** Test a DeFi protocol for functionality and security.
- Experiment 3.8.** Document the implementation of a DeFi protocol.
- Experiment 3.9.** Present a seminar on DeFi protocols.
- Experiment 3.10.** Create a report on the impact of DeFi in the financial sector.

### Module 4: NFTs and Token Standards (14 hours)

- **Topics:** Introduction to non-fungible tokens (NFTs); Understanding token standards: ERC20, ERC721, ERC1155; Creating and deploying NFTs on the blockchain; Practical session on developing NFT-based projects.

### Experiments:

- Experiment 4.1.** Study the ERC20, ERC721, and ERC1155 token standards.
- Experiment 4.2.** Create and deploy an ERC721 NFT.
- Experiment 4.3.** Develop a marketplace for NFTs.
- Experiment 4.4.** Implement smart contracts for NFT management.
- Experiment 4.5.** Analyze the economic model of NFTs.
- Experiment 4.6.** Document the process of creating and deploying NFTs.
- Experiment 4.7.** Test NFT transactions on a testnet.
- Experiment 4.8.** Present a seminar on the impact of NFTs.
- Experiment 4.9.** Create a report on a successful NFT project.
- Experiment 4.10.** Develop a simple NFT-based game.

### Module 5: Emerging Web3 Technologies (14 hours)

- **Topics:** Overview of emerging Web3 technologies: DAOs, decentralized identity, etc.; Case studies of successful Web3 projects; Exploring the potential and challenges of Web3 adoption; Practical exercises on implementing emerging Web3 technologies.

### Experiments:

- Experiment 5.1.** Study Decentralized Autonomous Organizations (DAOs).
- Experiment 5.2.** Implement a basic DAO.
- Experiment 5.3.** Explore decentralized identity solutions.
- Experiment 5.4.** Develop a project using emerging Web3 technologies.
- Experiment 5.5.** Analyze case studies of successful Web3 projects.
- Experiment 5.6.** Document the implementation of a Web3 technology.
- Experiment 5.7.** Test and deploy a Web3 solution.
- Experiment 5.8.** Present a seminar on emerging Web3 technologies.
- Experiment 5.9.** Create a report on the potential of Web3 adoption.
- Experiment 5.10.** Develop a proposal for a new Web3 project.

### **Module 6: Project: Web3 and DeFi Application Development (14 hours)**

- **Topics:** Project planning and requirement gathering; Developing a Web3 application with blockchain interaction; Implementing a DeFi protocol or an NFT-based project; Testing, deploying, and presenting the Web3 application project.

#### **Experiments:**

- Experiment 6.1.** Plan and define requirements for a Web3 application project.
- Experiment 6.2.** Design the architecture of a Web3 application.
- Experiment 6.3.** Implement the smart contracts for the application.
- Experiment 6.4.** Develop the frontend interface using React.
- Experiment 6.5.** Integrate the frontend with the smart contracts.
- Experiment 6.6.** Develop the backend services for the application.
- Experiment 6.7.** Test the complete application for functionality and security.
- Experiment 6.8.** Deploy the application on a blockchain network.
- Experiment 6.9.** Document the project development process and outcomes.
- Experiment 6.10.** Present the completed Web3 application project to peers and instructors.

#### **Textbooks and References:**

- "Mastering Blockchain" by Imran Bashir
- "Solidity Programming Essentials" by Ritesh Modi
- "Building Ethereum DApps" by Roberto Infante

## Advanced Blockchain Concepts and Development (84 Hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUBD1095	Advanced Blockchain Concepts and Development	3	0+1+2

### Course Prerequisites:

- Completion of "Web3 and Decentralized Technologies" or equivalent knowledge
- Proficiency in blockchain development and smart contract coding

### Course Objectives:

- To explore advanced concepts and emerging trends in blockchain technology.
- To develop expertise in scalability, security, and interoperability of blockchain systems.
- To gain practical experience in implementing advanced blockchain solutions.

### Course Outcomes (COs):

- **CO1:** Master advanced blockchain concepts and techniques. (Analyze, Evaluate)
- **CO2:** Develop scalable and secure blockchain applications. (Create, Apply)
- **CO3:** Implement cross-chain communication and interoperability solutions. (Create, Evaluate)
- **CO4:** Conduct security audits and enhance blockchain security. (Apply, Analyze)
- **CO5:** Explore and implement emerging blockchain trends and technologies. (Analyze, Create)

### CO-PO-PSO Mapping:

CO/PO/ PSO	P O1	P O2	P O3	P O4	P O5	P O6	P O7	P O8	P O9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	2	2	2	3	-	-	-	2	2	2	2	3	2	3
CO2	3	3	3	2	3	-	-	-	3	2	2	2	3	3	3
CO3	3	3	3	3	3	-	-	-	3	3	3	2	3	3	3
CO4	3	3	3	3	3	-	-	-	3	3	3	2	3	3	3
CO5	3	3	3	3	3	-	-	-	3	3	3	2	3	3	3

\*High-3, Medium-2, Low-1

## Course Syllabus:

### Module 1: Scalability Solutions in Blockchain (14 hours)

- **Topics:** Challenges of scalability in blockchain networks; Layer 1 solutions: Sharding, improved consensus algorithms; Layer 2 solutions: State channels, sidechains, rollups; Practical session on implementing a scalability solution.

#### Experiments:

- Experiment 1.1.** Implement a basic sharding protocol.
- Experiment 1.2.** Develop a state channel for off-chain transactions.
- Experiment 1.3.** Configure and deploy a sidechain.
- Experiment 1.4.** Test scalability improvements using rollups.
- Experiment 1.5.** Analyze the performance of Layer 1 vs. Layer 2 solutions.
- Experiment 1.6.** Optimize transaction throughput in a blockchain network.
- Experiment 1.7.** Compare different consensus algorithms for scalability.
- Experiment 1.8.** Implement a hybrid consensus mechanism.
- Experiment 1.9.** Simulate network conditions to test scalability solutions.
- Experiment 1.10.** Present a case study on a scalable blockchain application.

### Module 2: Blockchain Security (14 hours)

- **Topics:** Common security issues in blockchain and smart contracts; Advanced cryptographic techniques for enhancing security; Security auditing and best practices; Practical session on conducting a security audit.

#### Experiments:

- Experiment 2.1.** Identify common vulnerabilities in smart contracts.
- Experiment 2.2.** Implement cryptographic hash functions.
- Experiment 2.3.** Use digital signatures for transaction security.
- Experiment 2.4.** Conduct a security audit of a smart contract.
- Experiment 2.5.** Develop a secure smart contract with input validation.
- Experiment 2.6.** Implement multi-signature wallets.
- Experiment 2.7.** Analyze the security of blockchain networks.
- Experiment 2.8.** Conduct a code review for security flaws.
- Experiment 2.9.** Simulate a blockchain attack and defense mechanism.
- Experiment 2.10.** Present a case study on blockchain security breaches.

### Module 3: Interoperability and Cross-Chain Communication (14 hours)

- **Topics:** Importance of interoperability in blockchain ecosystems; Protocols for cross-chain communication: Polkadot, Cosmos, etc.; Implementing cross-chain communication solutions; Practical session on developing a cross-chain application.

### Experiments:

- Experiment 3.1.** Implement a basic cross-chain communication protocol.
- Experiment 3.2.** Use Polkadot's Substrate to create a parachain.
- Experiment 3.3.** Develop a cross-chain bridge using Cosmos SDK.
- Experiment 3.4.** Test interoperability between different blockchain networks.
- Experiment 3.5.** Analyze the performance of cross-chain communication protocols.
- Experiment 3.6.** Implement token transfers across chains.
- Experiment 3.7.** Develop a cross-chain decentralized exchange (DEX).
- Experiment 3.8.** Simulate cross-chain data exchange.
- Experiment 3.9.** Present a case study on cross-chain applications.
- Experiment 3.10.** Document the implementation of a cross-chain solution.

### Module 4: Privacy in Blockchain (14 hours)

- **Topics:** Privacy challenges in blockchain technology; Techniques for enhancing privacy: Zero-knowledge proofs, ring signatures; Case studies of privacy-focused blockchain projects; Practical session on implementing privacy-enhancing techniques.

### Experiments:

- Experiment 4.1.** Implement zero-knowledge proofs (ZKPs) in a blockchain application.
- Experiment 4.2.** Use ring signatures for transaction privacy.
- Experiment 4.3.** Develop a privacy-focused smart contract.
- Experiment 4.4.** Test the effectiveness of privacy techniques.
- Experiment 4.5.** Analyze the privacy features of different blockchain platforms.
- Experiment 4.6.** Implement a private blockchain network.
- Experiment 4.7.** Simulate private transactions using Monero.
- Experiment 4.8.** Develop a confidential transaction protocol.
- Experiment 4.9.** Present a case study on privacy-focused blockchains.
- Experiment 4.10.** Document privacy enhancements in a blockchain project.

### Module 5: Emerging Trends and Technologies in Blockchain (14 hours)

- **Topics:** Overview of emerging trends: DAOs, CBDCs, blockchain in IoT, etc.; Potential impact and future directions of blockchain technology; Exploring new blockchain platforms and protocols; Practical exercises on implementing emerging blockchain technologies.

## Experiments:

- Experiment 5.1.** Develop a Decentralized Autonomous Organization (DAO) smart contract.
- Experiment 5.2.** Implement a Central Bank Digital Currency (CBDC) prototype.
- Experiment 5.3.** Explore blockchain integration with IoT devices.
- Experiment 5.4.** Test blockchain applications in supply chain management.
- Experiment 5.5.** Analyze the impact of blockchain in healthcare.
- Experiment 5.6.** Develop a blockchain-based voting system.
- Experiment 5.7.** Simulate blockchain applications in finance.
- Experiment 5.8.** Present a case study on emerging blockchain trends.
- Experiment 5.9.** Implement a new blockchain protocol.
- Experiment 5.10.** Document the potential impact of emerging technologies.

## Module 6: Project: Advanced Blockchain Solution Development (14 hours)

- **Topics:** Project planning and requirement analysis; Developing an advanced blockchain solution with a focus on scalability, security, or interoperability; Testing, deploying, and presenting the advanced blockchain project; Documenting the project with detailed explanations of the advanced concepts and implementation.

## Experiments:

- Experiment 6.1.** Define the project scope and objectives.
- Experiment 6.2.** Plan and design the architecture of the blockchain solution.
- Experiment 6.3.** Develop the core components of the blockchain solution.
- Experiment 6.4.** Integrate scalability solutions in the project.
- Experiment 6.5.** Implement security enhancements.
- Experiment 6.6.** Develop cross-chain communication protocols.
- Experiment 6.7.** Test the complete blockchain solution.
- Experiment 6.8.** Deploy the solution on a testnet or mainnet.
- Experiment 6.9.** Document the development and deployment process.
- Experiment 6.10.** Present the completed project to peers and instructors.

## Textbooks and References:

- "Mastering Blockchain" by Imran Bashir
- "Solidity Programming Essentials" by Ritesh Modi
- "Building Ethereum DApps" by Roberto Infante

## Capstone Project in Blockchain Development (112 Hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUBD1096	Capstone Project in Blockchain Development	4	0+0+4

### Course Prerequisites:

- Completion of "Advanced Blockchain Concepts and Development" or equivalent knowledge
- Proficiency in blockchain development and smart contract coding

### Course Objectives:

- To apply theoretical and practical knowledge to solve real-world blockchain problems.
- To develop a comprehensive blockchain project that showcases advanced development skills.
- To demonstrate proficiency in blockchain project planning, implementation, and presentation.

### Course Outcomes (COs):

- **CO1:** Develop a comprehensive blockchain project from concept to deployment. (Create, Apply)
- **CO2:** Implement advanced blockchain techniques and solutions in a real-world scenario. (Analyze, Apply)
- **CO3:** Demonstrate proficiency in blockchain development tools and frameworks. (Apply, Evaluate)
- **CO4:** Conduct thorough testing, security audits, and optimizations of a blockchain application. (Evaluate, Analyze)
- **CO5:** Present and document a blockchain project effectively. (Create, Apply)

### CO-PO-PSO Mapping:

CO/PO/ PSO	P O1	P O2	P O3	P O4	P O5	P O6	P O7	P O8	P O9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	3	3	3	-	-	-	2	3	2	2	3	3	3
CO2	3	3	3	3	3	-	-	-	3	3	2	2	3	3	3
CO3	3	3	3	3	3	-	-	-	2	3	3	3	3	3	3



CO4	3	3	3	3	3	-	-	-	3	3	3	3	3	3	3
CO5	3	3	3	3	3	-	-	-	2	3	2	2	3	3	3

**\*High-3, Medium-2, Low-1**

## Course Syllabus:

### Module 1: Project Scope and Objectives (10 hours)

- **Topics:** Project Concept; Scope of Work; Blockchain Domain; Project Feasibility.

#### Experiments:

- Experiment 1.1.** Define the project concept and problem statement.
- Experiment 1.2.** Develop a comprehensive project scope and objectives.
- Experiment 1.3.** Conduct a feasibility study, including resource and time assessment.
- Experiment 1.4.** Identify the blockchain topics covered by the project.
- Experiment 1.5.** Present the project proposal for feedback and refinement.
- Experiment 1.6.** Finalize the project plan and timeline.
- Experiment 1.7.** Document the project scope and objectives.
- Experiment 1.8.** Review and refine the project feasibility.
- Experiment 1.9.** Prepare a detailed project plan.
- Experiment 1.10.** Conduct a peer review of project proposals.

### Module 2: Technology Stack and Tools (10 hours)

- **Topics:** Blockchain Platform; Development Tools; Frontend and Backend Technologies; Database Systems.

#### Experiments:

- Experiment 2.1.** Select the appropriate blockchain platform for the project.
- Experiment 2.2.** Set up development tools and frameworks.
- Experiment 2.3.** Configure the development environment.
- Experiment 2.4.** Integrate frontend technologies (e.g., React).
- Experiment 2.5.** Integrate backend technologies (e.g., Node.js, Express).
- Experiment 2.6.** Set up database systems and integrate them with the blockchain.
- Experiment 2.7.** Develop a basic prototype using the selected tools.
- Experiment 2.8.** Conduct initial tests of the development environment.
- Experiment 2.9.** Document the technology stack and tools used.
- Experiment 2.10.** Present a technical overview of the chosen tools and technologies.

### **Module 3: Project Design and Architecture (10 hours)**

- **Topics:** System Architecture; Component Design; Data Flow and Integration.

#### **Experiments:**

- Experiment 3.1.** Design the overall system architecture of the project.
- Experiment 3.2.** Develop detailed designs for key components.
- Experiment 3.3.** Create data flow diagrams to illustrate system integration.
- Experiment 3.4.** Design the smart contract architecture.
- Experiment 3.5.** Integrate DApps with backend services.
- Experiment 3.6.** Develop frontend components for user interaction.
- Experiment 3.7.** Document the system architecture and component design.
- Experiment 3.8.** Review and refine design documentation.
- Experiment 3.9.** Present the project design and architecture for feedback.
- Experiment 3.10.** Conduct a design review session with peers.

### **Module 4: Smart Contract Development and Deployment (10 hours)**

- **Topics:** Smart Contract Functionality; Smart Contract Deployment; Contract Security.

#### **Experiments:**

- Experiment 4.1.** Develop smart contracts based on the project requirements.
- Experiment 4.2.** Write unit tests for the smart contracts.
- Experiment 4.3.** Deploy smart contracts to a testnet.
- Experiment 4.4.** Implement security measures in the smart contracts.
- Experiment 4.5.** Conduct a security audit of the smart contracts.
- Experiment 4.6.** Document the smart contract development process.
- Experiment 4.7.** Review and refine the smart contract code.
- Experiment 4.8.** Deploy the smart contracts to a mainnet.
- Experiment 4.9.** Conduct integration tests with the deployed contracts.
- Experiment 4.10.** Present the smart contract development and deployment process.

### **Module 5: Decentralized Applications (DApps) (10 hours)**

- **Topics:** DApp Design; DApp Interaction; Web3.js Integration.

#### **Experiments:**

- Experiment 5.1.** Design the frontend interface of the DApp.
- Experiment 5.2.** Develop the backend services for the DApp.
- Experiment 5.3.** Integrate the frontend and backend components.
- Experiment 5.4.** Use Web3.js to interact with the blockchain.

- Experiment 5.5.** Conduct user testing of the DApp interface.
- Experiment 5.6.** Optimize the user experience of the DApp.
- Experiment 5.7.** Document the DApp development process.
- Experiment 5.8.** Review and refine the DApp components.
- Experiment 5.9.** Present the DApp development and user interaction.
- Experiment 5.10.** Conduct a usability review session with peers.

## **Module 6: Security and Privacy Measures (10 hours)**

- **Topics:** Security Threats and Mitigation; Smart Contract Security; User Data Privacy; Regulatory Compliance.

### **Experiments:**

- Experiment 6.1.** Identify and document common security threats.
- Experiment 6.2.** Implement security measures in smart contracts.
- Experiment 6.3.** Conduct a security audit of the DApp.
- Experiment 6.4.** Implement data privacy measures.
- Experiment 6.5.** Ensure compliance with regulations (e.g., KYC, AML, GDPR).
- Experiment 6.6.** Document security and privacy measures.
- Experiment 6.7.** Review and refine security implementations.
- Experiment 6.8.** Conduct a security and privacy review session.
- Experiment 6.9.** Present the security and privacy measures of the project.
- Experiment 6.10.** Conduct a compliance audit of the project.

## **Module 7: Scalability and Performance Optimization (10 hours)**

- **Topics:** Scalability Solutions; Gas Optimization; Performance Testing.

### **Experiments:**

- Experiment 7.1.** Implement scalability solutions (e.g., state channels, sidechains).
- Experiment 7.2.** Optimize gas costs for smart contracts.
- Experiment 7.3.** Conduct performance testing of the DApp.
- Experiment 7.4.** Document scalability and performance optimization techniques.
- Experiment 7.5.** Review and refine performance optimization strategies.
- Experiment 7.6.** Present the scalability and performance optimizations.
- Experiment 7.7.** Conduct a performance review session with peers.
- Experiment 7.8.** Implement additional scalability solutions based on feedback.
- Experiment 7.9.** Test the scalability solutions under different conditions.
- Experiment 7.10.** Conduct a final performance evaluation of the project.

## **Module 8: Testing and Quality Assurance (10 hours)**

- **Topics:** Unit Testing; Integration Testing; User Testing and Feedback; Code Review and Auditing.

### Experiments:

- Experiment 8.1.** Write unit tests for smart contracts and DApps.
- Experiment 8.2.** Conduct integration testing of blockchain and non-blockchain components.
- Experiment 8.3.** Perform user testing and gather feedback.
- Experiment 8.4.** Conduct a thorough code review.
- Experiment 8.5.** Perform a security audit.
- Experiment 8.6.** Document testing and quality assurance procedures.
- Experiment 8.7.** Review and refine testing methodologies.
- Experiment 8.8.** Present the testing and quality assurance results.
- Experiment 8.9.** Conduct a testing review session with peers.
- Experiment 8.10.** Implement feedback from testing and quality assurance.

### Module 9: Project Documentation and Presentation (12 hours)

- **Topics:** Project Documentation; Project Presentation; Feedback and Improvements.

### Experiments:

- Experiment 9.1.** Prepare comprehensive project documentation.
- Experiment 9.2.** Create a project presentation, including a live demonstration.
- Experiment 9.3.** Conduct a code walkthrough and explain design choices.
- Experiment 9.4.** Gather feedback from instructors and peers.
- Experiment 9.5.** Implement suggested improvements.
- Experiment 9.6.** Review and refine the project documentation.
- Experiment 9.7.** Present the final project to a panel of reviewers.
- Experiment 9.8.** Conduct a final project review session.
- Experiment 9.9.** Document the feedback and improvements process.
- Experiment 9.10.** Submit the final project documentation and presentation.

### Module 10: Real-World Applications and Use Cases (12 hours)

- **Topics:** Real-World Use Cases; Industry Relevance; Impact and Benefits.

### Experiments:

- Experiment 10.1.** Identify real-world use cases for the project.
- Experiment 10.2.** Assess the project's relevance to industry trends.
- Experiment 10.3.** Analyze the potential impact and benefits of the project.
- Experiment 10.4.** Document the real-world applications and use cases.
- Experiment 10.5.** Review and refine the industry relevance analysis.

**Experiment 10.6.** Present the project's real-world applications.

**Experiment 10.7.** Conduct a case study review session.

**Experiment 10.8.** Implement feedback on the real-world applications.

**Experiment 10.9.** Prepare a final report on the project's industry impact.

**Experiment 10.10.**

**Experiment 10.11.** Submit the real-world applications and use cases documentation.

### **Textbooks and References:**

- "Mastering Blockchain" by Imran Bashir
- "Solidity Programming Essentials" by Ritesh Modi
- "Building Ethereum DApps" by Roberto Infante

## Domain Track: Cybersecurity

### Linux Server Management and Security (112 hrs)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUCS1101	Linux Server Management and Security	4	2+2+0

**Course Description:** This course provides an in-depth understanding of Linux server management and security. Students will learn essential Linux commands, manage users and files, configure networks, and implement security measures.

#### Course Objectives:

1. Master essential Linux commands and server management tasks.
2. Implement and manage Linux security features.
3. Configure and optimize Linux server performance.

#### Course Outcomes (COs):

1. CO1: Access and manage the Linux command line for server management. (Apply, Analyze)
2. CO2: Manage local users, groups, and file system permissions. (Apply, Create)
3. CO3: Implement software installation, updates, and file system management. (Apply, Evaluate)
4. CO4: Configure Linux networking and secure services. (Apply, Create)
5. CO5: Perform system auditing, manage security policies, and ensure compliance. (Evaluate, Create)

#### CO-PO-PSO Mapping:

CO/PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	3	-	-	-	1	2	2	2	3	2	3
CO2	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO3	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO4	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO5	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3

**\*High-3, Medium-2, Low-1**

## Module Breakdown:

### Module 1: Command Line and File Management (16 hours)

- **Topics:** Access the command line; Linux Basic and advanced commands; Recovery of the root user password; Managing files from the command line; Creating, Viewing, and Editing Text File.

#### Experiments:

- Experiment 1.1.** Navigate the Linux file system using command line.
- Experiment 1.2.** Execute basic Linux commands for file management.
- Experiment 1.3.** Recover the root user password.
- Experiment 1.4.** Create, view, and edit text files using nano and vim.
- Experiment 1.5.** Manage directories and file permissions.
- Experiment 1.6.** Use advanced commands like find, grep, and awk.
- Experiment 1.7.** Write and execute shell scripts.
- Experiment 1.8.** Document and present file management techniques.
- Experiment 1.9.** Implement a backup and restore procedure.
- Experiment 1.10.** Compare different text editors and their features.

### Module 2: User Management and Process Monitoring (16 hours)

- **Topics:** Managing Local Linux Users and Groups; Using Virtualized Systems; Linux File System Permissions; Monitoring and Managing Linux Processes.

#### Experiments:

- Experiment 2.1.** Create and manage local users and groups.
- Experiment 2.2.** Configure file system permissions.
- Experiment 2.3.** Monitor processes using top, htop, and ps.
- Experiment 2.4.** Use virtualization tools like VirtualBox or VMware.
- Experiment 2.5.** Manage system resources and process priorities.
- Experiment 2.6.** Implement disk quotas for users.
- Experiment 2.7.** Use cron and at for scheduling tasks.
- Experiment 2.8.** Document and present user management best practices.
- Experiment 2.9.** Conduct a peer review of process management techniques.
- Experiment 2.10.** Compare virtualization tools and their features.

### Module 3: Software and File System Management (16 hours)

- **Topics:** Archiving and Copying Files Between Systems; Installing and Updating Software Packages; Accessing Linux File Systems; Mounting and Unmounting File System.

## Experiments:

- Experiment 3.1.** Archive files using tar and gzip.
- Experiment 3.2.** Copy files between systems using scp and rsync.
- Experiment 3.3.** Install and update software packages using apt and yum.
- Experiment 3.4.** Access and manage different file systems.
- Experiment 3.5.** Mount and unmount file systems.
- Experiment 3.6.** Use package managers for software maintenance.
- Experiment 3.7.** Configure software repositories.
- Experiment 3.8.** Document and present software management techniques.
- Experiment 3.9.** Implement a system update policy.
- Experiment 3.10.** Compare different file systems and their features.

## Module 4: Networking and Security (16 hours)

- **Topics:** Linux Networking; Connecting Network Defined User and Groups; Analyzing and Storing Logs; Configuring and Securing OpenSSH Service; Using Regular Expressions with grep.

## Experiments:

- Experiment 4.1.** Configure network interfaces and settings.
- Experiment 4.2.** Manage network users and groups.
- Experiment 4.3.** Analyze system logs using journalctl and logrotate.
- Experiment 4.4.** Secure SSH service with key-based authentication.
- Experiment 4.5.** Use grep with regular expressions for log analysis.
- Experiment 4.6.** Configure network services like DNS and DHCP.
- Experiment 4.7.** Implement firewall rules using iptables.
- Experiment 4.8.** Document and present network security best practices.
- Experiment 4.9.** Conduct a security audit of network configurations.
- Experiment 4.10.** Compare different logging and monitoring tools.

## Module 5: Advanced Security and Storage Management (16 hours)

- **Topics:** Scheduling Future Linux Tasks; ACLs; SELinux Security; Adding Disks, Partitions, and File Systems to a Linux System; Managing Logical Volume Management (LVM) Storage.

## Experiments:

- Experiment 5.1.** Schedule tasks using cron and at.
- Experiment 5.2.** Configure Access Control Lists (ACLs) for file permissions.
- Experiment 5.3.** Implement SELinux policies.

- Experiment 5.4.** Add and manage disks and partitions.
- Experiment 5.5.** Configure Logical Volume Management (LVM).
- Experiment 5.6.** Document and present advanced storage management techniques.
- Experiment 5.7.** Implement disk encryption.
- Experiment 5.8.** Conduct a peer review of SELinux configurations.
- Experiment 5.9.** Compare different storage management tools.
- Experiment 5.10.** Implement a secure backup and restore policy.

## **Module 6: Network Storage and Service Management (16 hours)**

- **Topics:** Network Storage with NFS and SMB; Boot Process; Managing different services using systemctl; Planning and Configuring Security Updates.

### **Experiments:**

- Experiment 6.1.** Configure NFS and SMB for network storage.
- Experiment 6.2.** Manage the Linux boot process.
- Experiment 6.3.** Use systemctl to manage services.
- Experiment 6.4.** Plan and implement security updates.
- Experiment 6.5.** Document and present network storage solutions.
- Experiment 6.6.** Configure network file sharing.
- Experiment 6.7.** Conduct a boot process analysis.
- Experiment 6.8.** Implement service monitoring and restart policies.
- Experiment 6.9.** Compare different network storage protocols.
- Experiment 6.10.** Implement a security update schedule.

## **Module 7: System Auditing and Security (16 hours)**

- **Topics:** Basics of System Auditing; Security guidelines during installation; Configuring firewalld; Compliance Policy and Vulnerability Scanning.

### **Experiments:**

- Experiment 7.1.** Perform a system audit using auditd.
- Experiment 7.2.** Implement security guidelines during installation.
- Experiment 7.3.** Configure firewalld for firewall management.
- Experiment 7.4.** Conduct vulnerability scanning using tools like Nessus.
- Experiment 7.5.** Document and present compliance policies.
- Experiment 7.6.** Implement a system hardening procedure.
- Experiment 7.7.** Conduct a security audit.
- Experiment 7.8.** Implement best practices for system security.
- Experiment 7.9.** Compare different auditing and scanning tools.
- Experiment 7.10.** Present findings from a security audit.

### Textbooks and References:

1. Soyinka Wale, "Linux Administration: A Beginner's Guide," McGraw-Hill HED, Sixth Edition
2. Lucas Barnes, "Linux Server Management: A Deep Dive into Configuration and Optimization," Kindle Edition

### Offensive Security (112 hrs)

Subject Code	Subject Name	T-P-Pj (Credit)	Pre- Requisite
CUCS1102	Offensive Security	4 (2-2-0)	Nil

### Course Objective:

- Equip students with the skills and knowledge necessary to conduct comprehensive penetration tests on networks, applications, and systems using industry-standard tools and methodologies.
- Ensure students understand the legal and ethical implications of offensive security practices and can apply ethical hacking principles to identify and mitigate vulnerabilities.
- Provide students with advanced knowledge of exploitation techniques, including the ability to discover, exploit, and document vulnerabilities

### Course Outcomes (COs):

- CO1: Explain the legal and ethical aspects of red teaming
- CO2: Use network scanning and enumeration tools to gather information about network assets and services.
- CO3: Interpret and analyze vulnerability assessment and penetration test results.
- CO4: Evaluate the performance and security implications of different web protocols, frameworks, and server software, discerning best practices for optimizing web application development and deployment.
- CO5: Develop comprehensive documentation and presentations for red team activities.

## CO-PO-PSO MAPPING:

CO/PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	3	-	-	-	1	2	2	2	3	2	3
CO2	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO3	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO4	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO5	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3

**\*High-3, Medium-2, Low-1**

### Course Content

#### **Module 1: 8 hours theory & 8 hours labs**

##### **Read teaming fundamentals**

- Understanding Red Teaming
- Legal and Ethical Aspects
- Reconnaissance and Information Gathering
- Threat Modelling and Attack Vector

#### **Module 2: 8 hours theory & 8 hours labs**

##### **Network Vulnerability Assessment & Penetration Testing:**

- Network Scanning
- Enumeration
- Network Vulnerability Assessment Process & Phases
- Network Penetration Testing Process & Phases
- Advanced Network Vulnerability Assessment and Penetration Testing Techniques
- Tools and Frameworks for Network Vulnerability Assessment and Penetration Testing

#### **Module 3: 8 hours theory & 8 hours labs**

##### **System Vulnerability Assessment & Penetration Testing**

- System VAPT Tools Overview
- System Vulnerability Assessment Process & Phases
- System Penetration Testing Process & Phases
- Advanced System Vulnerability Assessment and Penetration Testing Techniques
- Case Studies and Practical Applications

## **Module 4: 8 hours theory & 8 hours labs**

### **Post-Exploitation and Advanced Techniques**

- Post-Exploitation Fundamentals
- Persistence, Evasion, and Clearing Tracks
- Data Exfiltration and Exfiltration Techniques
- Clearing Tracks After Exploitation
- MITRE Framework Integration
- Advanced Post-Exploitation Techniques

## **Module 5: 8 hours theory & 8 hours labs**

### **Web Fundamentals**

- How the Web Works
- Web Architecture & Web Protocols
- Web Requests, Client & Server Model
- Web Request Lifecycle
- Web App Coding and Frameworks - HTML, CSS, JS, PHP
- Web App Layers & SDLC Basics

## **Module 6: 8 hours theory & 8 hours labs**

### **Web Application Vulnerability Assessment & Penetration Testing**

- Basics of Web Vulnerability Assessment
- Introduction to Web Penetration Testing
- Web Application Vulnerabilities & Exploitation
- Web Application VAPT Tools & OWASP
- Advanced Web Application Vulnerabilities

## **Module 7: 8 hours theory & 8 hours labs**

### **Communication Track - Red Teaming and Penetration Testing Reports and Documents Training**

- Effective Communication for VAPT and Red Teaming Reports
- Crafting Proposals for Red Teaming and VAPT Engagements
- Effective Presentation Skills for Red Teaming and VAPT Findings
- Writing Comprehensive Red Teaming and VAPT Reports

### ***Text Books:***

1. *"Red Team: How to Succeed By Thinking Like the Enemy"* by Micah Zenko

2. *"The Basics of Hacking and Penetration Testing: Ethical Hacking and Penetration Testing Made Easy"* by Patrick Engebretson

## Defensive Security (112)

### Course Objective:

- Understanding of the foundational principles of defensive security, including risk management and threat modeling.
- Design and deploy effective defensive security strategies, such as intrusion detection systems (IDS), firewalls, antivirus solutions, and encryption techniques.
- Effectively respond to security incidents, including the identification, containment, eradication, and recovery from cyber attacks

### Course Outcomes (COs):

- CO1: Explain the role of operating systems in cybersecurity and the importance of secure file transfer protocols CO2: Use network scanning and enumeration tools to gather information about network assets and services.
- CO2: Configure and manage IP addressing, DHCP, DNS, and routing protocols

Subject Code	Subject Name	T-P-Pj (Credit)	Pre- Requisite
CUCS1103	Defensive Security	4 (2-2-0)	Nil

- CO3: Analyzing network traffic and identify anomalies using packet sniffers and network scanners
- CO4: Assess the effectiveness of different defense tactics against APTs
- CO5: Develop comprehensive compliance reports and automated reporting strategies

### CO-PO-PSO MAPPING:

CO/PO/PS O	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	3	-	-	-	1	2	2	2	3	2	3
CO2	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO3	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO4	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO5	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3

**\*High-3, Medium-2, Low-1**

## Course Content

### **Module 1: 8 hours theory & 8 hours labs**

#### **Operating Systems from Security Perspective**

- Operating System Fundamentals
- Windows Fundamentals
- Linux Fundamentals
- Secure File Transfer
- SSH Configuration Security
- Linux and Windows Hardening.

**Experiment 1.1.** Exploring File System Permissions in Linux – Experiment with file permissions using chmod to secure files.

**Experiment 1.2.** Configuring Secure SSH on a Linux Server – Set up and harden SSH access with public key authentication.

**Experiment 1.3.** Hardening a Windows Server – Implement security policies, disable unnecessary services, and enforce password complexity.

**Experiment 1.4.** Using Secure File Transfer (SFTP) – Configure and test SFTP for secure file transmission over a network.

**Experiment 1.5.** Logging and Auditing in Linux – Set up and analyze system logs using tools like syslog or journalctl.

**Experiment 1.6.** Windows Security Policies – Configure and manage local security policies on Windows for system hardening.

**Experiment 1.7.** Enforcing User Privileges in Linux – Implement sudo privileges to restrict root access.

**Experiment 1.8.** Security Patches and Updates – Test OS patching mechanisms and automate security updates.

**Experiment 1.9.** Secure Boot Configuration in Windows – Configure and test secure boot on a Windows OS.

**Experiment 1.10.** User and Group Management in Linux and Windows – Create users/groups and apply different security policies for each.

### **Module 2: 8 hours theory & 8 hours labs**

#### **Networking from Security Perspective**

- Introduction to Networks
- Understanding Network Components
- Network Configuration, Administration, and Management
- Network Troubleshooting
- Network Architecture
- Securing Network Devices

**Experiment 2.1.** Setting Up a Secure Network Environment – Build a small network with secure protocols and firewall rules.

- Experiment 2.2.** Analyzing TCP/IP Traffic Using Wireshark – Capture and analyze basic network traffic.
- Experiment 2.3.** Configuring a Virtual Private Network (VPN) – Set up a VPN for secure remote access.
- Experiment 2.4.** Network Hardening Techniques – Disable unused network services and implement security on routers and switches.
- Experiment 2.5.** Network Troubleshooting Using Ping and Traceroute – Diagnose network issues using tools like ping, traceroute, and netstat.
- Experiment 2.6.** Securing Wireless Networks (WPA3) – Configure a wireless network with the latest security standards.
- Experiment 2.7.** Firewall Setup and Configuration – Install and configure a firewall for network protection.
- Experiment 2.8.** Monitoring Network Traffic – Use tools like Nagios or Zabbix to monitor network performance and security.
- Experiment 2.9.** Securing Routers and Switches – Implement access control lists (ACLs) on routers to block unauthorized traffic.
- Experiment 2.10.** Simulating a Network Attack – Perform basic penetration tests to expose vulnerabilities in a network.

### **Module 3: 8 hours theory & 8 hours labs**

#### **Blue Team Fundamentals**

- Introduction to Blue Teaming
  - Components of Blue Teaming
  - Tools for Blue Teaming
  - Defense Frameworks and Methodologies
- Experiment 3.1. Setting Up Intrusion Detection Systems (IDS)** – Install and configure tools like Snort for network defense.
- Experiment 3.2. Incident Response Simulation** – Simulate a security breach and carry out incident response steps.
- Experiment 3.3. Implementing Honeypots** – Deploy a honeypot to trap and monitor attackers in a controlled environment.
- Experiment 3.4. Monitoring with Security Information and Event Management (SIEM)** – Set up and analyze logs in a SIEM tool like Splunk.
- Experiment 3.5. Analyzing Network Logs for Anomalies** – Use log analysis tools to detect unusual activity.
- Experiment 3.6. Using Firewalls and IDS for Blue Teaming** – Implement firewall and IDS rules to protect systems from attacks.
- Experiment 3.7. Cyber Defense Methodology** – Simulate defense mechanisms using blue team tools against red team attacks.
- Experiment 3.8. Patch Management and Vulnerability Scanning** – Use tools like OpenVAS to scan and manage system vulnerabilities.
- Experiment 3.9. Network Segmentation for Security** – Simulate network segmentation to isolate critical systems.

**Experiment 3.10. Conducting Forensic Analysis Post-Breach** – Analyze and trace the source of a security breach in a lab setting.

#### **Module 4: 8 hours theory & 8 hours labs**

##### **Network Security**

- Introduction to Network Security
- Network Security Tools Overview
- Installation and Configuration of Network Security Tools
- Network Security Lab Exercises
- Defense Tactics and Techniques
- Advanced Network Security Topics

**Experiment 4.1.** Configuring Intrusion Prevention Systems (IPS) – Install and configure IPS to block malicious traffic.

**Experiment 4.2.** Network Firewall Configuration – Set up a firewall and configure rules for different network scenarios.

**Experiment 4.3.** Penetration Testing on Network Security Tools – Conduct penetration tests on the tools implemented to detect and analyze vulnerabilities.

**Experiment 4.4.** DoS Attack Simulation – Simulate a Denial of Service (DoS) attack and implement countermeasures.

**Experiment 4.5.** Installing and Configuring VPNs – Set up and configure VPNs for secure remote communication.

**Experiment 4.6.** Using Wireshark for Packet Analysis – Analyze network traffic and detect anomalies.

**Experiment 4.7.** Intrusion Detection with Snort – Configure Snort to detect and alert on malicious traffic.

**Experiment 4.8.** Setting Up Security on Network Devices – Secure routers and switches by disabling unused ports and configuring ACLs.

**Experiment 4.9.** Implementing and Analyzing Firewall Logs – Capture firewall logs and analyze for unusual traffic.

**Experiment 4.10.** Network Traffic Encryption with TLS/SSL – Configure and test encrypted traffic over the network.

#### **Module 5: 8 hours theory & 8 hours labs**

##### **Network Analysis & Deep Packet Inspection**

- Introduction to Network Analysis
- Introduction to Wireshark
- Understanding Packet Types and Basics
- Structure of Different Kinds of Packets
- Manual Packet Inspection Basics
- Advanced Network Analysis Techniques

- Experiment 5.1.** Packet Capture with Wireshark – Capture live network traffic and analyze different packet types.
- Experiment 5.2.** Examining HTTP and HTTPS Traffic – Analyze the differences in encrypted and unencrypted web traffic.
- Experiment 5.3.** Inspecting DNS Packets – Capture and analyze DNS traffic to understand how queries and responses work.
- Experiment 5.4.** TCP/IP Flow Analysis – Analyze packet flows for TCP handshake, data transmission, and termination.
- Experiment 5.5.** Analyzing Malicious Packets – Capture and analyze packets containing potential malware or exploits.
- Experiment 5.6.** Network Traffic Filtering with Wireshark – Set up filters to isolate specific types of traffic (e.g., ICMP, ARP).
- Experiment 5.7.** Deep Packet Inspection (DPI) Setup – Implement DPI tools to inspect packet contents for malicious activity.
- Experiment 5.8.** Understanding ARP Spoofing – Simulate an ARP spoofing attack and analyze traffic with Wireshark.
- Experiment 5.9.** Packet Fragmentation and Reassembly – Analyze fragmented packets and their reassembly in a network.
- Experiment 5.10.** Examining IPv6 Traffic – Capture and analyze IPv6 packets and compare them with IPv4 traffic.

## **Module 6: 8 hours theory & 8 hours labs**

### **End Point & Advanced Persistent Threat**

- Introduction to Endpoint Protection
- Advanced Persistent Threats (APT)
- Endpoint Protection Tools
- Installation and Configuration of Endpoint Protection Tools
- Managing Endpoint Protection Solutions
- Defense Tactics Against APTs

- Experiment 6.1.** Endpoint Protection Tool Installation – Install endpoint protection tools like Symantec or Bitdefender and test them.
- Experiment 6.2.** Configuring Endpoint Protection Policies – Set up and configure security policies on endpoint devices.
- Experiment 6.3.** Analyzing APT Behavior – Simulate an APT attack and monitor endpoint defense mechanisms.
- Experiment 6.4.** Implementing Patch Management on Endpoints – Automate patch deployment across endpoints and monitor for vulnerabilities.
- Experiment 6.5.** Simulating Malware Attacks on Endpoints – Simulate malware attacks and evaluate the endpoint protection tool’s response.

- Experiment 6.6.** Endpoint Logging and Monitoring – Analyze endpoint logs to detect unusual or malicious activity.
- Experiment 6.7.** Installing Anti-APT Solutions – Implement specialized anti-APT solutions and simulate APT behavior.
- Experiment 6.8.** Encryption on Endpoint Devices – Configure encryption on endpoints for secure data storage.
- Experiment 6.9.** Mobile Device Endpoint Protection – Test mobile device management (MDM) for endpoint protection.
- Experiment 6.10.** Remote Endpoint Monitoring – Set up remote monitoring for endpoint devices and detect potential threats.

## **Module 7: 8 hours theory & 8 hours labs**

### **Compliance, Technical Controls, Tools & Data Protection**

- Introduction to Compliance Frameworks
  - Different Compliance Standards
  - Data Protection Tools
  - Compliance Tools
  - Technical Controls for Compliance
  - Compliance Reporting Requirements
- Experiment 7.1. Implementing GDPR Compliance** – Simulate data protection measures to comply with GDPR regulations.
- Experiment 7.2. Automating Compliance Reporting** – Configure tools like Splunk to automate compliance reporting for audits.
- Experiment 7.3. Implementing Data Loss Prevention (DLP) Tools** – Set up and configure DLP tools to monitor and block unauthorized data access.
- Experiment 7.4. Encryption Techniques for Data Protection** – Use encryption tools like OpenSSL to secure sensitive data.
- Experiment 7.5. Auditing Security Configurations for Compliance** – Run security audits to check compliance with standards like ISO 27001.
- Experiment 7.6. Managing Compliance Frameworks** – Implement and simulate a compliance management system (e.g., HIPAA, PCI-DSS).
- Experiment 7.7. Monitoring Data Access Logs** – Set up and analyze data access logs to detect compliance violations.
- Experiment 7.8. Using Compliance Tools for Vulnerability Management** – Use tools like Nessus to scan systems for compliance gaps.
- Experiment 7.9. Configuring Role-Based Access Control (RBAC)** – Simulate the implementation of RBAC to meet compliance standards.
- Experiment 7.10. Compliance Dashboard Setup** – Set up a compliance monitoring dashboard to track the status of various controls and frameworks.

### **Text Book:**

1. "Operating System Concepts" by Abraham Silberschatz, Peter Baer Galvin, and Greg Gagne

2. "Blue Team Handbook: Incident Response Edition: A condensed field guide for the Cyber Security Incident Responder" by Don Murdoch GSE

3. "Defensive Security Handbook: Best Practices for Securing Infrastructure" by Lee Brotherston and Amanda Berlin

### Security Analytics (112)

Subject Code	Subject Name	T-P-Pj(Credit)	Prerequisite
CUCS1104	Security Analytics	4(2-2-0)	NIL

#### Course Objective:

- To equip students with the foundational knowledge and skills to understand and utilize various security analytics tools and techniques for monitoring and securing information systems.
- To analyze and interpret security data, identify patterns of malicious activity, and assess vulnerabilities within an organization's network and systems.
- To prepare students to develop and implement effective security strategies and response plans based on data-driven insights

#### Course Outcomes (COs):

- CO1: Describe the purpose and importance of a Security Operations Center (SOC)
- CO2: Utilize SIEM tools to collect, analyze, and correlate security data from various sources to identify potential threats.
- CO3: Investigate and analyze security incidents using forensic tools and techniques to determine the cause and impact.
- CO4: Assess the quality and relevance of threat intelligence data and its effectiveness in enhancing security measures.
- CO5: Develop comprehensive threat hunting strategies, including the formulation of hunting hypotheses, selection of tools, and implementation of hunting campaigns.

## CO-PO-PSO MAPPING:

CO/PO/PS O	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	3	-	-	-	1	2	2	2	3	2	3
CO2	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO3	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO4	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
CO5	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3

**\*High-3, Medium-2, Low-1**

### Course Content

#### **Module 1: 8 hours theory & 8 hours labs**

##### **Fundamentals of Purple Teaming & Tools**

- Introduction to Purple Teaming
- Key Terminologies
- Introduction to SOC (Security Operations Center)
- Roles in a SOC
- Components to Build a SOC
- Purple Team Tools Overview

#### **Module 2: 8 hours theory & 8 hours labs**

##### **SIEM (Security Information and Event Management)**

- Introduction to SIEM
- SIEM Setup and Configuration
- Use Cases
- Custom Rules

#### **Module 3: 8 hours theory & 8 hours labs**

##### **Incident Response**

- SOAR (Security Orchestration, Automation, and Response)
- Incident Response Process
- Incident Response Tools
- Simulated Attack Scenarios

#### **Module 4: 8 hours theory & 8 hours labs**

##### **Threat Intelligence**

- Threat Intelligence Gathering & Sharing
- Mitigation Strategies
- Process & Phase-wise Approach
- Tools for Threat Intelligence

### **Module 5: 8 hours theory & 8 hours labs**

#### **Threat Hunting**

- Adversary Tactics, Techniques, and Procedures (TTPs)
- Hunting for Indicators of Compromise (IoCs)
- Threat Hunting Methodologies

### **Module 6: 8 hours theory & 8 hours labs**

#### **Vulnerability Management**

- Vulnerability Management Features and Process
- Tools for Vulnerability Management
- Asset Discovery and Inventory
- Vulnerability Scanners
- Patch Management

### **Module 7: 8 hours theory & 8 hours labs**

#### **Digital Forensics**

- Forensic Methods & Investigations
- Tools for Digital Forensics
- Evidence Collection
- Hashing
- Linux & Windows Forensics
- Evidence Searching

#### **Text Book:**

1. *"Security Operations Center: Building, Operating, and Maintaining Your SOC"* by Joseph Muniz, Gary McIntyre, and Nadhem AlFardan

2. *"Applied SIEM: Threat Hunting and Detection with Graylog"* by Anthony Critelli

3. *"Security Information and Event Management (SIEM) Implementation"* by David Miller, Shon Harris, and Allen Harper

## CONSTRUCTION PLANNING, MONITORING AND PROJECT MANAGEMENT [CPCU3000]

Course Title	Type of course	T+P+PJ	Prerequisite
Construction Planning, Monitoring and Project Management	Theory + Practice + Project	4+8+8	Nil

DOMAIN: Construction Planning, Monitoring and Project Management (4+8+8)					
Sl. No.	Code	Subject Name	T+P+P	Credits	Hrs.
1.	CUCP3001	Site Study & Structural Drawings	0+2+2	4	35
2.	CUCP3002	Computational Techniques in Construction	0+2+0	2	30
3.	CUCP3003	Contract Laws & Equipment Management	2+0+0	2	30
4.	CUCP3004	Project Quality Control & Safety Management	0+2+0	2	30
5.	CUCP3005	Modern Construction and Material Supervision	2+2+0	4	45
6.	CUCP3006	Sustainability in Construction & Green Structures	0+0+6	6	50
<b>Total</b>				<b>20</b>	

### Domain Objectives:

- Students will be able to work with the latest trend of the construction industry needs.
- Understand different methods of project delivery and the roles and responsibilities of all constituents involved in the design and constant process.
- Give the students experience, supervision and direction in recognizing and applying the concepts of project management and construe planning.

### PHASE-I: Site Study & Structural Drawings (115 hours)

Code	Course Title	Credit	T-P-PJ
CUCP3001	Site Study & Structural Drawings	4	0+2+2

#### Course objective:

- To equip students with the skills necessary to conduct comprehensive site surveys and develop detailed site maps and plans.
- To enable students to create accurate and detailed structural drawings and 3D models of buildings, including electrical and plumbing layouts.
- To train students in structural design and detailing using industry-standard software, ensuring compliance with relevant codes and standards.

#### Course Outcomes:

After successful completion of the course the students will be able to

- **CO1:** Conduct comprehensive site surveys and prepare detailed site maps and engineering plans.
- **CO2:** Develop detailed structural drawings and 3D models for construction projects, including exterior and interior designs.
- **CO3:** Create accurate electrical and plumbing layouts and technical documents for construction projects.
- **CO4:** Perform structural design and detailing of RCC and steel components using software tools, ensuring compliance with IS codes.
- **CO5:** Prepare bar bending schedules, field layouts, and comprehensive project reports.

#### Course Outcome to Program Outcome Mapping:

COs / Pos / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2													
CO2			3		2								1		
CO3				3		2								2	
CO4		3			3						2				



CO5								2	2	2					
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\*High-3, Medium-2, Low-1

## Course Syllabus

### Module 1: Preparation of Site Map (25 hours)

#### Practice

- Experiment 1.1: Conduct a site survey to gather information about the topography, soil conditions, vegetation, and existing structures on the site.
- Experiment 1.2: Analyze the site data to identify potential challenges and opportunities for the project. This may include assessing the suitability of the site for the proposed development, identifying potential hazards, and determining the most appropriate location for key features such as buildings, roads, and utilities.
- Experiment 1.3: Develop a conceptual site plan that includes the proposed layout of the development, including the location of buildings, roads, sidewalks, and other infrastructure.
- Experiment 1.4: Prepare detailed engineering plans and specifications for the site, including grading plans, drainage plans, and utility plans.

### Module 2: Preparation of 3D model of Structure (25 hours)

#### Practice

- Experiment 2.1: Preparation of plans, elevations and section drawings of the structure.
- Experiment 2.2: Identifying the columns position as per the plan and preparation of column layout of the structure.
- Experiment 2.3: Preparation of 3D exterior design of the structure with rendering effect.
- Experiment 2.4: Preparation of 3D interior design with all necessary appliances of the structure with rendering effect.

### Module 3: Preparation of Electrical and Plumbing drawing (25 hours)

#### Practice

- Experiment 3.1: Review the architectural plans and specifications to understand the electrical and plumbing requirements of the project.
- Experiment 3.2: Develop a rough electrical layout, which includes the location of electrical panels, switches, outlets, and lighting fixtures.

- Experiment 3.3: Develop a rough plumbing layout, which includes the location of plumbing fixtures, water supply, and drainage lines.
- Experiment 3.4: Prepare single-line diagrams, load schedules, and other technical documents as needed.
- Experiment 3.5: Use the electrical and plumbing drawings as a guide during the construction phase, to ensure that the project is built according to the approved plans.

#### **Module 4: Structural design and detailing of structural components (20 hours)**

##### **Practice**

- Experiment 4.1: Structural design of indeterminate RCC beams, columns, walls and slabs as per IS code using STAAD Pro and E-Tabs.
- Experiment 4.2: Structural design of foundations as per IS code using STAAD foundations.
- Experiment 4.3: Design of steel girders, columns and truss members as per IS code using STAAD Pro and E-Tabs.
- Experiment 4.4: Structural design of the whole structure considering DL, LL, Earthquake load and/or wind load as per IS code.

#### **Module 5: Bar bending schedule, Field Work and Report preparation (20hours)**

##### **Practice**

- Experiment 5.1: Preparation of different bar bending schedules as per the structural design.
- Experiment 5.2: Preparation of a master drawing of a structure showing the detail plan and column layout. Preparation of a master structural diagram of the structure
- Experiment 5.3: Preparation of layout of the structure on the field showing the column layout.
- Experiment 5.4: Report preparation and review

##### **References book:**

1. "Engineering Drawing and Design" by David A. Madsen and David P. Madsen
2. "Technical Drawing with Engineering Graphics" by Frederick E. Giesecke, Alva E. Mitchell, Henry C. Spencer, Ivan L. Hill, John T. Dygdon, James E. Novak, and Shawna E. Lockhart
3. "Civil Drafting Technology" by David P. Madsen and Karen L. Madsen
4. "AutoCAD and Its Applications Basics" by Terence M. Shumaker, David A. Madsen, and David P. Madsen

## PHASE- II: Computational Techniques in Construction (60 hours)

Code	Course Title	Credit	T-P-PJ
CUCP3002	Computational Techniques in Construction	2	0+2+0

### Course objective:

- To impart knowledge on the principles and practices of project management and scheduling in construction projects
- To equip students with the skills to utilize advanced project planning tools and simulation techniques for efficient construction management.
- To enable students to integrate modern technologies like Building Information Modeling (BIM) into construction supervision and management for enhanced project outcomes

### Course Outcomes:

After successful completion of the course the students will be able to

- **CO1:** Develop proficiency in project scheduling and management using software tools.
- **CO2:** Utilize project planning tools like Bar Charts, Milestones, CPM, and PERT for effective project management.
- **CO3:** Perform cost analysis, project updating, and optimization for construction projects.
- **CO4:** Apply simulation techniques such as Monte Carlo and discrete event simulation for project risk analysis
- **CO5:** Integrate Building Information Modeling (BIM) in construction supervision for improved project outcomes.

### Course Outcome to Program Outcome Mapping:

COs / Pos / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3				2										
CO2		3			2										
CO3				3						2			1		
CO4				3	2										
CO5					3						2			2	

**\*High-3, Medium-2, Low-1**

## **Course Syllabus**

### **Module1: Project Management and Scheduling (12 hours)**

#### **Theory**

Introduction, Project planning, scheduling, controlling, Role of decision in project management, Project management Process and role of Project Manager.

#### **Practice**

- Experiment 1.1: Project scheduling and management using software tools.
- Experiment 1.2: Case studies: Real-world construction project planning and scheduling.

### **Module 2: Project Planning Tools (12 hours)**

#### **Theory**

Bar Charts and Milestones Chart: Introduction, Development of bar chart, short comings and remedial measures, Milestone charts. CPM & PERT: Elements of network, Time estimates, frequency distribution, mean, variance and standard deviation, probability distribution. Network Analysis: Slack, Float, Critical path, crashing of activity.

#### **Practice**

- Experiment 2.1: Creating Gantt Charts and Milestones in project management software
- Experiment 2.2: Developing CPM and PERT networks and performing network analysis

### **Module 3: Cost Analysis & Updating (12 hours)**

#### **Theory**

Introduction, Projects cost: Direct cost, Indirect cost, slope of direct cost curve, total project cost and optimum duration, cost optimization. **Project Updating:** Introduction, updating process, data required for updating, steps in process updating.

#### **Practice**

- Experiment 3.1: Cost estimation and optimization in project management software
- Experiment 3.2: Project updating exercises using real-world data

## **Module 4: Simulation Techniques (12 hours)**

### **Theory**

Monte Carlo Simulation: Principles and applications in construction. Monte Carlo simulation exercises in MATLAB/Python. Basic discrete event simulation using appropriate software.

### **Practice**

- Experiment 4.1: Monte Carlo simulation exercises in MATLAB/Python
- Experiment 4.2: Discrete event simulation exercises

## **Module 5: Building Information Modeling (BIM) (12 hours)**

### **Theory**

Introduction to BIM. Applications of BIM in construction supervision. Benefits of BIM in modern construction projects

### **Practice**

- Experiment 5.1: BIM software exercises (e.g., Autodesk Revit)
- Experiment 5.2: Case studies on BIM implementation in construction projects

### **Text Books**

1. Project Planning and Control with PERT and CPM by B. C. Punmia, K.K. Khandelwal, Laxmi Publication.
2. Sharma S.C. Construction equipment and management, Khanna Publishers, New Delhi.

### **Reference Books**

1. Peurifoy, R.L., Ledbetter, W.B and Schexnayder, C, construction planning and equipment methods, McGraw Hill, Singapore.
2. Callahan, M.T., Quackenbush, D.G., and Rowing, J.E., Construction project scheduling, McGraw Hill, New York.
3. Cleland, D.I. and Ireland, L.R., project management: Strategic design and implementation, McGraw-Hill, New York.

### PHASE III Contract Laws & Equipment Management (30 hours)

Code	Course Title	Credit	T-P-PJ
CUCP3003	Contract Laws & Equipment Management	2	2+0+0

#### Course Objective:

- To provide a comprehensive understanding of construction contracts and the legal frameworks governing them.
- To prepare students with the skills to prepare, evaluate, and manage construction contract documents effectively.
- To familiarize students with the principles of equipment management and procurement in construction projects.

**Course Outcomes:** After successful completion of the course the students will be able to

- **CO1:** Understand and differentiate between various types of construction contracts and the legal principles governing them.
- **CO2:** Develop and evaluate comprehensive construction contract documents as per CPWD guidelines
- **CO3:** Prepare detailed tender documents and manage the bidding process effectively
- **CO4:** Interpret and apply contract conditions, including obligations, responsibilities, and legal protections.
- **CO5:** Manage construction equipment procurement, maintenance, and operational processes efficiently.

#### Course Outcome to Program Outcome Mapping:

COs / Pos / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3					2									
CO2		3			2								1		
CO3			3					2							
CO4				3		2	2								
CO5									2	3					

\*High-3, Medium-2, Low-1

## **Course Syllabus**

### **Module 1: Contracts and forms (6 hours)**

#### **Theory**

What is contract, Types of contracts, Laws governing structure & Working of Construction Organization Firms, Overview of different CPWD forms to be used for contract (CPWD Form 6, Form 7, Form 8, Form 9, Form 10, Form 11, Form 11A, Form 12 and Form 47)

### **Module 2: Construction Contract Documents (6 hours)**

#### **Theory**

Documents required for a contract, Evaluation of contract documents, need for documents, present stage of national and international contract documents, types of construction contracts, roles and functions of parties to the contract.

#### **Practice**

- Experiment 2.1: Preparation of sample contract documents for different construction projects as per CPWD guidelines.

### **Module 3: Stages in Contracting (6 hours)**

#### **Theory**

Preparation of tender documents estimating, pre-qualification, bid evaluation, award of contract, project financing and contract payments, contracts close out and completion.

#### **Practice**

- Experiment 3.1: Preparation of sample tender documents for different construction projects as per CPWD guidelines.

### **Module 4: Contract Conditions (6 hours)**

#### **Theory**

Interpretation by parties to contract, obligations and responsibilities of the parties, protection and indemnification, bonds and insurance, laws and liens, subsurface conditions, inspection of work, change of work, rejected work and deficiencies.

#### **Practice**

- Experiment 4.1: Preparation of sample documents with respect to the above conditions of contract for various project works as per CPWD guidelines.

### **Module 5: Equipment Management (6 hours)**

#### **Theory**

Equipment Management & Procurement: Equipment Management Check List - Equipment Order and Invoice - Equipment Maintenance sheets and Log Book.

#### **Practice**

- Experiment 5.1: study on the functions, operational process, specifications for different constructional

### **Equipment**

1. Road Making Equipment, Material Handling Equipment and Grading Equipment
2. Batching Plant, Concreting Equipment & Slip form Equipment
3. Hauling, Tunneling and other Equipment
4. Excavation & Embankment Making Equipment and Grading Equipment
5. Batching & Mixing Equipment, Concreting Equipment & Slip form Equipment and Asphaltic Equipment
6. Material Handling Equipment and Hauling & Hoisting Equipment
7. Pile Driving Equipment and De-watering Equipment

### **Text/Reference Books:**

1. B.S. Patil, Legal Aspects of Building and Engineering Contracts, 1974.
2. The National Building Code, BIS, 2017
3. RERA Act, 2017
4. Neelima Chandiramani (2000), The Law of Contract: An Outline, 2nd Edn. Avinash Publications; Mumbai

## PHASE IV Project Quality Control & Safety Management (60 hours)

Code	Course Title	Credit	T-P-PJ
CUCP3004	Quality Control & Safety Management	2	0+2+0

### Course Objectives:

- To make the student realize the necessity of quality control and quality assurance in construction projects.
- To equip students with practical skills in developing and implementing quality management systems and standards.
- To familiarize students with health and safety regulations, risk management, and resource allocation in construction projects.

### Course Outcomes:

After successful completion of the course the students will be able to

- **CO1:** Understand the principles and evolution of quality control and quality assessment in construction.
- **CO2:** Develop and implement quality management systems and standards, including ISO standards and Total Quality Management (TQM).
- **CO3:** Create and utilize quality control inspection checklists and schedules for different types of construction projects.
- **CO4:** Conduct laboratory and field tests to ensure quality assurance in construction processes and materials
- **CO5:** Understand and apply health and safety regulations, risk management principles, and resource allocation techniques in construction projects.

### Course Outcome to Program Outcome Mapping:

COs / Pos / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3					2							1		
CO2		3			2										



CO3			3					2						
CO4				3					2					2
CO5						2	3			2				

\*High-3, Medium-2, Low-1

## Course Syllabus

### Module 1: Introduction (12 hours)

#### Theory

Quality Control and Quality Assessment - Construction Quality - Purpose & Scope Definition & Evolution of Quality. Factors influencing Construction Quality, Quality Circle. Establishing QC Requirements - Setting up a Quality Management System - Total Quality Management, Concept of Quality ISO Standards. Quality Audit.

#### Practice

- Experiment 1.1: Use a case study or a real construction project scenario to develop a Quality Management System (QMS) framework
- Experiment 1.2: Create documents such as Quality Policy, Quality Manual, and Standard Operating Procedures (SOPs) for quality control processes.

### Module 2: Quality Assurance (12 hours)

#### Theory

Quality Assurance & Control: Objective, Regularity Agent - Owner, Contract and Construction Oriented Objectives & Methods. Techniques and needs of QA / QC. Construction Quality Assurance System (CONQUAS). Principles of Quality Control and Quality Assessment. Quality Management System, Quality Control Inspection Process.

#### Practice

- Experiment 2.1: Evaluate sample construction projects using CONQUAS to assess quality levels and identify areas for improvement.
- Experiment 2.2: Develop inspection checklists for critical construction activities such as concrete pouring, steel reinforcement installation, and formwork erection.

### Module 3: Quality Control (12 hours)

#### Practice

- Experiment 3.1: Quality Control Testing Procedure & Quality Control Schedule preparation Practice Session on Generation of sample Quality Control inspection Check list for Design Standards and design processes.

- Experiment 3.2: Generation of sample Quality Control Inspection schedule Check list for form work for a Building / Irrigation Structure.
- Experiment 3.3: Generation of sample Quality Control Inspection Schedule Check list for concreting in a Residential building / Irrigation Structure.
- Experiment 3.4: Generation of sample Quality Control Inspection Schedule Check list for various works connected with a Highway project.

#### **Module 4: Laboratory and field tests for Quality Assurance (12 hours)**

##### **Theory**

Study of laboratory and field tests for Quality Assurance. Study of QC standards for various construction equipment including Concrete batch mixing / Bitumen batch mixing equipment. Practice Sessions on laboratory tests, field tests and Field Visits

##### **Practice:**

- Experiment 4.1: Conduct hands-on experiments in a lab setting to simulate standard tests for construction materials (e.g., soil compaction tests, slump tests for concrete).
- Experiment 4.2: Emphasize proper test preparation, execution, and interpretation of results.
- Experiment 4.3: Demonstrate field tests such as plate load tests for soil compaction and non-destructive testing (NDT) methods for structural elements.

#### **Module 5: Health and Safety in Construction (12 hours)**

##### **Theory**

Occupational health and safety regulations, Safety management systems, Risk assessment and mitigation. **Risk analysis and Resource allocation:** Certainty, risk and uncertainty, risk management, identification and nature of construction risks, contractual allocation of risk, types of risks, minimizing risks and mitigating losses, use of expected values, utility in investment decisions, decision trees, sensitivity analysis. Resource Allocation: Resource usage profiles, Resource smoothing and levelling.

##### **Practice:**

- Experiment 5.1: Develop a safety management plan for a construction site, considering hazards identification, risk assessment, and control measures.

- Experiment 5.2: Conduct a hazard hunt exercise on-site to identify potential safety risks and propose mitigation strategies.

### **Resources List**

1. "Construction Quality Management" by John S. Oakland and Marton Marosszeky.
2. "Quality Control Handbook" by Juran.
3. "Construction Quality Control/Quality Assurance Plan" by U.S. Army Corps of Engineers.
4. "Construction Inspection Handbook: Quality Assurance/Quality Control" by James J. O'Brien.

## PHASE V Modern Construction and Material Supervision (85 hours)

Code	Course Title	Credit	T-P-PJ
CUCP3005	Modern Construction and Material Supervision	4	2+2+0

### Course Objectives:

- To understand modern construction methods and technologies.
- To gain knowledge about advanced construction materials and their properties.
- To learn effective supervision and management techniques in construction projects.

### Course Outcomes:

After successful completion of the course, the students will be able to

- **CO1:** Identify and implement modern construction techniques.
- **CO2:** Assess the environmental impacts of construction activities and apply mitigation strategies.
- **CO3:** Apply supervision and management principles effectively on-site.
- **CO4:** Utilize Building Information Modeling (BIM) for Construction Supervision
- **CO5:** Integrate Sustainable Practices and Renewable Energy Systems in Construction

### Course Outcome to Program Outcome Mapping:

COs / Pos / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3		2												
CO2				3	3										
CO3						2			2					2	
CO4	3										2				
CO5							3					2			

\*High-3, Medium-2, Low-1

## Course Syllabus

### Module 1: Introduction to Modern Construction and Advanced Materials (16 hours)

#### Theory

Overview of modern construction methods, Differences between traditional and modern construction, Role of technology in modern construction. **Advanced Construction Materials:** Introduction to advanced materials (composites, high-performance concrete, etc.), Properties and applications of advanced materials, Selection criteria for materials in modern construction. **Sustainable Construction Materials:** Green and sustainable materials, Life cycle analysis of construction materials, Case studies on the use of sustainable materials.

### Module 2: Prefabrication, Modular Construction, and High-Rise Buildings (16 hours)

#### Theory

**Prefabrication and Modular Construction:** Principles of prefabrication and modular construction, Benefits and challenges, Case studies of prefabricated and modular projects. **High-Rise and Smart Buildings:** Techniques for high-rise construction, Smart building technologies, Integration of smart systems in modern buildings. **Renewable Energy Systems and Smart Building Technologies:** Renewable energy systems in buildings (solar, wind, etc.), Integration of smart building technologies, Case studies.

### Module 3: Site Management (18 hours)

#### Theory

**Construction Site Management:** Roles and responsibilities of a site supervisor, Coordination and communication on construction sites, Resource management and scheduling, Documentation, and reporting.

### Module 4: Material Supervision and Testing (18 hours)

#### Theory

**Concrete Technology:** Advanced concrete types and their applications, Mix design and testing of concrete, and Quality control in concrete construction. **Steel Structures and Supervision:** Modern techniques in steel construction, Supervision of steel erection and assembly, and Quality assurance in steel structures. **Inspection and Testing of Construction Materials:** Standard testing

procedures for construction materials, Non-destructive testing methods, Material compliance, and certification.

### **Module 5: Project Management, and Case Studies (17 hours)**

#### **Theory**

**Project Management Principles:** Basics of project management, Construction project planning and scheduling, Cost control, and budget management. **Case Studies and Practical Applications:** Detailed analysis of contemporary construction projects, Student presentations and discussions, Group project: Developing a supervision plan for a modern construction project.

#### **Resources List**

1. Construction Equipment-James E.Russel, Prentice Hall
2. Construction Planning and project management-Neeraj K.Jha
3. Construction Planning and project management-U.K.Shrivastava
4. Construction Planning and project management-P.S.Gahlot & B.M.Dhir

## PHASE VI Sustainability in Construction & Green Structures (170 hours)

Code	Course Title	Credit	T-P-PJ
CUCP3006	Sustainability in Construction & Green Structures	6	0+0+6

### Course Objectives:

- To understand the fundamental concepts of sustainability and their application in construction.
- To analyze the principles of green building design and construction.
- To develop strategies for implementing sustainable practices in construction projects.

### Course Outcomes:

After the end of the course, students will be able to:

- **CO1:** Gain a comprehensive understanding of sustainability concepts and their significance in construction.
- **CO2:** Assess the environmental impacts of construction activities and apply mitigation strategies.
- **CO3:** Evaluate and select sustainable construction materials, considering their characteristics and environmental benefits.
- **CO4:** Apply principles of energy-efficient building design and sustainable water management to enhance building performance.
- **CO5:** Implement green building practices, comply with regulations, and assess sustainable construction's economic and social impacts.

## Course Outcome to Program Outcome Mapping:

COs / Pos / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3					2									
CO2		3			2										
CO3			3	3										2	
CO4		3		3									1		
CO5			3		2										

\*High-3, Medium-2, Low-1

## Course Syllabus

### Module 1: Sustainability (30 hours)

#### Theory

**Introduction to Sustainability:** Definition and concepts of sustainability, Importance of sustainability in construction, Global and local perspectives on sustainable development. **Environmental Impact of Construction:** Lifecycle assessment of construction activities, Environmental impacts of conventional construction practices Mitigation strategies. **Sustainable Materials:** Characteristics of sustainable materials Recycled and renewable materials, Case studies of sustainable material usage

### Module 2: Environmental Quality (30 hours)

#### Theory

**Energy Efficiency in Buildings** Principles of energy-efficient building design, Passive and active energy systems, Case studies of energy-efficient buildings. **Water Efficiency and Management:** Water conservation techniques, Sustainable water management systems, Greywater and rainwater harvesting, **Indoor Environmental Quality:** Indoor air quality and its importance, Sustainable HVAC systems, Natural ventilation and lighting.

### **Module 3: Management in Construction (30 hours)**

#### **Theory**

**Waste Management in Construction:** Construction and demolition waste management, Recycling and reuse of construction waste, Strategies for minimizing waste. **Green Building Rating Systems:** Overview of major green building rating systems (LEED, BREEAM, IGBC, etc.), Certification processes, Case studies of certified green buildings. **Sustainable Site Development:** Site selection and analysis, Land use and ecological considerations, Sustainable landscaping practices

### **Module 4: Renewable Energy (40 hours)**

#### **Theory**

**Renewable Energy Systems in Buildings:** Types of renewable energy systems (solar, wind, geothermal, etc.), Integration of renewable energy systems in buildings. Case studies: Sustainable Construction Practices: Green construction techniques, Role of technology in sustainable construction, Prefabrication and modular construction. Economic and Social Aspects of Sustainability: Cost-benefit analysis of sustainable construction, Social impacts of sustainable practices, Community involvement and sustainable development. Policies and Regulations: Government policies and regulations related to sustainable construction, international standards and guidelines, Legal and ethical considerations

### **Module 5: Emerging Trends in Sustainable Construction (40 hours)**

#### **Theory**

Innovations in sustainable construction technologies, Future directions and trends, Smart buildings and cities,

#### **Case Studies and Project Work**

- Detailed analysis of successful sustainable construction projects,
- Student presentations and discussions,
- Group project: Developing a sustainable construction plan

## **Projects:**

1. Small scale (initial) with interior
  - 1.a. Hostel room
  - 1.b. Individual home
  - 1.c. Duplex bungalow
  - 1.d. Shop
2. Live/ ongoing Project/Turn key basis
  - 2.a. Multi storey building
  - 2.b. Hospital
  - 2c. Hostel
  - 2.d. Office Building
3. Design and analysis industrial ware house
4. Design and analysis of auditorium with proper load calculation, load cases, load combination based on code (IS 456:2000 and BS 8007).

## **REPORT WRITING**

Inputs required completing the project

1. Functional Planning of the project
2. Identification of Objects
3. Literature Review
4. Preparation of Flow chart for Methodology
5. Sequences of construction process
6. Identifying the possible Risks involved (specific to the project)
7. Result and Discussion
8. Conclusion
9. Recommendation
10. References

Each student is expected to do an individual project. At the completion of a project the student will

submit a project report, which will be evaluated (end semester assessment) by duly appointed examiner(s). This evaluation will be based on the project report and a viva voce examination on the project. Student will be allowed to appear in the final viva voce examination only if he / she has submitted his / her project work in the form of paper for presentation / publication in a conference / journal and produced the proof of acknowledgement of receipt of paper from the organizers / publishers.

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## Aerial Surveying and Remote Sensing Applications

Course Title	Type of course	T-P-PJ	Prerequisite
Aerial Surveying and Remote Sensing Applications	Theory + Practice + Project	4 - 10 - 6	Nil

### Courses Division:

Sl. No.	Code	Subject Name	T-P-P	Credits	Hrs.
1.	CUAS2020	Remote Sensing & Digital Image Processing	2-2-0	4	45
2.	CUAS2021	Geospatial Technology and Its Application	2-2-0	4	45
3.	CUAS2026	Photogrammetry and Its Application	0-2-2	4	45
4.	CUAS2023	Lidar Remote Sensing and Its Applications	0-2-0	2	25
5.	CUAS2024	Hyperspectral Remote Sensing and Its Application	0-2-0	2	25
6.	CUAS2025	Project	0-0-4	4	54
<b>Total</b>				<b>20</b>	

### Course Objective

- Apply the principles of Remote Sensing and GIS to collect, map and retrieve spatial information.
- Plan, assess and evaluate natural and manmade systems using geospatial models and methods. Use geospatial tools and techniques for natural resources planning and management.
- Pursue research and develop capabilities to handle multi-disciplinary field projects. Work in teams and demonstrate leadership skills with professional ethics

### Course Outcomes:

At the end of the program, students will be able to

- **CO1:** Identify specific data knowledge and analysis methodology for effective mapping and evaluation resources.
- **CO2:** Understand the geospatial model's skills to address social and engineering problems.
- **CO3:** Design multi-criteria geospatial systems for decision-making.
- **CO4:** Work in a team using geospatial tools and environment to achieve project objectives.
- **CO5:** Pursue lifelong learning for professional advancement.

**Course Outcome to Program Outcome Mapping:**

COs / Pos / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	1													
CO2				1		1									
CO3			2											2	
CO4									3						
CO5												3			3

\*High-3, Medium-2, Low-1

## Remote Sensing and Digital Image Processing (84 Hours)

Code	Course Title	Credit	T-P-PJ
CUAS2020	Remote Sensing and Digital Image Processing	4	2+2+0

### Course Objective

- Able to learn the procedures and techniques involved in data acquisition for remote sensing, as well as image interpretation methods.
- Understand of the various types of satellite platforms used for land and marine observation including image rectification and geometric correction processes in remote sensing.
- Understand of image classification techniques.

### Course Outcomes:

At the end of the program, students will be able to

- **CO1:** Understand the fundamental principles of remote sensing.
- **CO2:** Gain knowledge and skills necessary to acquire, process, and interpret remote sensing data effectively.
- **CO3:** Understand the diverse applications of satellite data in various fields.
- **CO4:** learn methods for assessing the quality of satellite imagery.
- **CO5:** Equipped with the knowledge and skills necessary for image classification.

### Course Outcome to Program Outcome Mapping:

COs / Pos / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3														
CO2		2			2										
CO3						2							2		
CO4								3							
CO5			3											2	

## Course Syllabus

### Module I: Basic Concept of Remote Sensing (12 Hours)

#### Theory

Introduction of Remote Sensing: Principles of RS and its Type; Energy sources and Radiation principles, Pixel, DN value, Energy equation; EMR and Spectrum; EMR interaction with Atmosphere; scattering, Absorption, Atmospheric window, Black body radiation; EMR interaction with earth surface features, reflection, absorption, emission and transmission, Spectral signature; Interaction with vegetation, soil, water bodies; Advantage of RS over conventional method, Limitation, Ideal remote sensing.

#### Practice

- Experiment 1.1: Installation of Image Processing software's
- Experiment 1.2: Download satellite data from GLOVIS / Earth Explorer / Bhuvan etc.
- Experiment 1.3: Layer stacking
- Experiment 1.4: LUT and Image Subset
- Experiment 1.5: Spectral Signature mapping (soil, vegetation, water)

### Module II: Digital Image (12 Hours)

#### Theory

Data acquisition: Procedure, Reflectance and Digital numbers; Intensity, Reference data, Ground truth, Analog to digital conversion, FCCs, TCC, Platforms and sensors; orbits, types, Resolutions; Image Interpretation; visual- Interpretation keys.

#### Practice

- Experiment 2.1: FCCs and TCC
- Experiment 2.2: Resolution
- Experiment 2.3: Image Interpretation

### Module III: Satellite Information and Principles (8 Hours)

#### Theory

Land observation satellites, characters and applications; PSLV, GSLV, Satellite, Platform Types; LANDSAT series; IRS series; IKONOS Series; QUICKBIRD series; Weather/Meteorological satellites; INSAT series, NOAA, Applications, Marine observation satellites; OCEANSAT

#### Practice

- Experiment 3.1: Image filtering and Band ratioing
- Experiment 3.2: Mosaicking

## **Module IV: Image Acquisition and Format (12 Hours)**

### **Theory**

Digital Image Processing; Export and import, Data formats; BSQ, BIL, BIP, Run length encoding, Image Compression Data products.

### **Practice**

- Experiment 4.1: Export and Import
- Experiment 4.2: Histogram
- Experiment 4.3: Subset using AOI

## **Module V: Image Processing (12 Hours)**

### **Theory**

IMAGE RECTIFICATION; Pre-processing and Post-processing Geometric distortion; sources and causes for distortion, rectification, GCP, Resampling, Image registration; Radiometric distortion; sources and causes, atmospheric correction.

### **Practice**

#### **(Spectral Python and ENVI)**

- Experiment 5.1: Geometric correction
- Experiment 5.2: Radiometric correction
- Experiment 5.3: Atmospheric correction

## **Module VI: Image Classification (16 Hours)**

### **Theory**

IMAGE CLASSIFICATION; Classification techniques, types, Supervised and Unsupervised; Principal Component Analysis (PCA); Image Enhancement; Accuracy assessment.

### **Practice**

- Experiment 6.1: PCA analysis (spectral Python and ENVI)
- Experiment 6.2: NDVI, DVI, NDWI calculation
- Experiment 6.3: Image classification in Spectral Angel Mapper
- Experiment 6.4: MNF Rating
- Experiment 6.5: Supervised Classification (spectral Python and ENVI)
- Experiment 6.6: Un-supervised Classification (spectral Python and ENVI)
- Experiment 6.7: Image Enhancement (ENVI)

- Experiment 6.8: Accuracy Assessment (ENVI)

## **Module VII: Remote Sensing and Its Application (12 Hours)**

### **Theory**

Microwave RS and its application; Thermal RS and its application; Optical RS and its application; Sensor and its types.

### **Practice**

#### **Using Spectral Python**

- Experiment 7.1: Application of microwave remote sensing (Structural Trend line mapping)
- Experiment 7.2: Application of thermal remote sensing and case study (Land surface Temp. estimation)
- Experiment 7.3: Application of optical remote sensing and case study

## Geospatial Technology and its Application (85 Hours)

Code	Course Title	Credit	T-P-PJ
CUAS2021	Geospatial Technology and its Application	4	2+2+0

### Course Objective

- Understand of Geographic Information Systems (GIS) and Cartography. Apply Knowledge and skills necessary to perform advanced spatial analysis and data manipulation tasks using GIS.
- Understand of multi-criteria decision-making (MCDM) principles and techniques
- Understand the principles behind DEMs, and generate DEMs using various techniques.

### Course Outcomes:

At the end of the program, students will be able to

- **CO1:** Understand the fundamentals of GIS.
- **CO2:** Learn advanced data analysis tools and techniques in GIS software.
- **CO3:** Learn multi-criteria decision-making techniques, including AHP, to solve complex spatial analysis.
- **CO4:** Gain knowledge of Digital Elevation Models (DEMs), their generation techniques, derivatives, integration with satellite data, sources, limitations, and future trends.
- **CO5:** Gain Knowledge and skills necessary to apply geospatial technology in various applications.

### Course Outcome to Program Outcome Mapping:

COs / Pos / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3					2									
CO2		2			2										
CO3			2										3		
CO4				3											
CO5										3					

\*High-3, Medium-2, Low-1

## Course Syllabus

### Module I: GIS & Cartography (14 hours)

#### Theory

Components of GIS, Types of Data in GIS, Scale Application of GIS, Advantage and limitation of GIS. History and development of Cartography; Definition, scope and concepts of cartography, Characteristics of Map; Categories of maps, Methods of mapping, relief maps, thematic maps.

#### Practice

- Experiment 1.1: Symbology (generalization, symbology, and colour effect, change symbology and use transparency in creative ways) using GRASS and QGIS, Geo-referencing (Map to Image and Image to Image), Projection, Data base creation: Digitization using Point, line and polygon, Edit, Clip, Intersect, Union, Merge, Join and subset. Attribute table editing
- Experiment 1.2: Google Earth (Convert Shape file to KML Format and KML File to shape file, import data into Google earth, Bhuvan view, Extract data From Google Earth, Extract Point Data, Extract Polygon data, Extract line data, overlaying an image into Google earth)

### Module II: Data analysis tools (15 hours)

#### Theory

Raster data spatial analysis, Network analysis, Vector operations and analysis, Data editing, Primary and secondary data. Data model and data structure, Geodatabase and metadata, GIS data model, Overlay analysis, Network modeling, Data Structure Models, Spatial interpolation; measurement and analysis methods, Advantage and disadvantage

#### Practice

- Experiment 2.1: Linking of spatial and non-spatial data and queries, Joining tabular data with the feature attribute data, Non-spatial query, Spatial query, Spatial join, Vector based spatial analysis, Raster based spatial data analysis
- Experiment 2.2: Buffering and Creation of Contour
- Experiment 2.3: Network Analysis

### Module: III multi-criteria analysis and decision making (15 hours)

#### Theory

Principles and elements of multiple-criteria decision making, Classification of Multiple-criteria Decision Problem: Multi-objective Vs Multi-attribute, Decision Alternatives and constraints, Criterion weighting, Decision rules, Multiple-criteria decision making in spatial data analysis. Introduction to AHP, Basic Principles of AHP, Effect Table, Pair Wise comparison, Consistency, Weightage, performance score, Case studies involving AHP

#### Practice:

- Experiment 3.1: Mapping accident locations using Linear Referencing technique.
- Experiment 3.2: Preparation of raster layers for Multicriteria Analysis
- Experiment 3.3: Solving a spatial problem using Multicriteria Analysis (Spatial AHP)

#### **Module IV: Digital Elevation Model (DEM) (14 hours)**

##### **Theory**

Concept of DEM, Various techniques to generate DEM, Importance of spatial resolution to DEM, Integration of DEM to satellite data, Common Derivatives of DEM, Slope, Aspects, TIN, Sources of DEM, Laminations, and future of DEM.

##### **Practice:**

- Experiment 4.1: Google Earth to DEM, 3D Map preparation, Contour to DEM, TIN, and Aspect
- Experiment 4.2: DEM-based surface Hydrology modeling,
- Experiment 4.3: LiDAR classification, DEM from LiDAR

#### **Module V: Geospatial Technology for Water Resources Engineering (14 hours)**

##### **Theory**

**Watershed**, types, divide catchment, command area, stream types, Drainage network, different pattern; morphometric analysis, Bifurcation ratio analysis; Assessment of **Groundwater potential zones** and Groundwater mapping; Site selection for recharge structures, Hydrogeological Mapping GIS applications to groundwater studies.

##### **Practice:**

- Experiment 5.1: Mapping of catchment, command area
- Experiment 5.2: Drainage network analysis
- Experiment 5.3: Morphometric analysis
- Experiment 5.4: Mapping of Groundwater potential zones

#### **Module VI: Geospatial Technology for Environmental Engineering Theory (13 hours)**

Monitoring atmosphere constituents, air pollution, industrial activity, GIS modeling, Resource development in remote areas, Impacts of anthropogenic activity, Solid Waste management, Water Pollution, Shortest path Identification, and Network analysis.

##### **Practice**

- Experiment 6.1: Air pollution mapping
- Experiment 6.2: Solid waste management
- Experiment 6.3: Water pollution

## Photogrammetry and Application (115 Hours)

Code	Course Title	Credit	T-P-PJ
CUAS2026	Photogrammetry and Application	4	0+2+2

### Course Objective

- Hands-on experience and practical skills in various aspects of aerial photography and photogrammetry.
- Generating digital elevation models (DEMs), orthoimages and mosaics.
- Integrating photogrammetry with Geographic Information Systems (GIS)

### Course Outcomes:

At the end of the program, students will be able to

- **CO1:** Understand the aerial photography and photogrammetry principles.
- **CO2:** Gain practical Skills in Photogrammetric Techniques.
- **CO3:** Learn techniques for processing satellite imagery.
- **CO4:** Acquire knowledge in Integration of photogrammetry and GIS.
- **CO5:** Learn about aerial mapping using drones.

### Course Outcome to Program Outcome Mapping:

COs / Pos / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3					2									
CO2		2			2										
CO3				2											
CO4			3										2		
CO5						3									

\*High-3, Medium-2, Low-1

## Practice

- Experiment 1.1: Scale determination from aerial photo
- Experiment 1.2: Aerial Photo Interpretation
- Experiment 1.3: Use of Parallax bar and determination of Height from stereo pair
- Experiment 1.4: Satellite DEM and ortho Image generation
- Experiment 1.5: Primary and additive color creation
- Experiment 1.6: Stereo test
- Experiment 1.7: Mosaic
- Experiment 1.8: Stereoscopic vision
- Experiment 1.9: Relief displacement
- Experiment 1.10: Analog to digital conversion, Orientation of stereo model and Determination of Height
- Experiment 1.11: Aerial mapping using DRONE
- Experiment 1.12: Mosaicking of aerial Photo
- Experiment 1.13: Correction and rectification
- Experiment 1.14: DTM generation Image correction, Link between GIS and Digital Photogrammetry, and Ortho Image generation

## Theory

Introduction to Drones, Parts of Drones, Digital Sky Platform, Different flying Zones, and Different forms (D1 to D5)

## Practice

- Experiment 2.1: Flight Simulator Training and Checklist for before and after flying.
- Experiment 2.2: Take-off, Cruise flight, and Landing
- Experiment 2.3: Mission Planner
- Experiment 2.4: Drone Data processing and pre-processing
- Experiment 2.5: DEM, DTM, DEM, and contour generation
- Experiment 2.6: Drone data analysis

## 4. LIDAR Remote Sensing and Application (60 Hours)

Code	Course Title	Credit	T-P-PJ
CUAS2023	LIDAR Remote Sensing and Application	2	0+2+0

### Course Objective

- Practical skills in downloading LIDAR data, processing, validating, and analyzing it to generate accurate and reliable geospatial products.
- Understanding of LIDAR data processing techniques.
- Utilization of LIDAR data for a wide range of applications.

### Course Outcomes:

At the end of the program, students will be able to

- **CO1:** Understand the LIDAR Data acquisition technique.
- **CO2:** Learn techniques for layer stacking and georeferencing of LIDAR data.
- **CO3:** Understand the LIDAR data processing techniques.
- **CO4:** Learn 3D modeling using LIDAR data.
- **CO5:** Use LIDAR data across various applications.

### Course Outcome to Program Outcome Mapping:

COs / Pos / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3			2											
CO2		2	2												
CO3				2											
CO4						3									
CO5												3			

\*High-3, Medium-2, Low-1

## **Practice Experiments:**

Experiment 1.1: Download of LIDAR data

Experiment 1.2: Layer stacking

Experiment 1.3: Data Validation

Experiment 1.4: Georeferencing Technology

Experiment 1.5: Boresight Calibration - Lidar Data Pre-processing

Experiment 1.6: Project Coverage Verification - Review Lidar Data against Field Control

Experiment 1.7: Lidar data errors and rectifications, - processes calibration of Lidar data - artifacts and anomalies - Lidar Error Budget.

Experiment 1.8: Noise Removal and other sensor-related artifacts - Layer Extraction - Automated Filtering

Experiment 1.9: Manual Editing and Product Generation – Surface Editing - Hydrologic Enforcement

Experiment 1.10: Breaklines, Contours, and Accuracy Assessment

Experiment 1.11: Topographic Mapping, flood inundation analysis, line-of-sight analysis

Experiment 1.12: Forestry, various types of LIDAR sensors-, vegetation metric calculations - specific application software.

Experiment 1.13: Corridor mapping system, data processing and quality control procedures.

Experiment 1.14: Modelling

## 5. Hyperspectral Remote Sensing and Application (60 Hours)

Code	Course Title	Credit	T-P-PJ
CUAS2024	Hyperspectral Remote Sensing and Application	2	0+2+0

### Course Objective

- Basic understanding of hyperspectral remote sensing
- Data processing and interpretation of hyperspectral imagery using software tools like ENVI and Python.
- Applications in agriculture, forestry, urban studies, and geological studies.

### Course Outcomes:

At the end of the program, students will be able to

- **CO1:** Understand the hyperspectral remote sensing principles.
- **CO2:** Gain Practical skills in data processing, analysis, and interpretation using ENVI and Python
- **CO3:** Understand the principles and techniques of atmospheric correction for hyperspectral imagery
- **CO4:** Learn supervised and unsupervised classification techniques for hyperspectral imagery.
- **CO5:** Use this methodology in geological studies for mineral identification, lithological and geological mapping.

### Course Outcome to Program Outcome Mapping:

COs / Pos / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3			2											
CO2		2			2										
CO3				2											
CO4			3												
CO5						3									

\*High-3, Medium-2, Low-1

**Practice:**

- Experiment 1.1: Introduction to ENVI, Python and Downloading, Displaying, and Analyzing Hyperspectral Imagery
- Experiment 1.2: Atmospheric Correction of Hyperspectral Imagery.
- Experiment 1.3: MNF rationing from Hyperspectral (EO1)
- Experiment 1.4: Hyperspectral Image Classification Using Spectral Angle Mapper (SAM) & Spectral Feature Fitting (SFF).
- Experiment 1.5: Hyperspectral Imagery Classification Using an Unsupervised Neuron fuzzy System.
- Experiment 1.6: Application of Hyperspectral Imagery in Geological Studies.
- Experiment 1.7: Hyperspectral Signatures & Feature Fitting.
- Experiment 1.8: Hyperspectral Remote Sensing for Agriculture and soil Studies.
- Experiment 1.9: Hyperspectral Remote Sensing for Forestry Applications.
- Experiment 1.10: Hyperspectral Remote Sensing for Urban Studies.
- Experiment 1.11: Mineral identification from Hyperspectral imagery
- Experiment 1.12: Python Programming for Hyperspectral data analysis.

## 6. Project (115 Hours)

Subject Name	Code	Type of course	Credit	T-P-P	Prerequisite
Project	CUAS2025	Project	4	0-0-4	NIL

### List of Projects:

1. Flood inundation mapping and Risk Evaluation using Geospatial Technology.
2. Landslide Hazard mapping using GIS and RS.
3. Land use and Land cover Dynamics using Earth observation Technology.
5. Mangrove change detection study using Multi-Temporal satellite data.
6. Solid waste management and shortest path identification using GIS Technology.
7. Watershed management using GIS Technology.
8. Identification of Mineral mapping using GIS and RS.
9. Crop Health Monitoring using Geospatial Technology.
10. Identification of Hydrocarbon Locales using space inputs and Geospatial Technology.
11. Groundwater exploration using GIS and RS Techniques.
12. Interlinking of River using GIS Technology.
13. Biomass estimation using Space Technology.
14. Land surface Temperature mapping using RS Technology.
15. Climate Change study using Earth Observation Technology.
16. Erosion and Accretion study of Shorelines and its impact in coastal habitats.

Students take up group projects and deal the following activities during the project. The project Report should contain below gate process.

**Step 1:** Functional Planning of the project and Objective Identification

**Step 2:** Literature Review

**Step 3:** Preparation of Flow chart for Methodology

**Step 4:** Layer creation and GIS analysis

**Step 5:** Identifying the possible Risks involved (specific to the project)

**Step 6:** Report writing

Each student is expected to do an individual project. At the completion of a project the student will submit a project report, which will be evaluated (end semester assessment) by duly appointed examiner(s). This evaluation will be based on the project report and a viva voce examination on the project. Student will be allowed to appear in the final viva voce examination only if he / she has submitted his / her project work in the form of paper for presentation / publication in a conference / journal and produced the proof of acknowledgement of receipt of paper from the organizers / publishers.

## Course Structure & Syllabus

### Go To Market Domain

Code	Subject	Course Type	Credit
CUGM2140	DESIGN THINKING & MANAGING INNOVATION THROUGH GATE PROCESS	T + P + PJ (1+2+0)	3
CUGM2141	PLM TOOLS ON DASSAULT PLATFORM (DESIGN AND VALIDATION USING DYMOLA, CATIA, SIMULIA)	T + P + PJ (2+6+0)	8
CUGM2142	PROCESS MANAGEMENT USING ENOVIA	T + P + PJ (1+2+0)	3
CUGM2143	PRODUCT Development	T-P-PJ (0-0-8)	8
	<b>TOTAL CREDITS</b>	<b>T-P-PJ (4-10-8)</b>	<b>22</b>

#### Domain Track Objectives:

- To familiarize the student with Industrial Product Life Cycle Management Processes
- Teach Dassault tools for PLM
- Develop digital prototypes of the products and validate them and innovate for design efficiency

#### Domain Track Course Outcome:

#### After completion of the domain, students will be able to:

- CO1: Understand the design concept of a product
- CO2: Apply the design principle to manufacture a product
- CO3: Analyze the failure of an existing product
- CO4: Select the materials for enhancing the product quality
- CO5: Create a digital product using various dassault tools.

#### Course Outcome to Program Outcome Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3		1	1	1	2						1		1	1
CO2	3	1	1	2		1	1							2	1
CO3	2	2	3	2				2						3	1
CO4	1	2	1	2					3					3	1
CO5	3	2	1	1		2								2	1

\*High-3, Medium-2, Low-1

## DOMAIN SYLLABUS:

### **1.Design Thinking and Managing Innovation Through GATE Process (1-2-0)**

#### **1.1 Customer or User Requirement for Specification (Gate 0)**

- 1.2 Requirement gathering and feasibility study of the project
- 1.3 understanding users' motivations and to gather deep insights about a product
- 1.4 challenges and benefits of the products
- 1.5 Understanding the product through literature survey and available resources
- 1.6 Market analysis of existing products
- 1.7 Finalizing the product specification
- 1.8 Preparing a project plan

#### **2.1 Design Parameter Optimization in Dymola (Gate 1)**

- Designing and simulating system and subsystem of the product using system Engineering Dymola
- 2.2 Final functional and logical design of integrated product in system engineering with simulation.
- 2.2 Customizing the product properties with required inputs and analyzing the outputs.

#### **3.1 CATIA Drawing with Styling (Full product drawing) (Gate 2)**

- 3.2 CATIA part design with assembly design of the product.
- 3.3 Behaviour experience of the product

#### **4.1 Digital Testing and Validation of the Product Using Simulia (Gate 3)**

- 4.2 Complete structural, thermal, mechanical simulations with other required simulation is done for the product.

#### **5.1 Regulatory Certification (Gate 4)**

- 5.2 Once the regulatory certification for a particular product is over through certain testing and validation, the product is all set for the next stage.

#### **6.1 BOM and Production planning and Vendors development (ENTRY)**

- 6.2 Launching of Product.

### **2.PLM Tools on Dassault Platform (Design and Validation using Dymola, Catia, Simulia) (2-6-0)**

- 2.1 System Engineering Dymola
- 2.2 Finding energetic dimension of the desired product
- 2.3 Designing system and subsystem using behaviour modelling work bench
- 2.4 Getting familiar with Dymola- modelica library.
- 2.6 Understanding the behaviour of the model through input n output data
- 2.7 Customizing the product properties

- 2.8 System Integration with product dimension.
- 2.10 Functional and logical design of integrated product in system engineering.
- 2.11 D Model using CATIA
- 2.12 ATIA part design of different components
- 2.13 Surface designing for creating high end complex design
- 2.14 Assembly Designing of the complete product
- 2.15 Wire routing and entire harnessing of the design.
- 2.16 Mechanical system Designing of the product
- 2.17 CATIA live rendering
- 2.18 Behaviour experience of the complete product.
- 2.19 Design validation/Simulation using Simulia
- 2.20 Simulation using Simulia
- 2.21 Classification of simulation
- 2.22 Structural simulation, Thermal simulation and both
- 2.23 Linear and non linear analysis
- 2.24 CFD Analysis, Fatigue, Durability
- 2.25 Explicit Analysis, Crash Analysis (Abaqus)

### **3. Process management (Using Enovia) (1-2-0)**

- 3.1 Introduction to project management, Project Definition, Project Initiation
- 3.2 Need for Project Management
- 3.3 Provide vision and direction, increase efficiency, Control.
- 3.4 Project scope, manage costs, manage time, Schedule the work
- 3.5 Deal with potential risks
- 3.6 Project Management Principles, Project structure, Clear goals
- 3.7 Transparency about project status, Risk recognition,
- 3.8 The Project Life Cycle: The project initiation stage, The project planning stage, The project execution stage, The project closure stage.
- 3.9 Project Identification and Selection: Introduction, Project Identification Process
- 3.10 Project Initiation, Pre-Feasibility Study, Feasibility Studies, Project Break-even point
- 3.11 Core functionality integration with different engineering IT tools, specifically with **Catia**, **Delmia**, **Dymola**, **Simulia** etc.
- 3.12 PDM (product data management) systems and their implementations in product lifecycle (Enovia)
- 3.13 Exemplification on how PLM functionality can be used to facilitate increased information management efficiency and exchange (Enovia)
- 3.14 Resources Considerations in Projects: Resource Allocation, Scheduling, Project Cost Estimate and Budgets, Cost Forecasts (Enovia)

### **4. Product Development (0-0-8)**

- 4.1 The Domain will be delivered through case studies, assignments and product development.
- 4.2 The outcome will be an end-to-end digital prototype of a product, which may be patinized.

#### 4.3 Product Development Stack:

1. E- Cart ( Full product)
2. E- SCV ( Modular Platform design and electric power train design , BIW)
3. Insulin Pump ( Design of different components like control unit, PCB, micro dc motor)
4. 500 kg Payload Drone ( Design of Mechanical system)

#### Session Plan for the Entire Domain:

### **Design Thinking and Managing Innovation Through GATE Process (1-2-0)**

Session	1	1.1 Customer or User Requirement for Specification (Gate 0)
Session	2	1.2 Requirement gathering and feasibility study of the project
Session	3	1.3 Market analysis of existing products
Session	4	1.4 Finalizing the product specification and preparing a project plan
Session	5	1.5 Design Parameter Optimization in Dymola (Gate 1)
Session	6	1.6 Designing and simulating system and subsystem of the product using system Engineering Dymola
Session	7	1.7 Final functional and logical design of integrated product in system engineering with simulation.
Session	8	1.8 CATIA Drawing with Styling (Full product drawing) (Gate 2)
Session	9	1.9 Digital Testing and Validation of the Product Using Simulia (Gate 3)
Session	10	1.10. Regulatory Certification (Gate 4) BOM and Production planning and Vendors development (ENTRY)
Practice(2h)	1	1.1 Customer or User Requirement for Specification and Requirement gathering and feasibility study of the project
Practice(2h)	2	1.3 Market analysis of existing products and finalizing the product specification and preparing a project plan
Practice(2h)	3	Review (Gate 0)
Practice(2h)	4	1.5 Design Parameter Optimization in Dymola
Practice(2h)	5	1.6 Designing and simulating system and subsystem of the product using system Engineering Dymola
Practice(2h)	6	Review (Gate 1)
Practice(2h)	7	1.7 Final functional and logical design of integrated product in system engineering with simulation.
Practice(2h)	8	1.8 CATIA Drawing with Styling (Full product drawing) (Gate 2)
Practice(2h)	9	Review
Practice(2h)	10	1.9 Digital Testing and Validation of the Product Using Simulia (Gate 3)
Practice(2h)	11	1.10. Regulatory Certification (Gate 4) BOM and Production planning and Vendors development (ENTRY)
Practice(2h)	12	Review

## **2.PLM Tools on Dassault Platform ( Design and Validation using Dymola, Catia, Simulia) (2-6-0)**

Session	1	2.1 System Engineering Dymola
Session	2	2.2 Finding energetic dimension of the desired product
Session	3	2.3 Designing system and subsystem using behaviour modelling work bench
Session	4	2.4 Getting familiar with Dymola- modelica library.
Session	5	2.5 Understanding the behaviour of the model through input n output data
Session	6	2.6 Customizing the product properties
Session	7	2.7 System Integration with product dimension.
Session	8	2.8 Functional and logical design of integrated product in system engineering.
Session	9	2.9 3D Model using CATIA
Session	10	2.10 CATIA part design of different components
Session	11	2.11 Surface designing for creating high end complex design
Session	12	2.12 Assembly Designing of the complete product
Session	13	2.13 Wire routing and entire harnessing of the design.
Session	14	2.14 Mechanical system Designing of the product
Session	15	2.15 CATIA live rendering
Session	16	2.16 Behaviour experience of the complete product.
Session	17	2.17 Design validation/Simulation using Simulia
Session	18	2.18 Simulation using Simulia, Classification of simulation, Structural simulation, Thermal simulation and both
Session	19	2.19 Linear and non-linear analysis
Session	20	2.20 CFD Analysis, Fatigue, Durability, Explicit Analysis, Crash Analysis (Abaqus)

Practice(3 h)	1	<b>P2.1 System Engineering Dymola</b>
Practice(3 h)	2	P2.2 Finding energetic dimension of the desired product
Practice(3 h)	3	P2.3 Designing system and subsystem using behaviour modelling work bench
Practice(3 h)	4	P2.4 Getting familiar with Dymola- modelica library.
Practice(3 h)	5	P2.5 Understanding the behaviour of the model through input n output data
Practice(3 h)	6	P2.6 Customizing the product properties
Practice(3 h)	7	P2.7 System Integration with product dimension.
Practice(3 h)	8	P2.8 Functional and logical design of integrated product in system engineering.
Practice(3 h)	9	P2.9 3D Model using CATIA <a href="https://www.youtube.com/watch?v=ISdup32L6Mw">https://www.youtube.com/watch?v=ISdup32L6Mw</a>
Practice(3 h)	10	P2.10 CATIA part design of different components <a href="https://www.youtube.com/watch?v=CQWjb91_vKg">https://www.youtube.com/watch?v=CQWjb91_vKg</a>
Practice(3 h)	11	P2.11 Surface designing for creating high end complex design <a href="https://www.youtube.com/watch?v=RT24Yj5thd8">https://www.youtube.com/watch?v=RT24Yj5thd8</a>
Practice(3 h)	12	P2.12 Assembly Designing of the complete product <a href="https://www.youtube.com/watch?v=B7_irVMmOzw">https://www.youtube.com/watch?v=B7_irVMmOzw</a>
Practice(3 h)	13	P2.13 Wire routing and entire harnessing of the design.
Practice(3 h)	14	P2.14 Mechanical system Designing of the product <a href="https://www.youtube.com/watch?v=B-XoaRfeD9w">https://www.youtube.com/watch?v=B-XoaRfeD9w</a>
Practice(3 h)	15	P2.15 CATIA live rendering <a href="https://www.youtube.com/watch?v=HsK3RVTOX1Q">https://www.youtube.com/watch?v=HsK3RVTOX1Q</a>
Practice(3 h)	16	P2.16 Behaviour experience of the complete product <a href="https://www.youtube.com/watch?v=9RgdZUvEjPw">https://www.youtube.com/watch?v=9RgdZUvEjPw</a>
Practice(3 h)	17	P2.17 Design validation/Simulation using Simulia <a href="https://www.youtube.com/watch?v=cDDeWRB7PCs">https://www.youtube.com/watch?v=cDDeWRB7PCs</a>
Practice(3 h)	18	P2.18 Simulation using Simulia <a href="https://www.youtube.com/watch?v=cDDeWRB7PCs">https://www.youtube.com/watch?v=cDDeWRB7PCs</a>
Practice(3 h)	19	P2.19 Classification of simulation <a href="https://www.youtube.com/watch?v=gVlvp1RDi2s">https://www.youtube.com/watch?v=gVlvp1RDi2s</a>

Practice(3 h)	20	P2.20 Structural simulation, Thermal simulation and both
Practice(3 h)	21	P2.21 Linear and non linear analysis
Practice(3 h)	22	P2.22 CFD Analysis, Fatigue, Durability
Practice(3 h)	23	P2.23 Explicit Analysis, Crash Analysis(Abaqus)
Practice(3 h)	24	P2.24 Explicit Analysis, Crash Analysis(Abaqus)
Practice(3 h)	25	P2.25 CFD Analysis, Fatigue, Durability

### **3.Process management ( Using Enovia ) ( 1-2-0)**

Session	1	3.1 Introduction to project management, Project Definition, Project Initiation
Session	2	3.2 Need for Project Management
Session	3	3.3 Provide vision and direction, increase efficiency, Control.
Session	4	3.4 Project scope, manage costs, manage time, Schedule the work
Session	5	3.5 Project Management Principles, Project structure, Clear goals
Session	6	3.6 Transparency about project status, Risk recognition, Deal with potential risks
Session	7	3.7 The Project Life Cycle: The project initiation stage, The project planning stage, The project execution stage, The project closure stage.
Session	8	3.8 Project Identification and Selection: Introduction, Project Identification Process
Session	9	3.9 Project Initiation, Pre-Feasibility Study, Feasibility Studies, Project Break-even point
Session	10	3.10 Core functionality integration with different engineering IT tools, specifically with Catia,Delmia, Dymola, Simulia etc.
Practice (2 h)	1	P3.1 Getting started with Enovia with known use case.
Practice (2 h)	2	P3.2 Practicing for the given project
Practice (2 h)	3	P3.3 Define an existing project using Enovia

Practice 4 (2 h)	P3.4 Practicing for the given project
Practice 5 (2 h)	P3.5 Learning Task allocation for an existing project using Enovia
Practice 6 (2 h)	P3.6 Practicing for the given project
Practice 7 (2 h)	P3.7 Resource allocation for different tasks in an existing project using Enovia
Practice 8 (2 h)	P3.8 Practicing for the given project
Practice 9 (2 h)	P3.9 Review and monitoring of an existing project through Enovia
Practice 10 (2 h)	P3.10 Practicing for the given project
Practice 11 (2 h)	P3.11 Uploading deliverables of the project through Enovia
Practice 12 (2 h)	P3.12 Practicing for the given project

List of Projects/ papers/jobs/products to be done in domain:

## DOMAIN TITLE: Automobile Engineering (AECU2170)

Sl. No.	Course Code	Course Title	Course Type	T-P-Pj	Credits
1	CUAE2170	Introduction to Automobile Engineering	Theory +Practice	2-1-0	3
2	CUAE2171	Subsystems of Automobile	Theory + Practice	3-2-0	5
3	CUAE2172	Electric Vehicles	Theory + Practice	2-1-0	3
4	CUAE2176	Maintenance of Automobile (2 Wheeler & 4 Wheeler)	Practice	0-5-0	5
5	CUAE2177	Project		0-0-4	4
6	CUAE2175	Internship		0-0-4	4
<b>Total</b>					<b>24</b>

### Domain Track Objectives:

- To familiarise the students with different systems and subsystems of automobile.
- To teach basic skill in maintenance of different types of automobiles.
- To know the operation and maintenance of electric vehicle.

### Domain Track Course Outcomes:

After completion of the domain, students will be able to:

- CO1: Remember the names of different automobile components
- CO2: Understand the construction and working of different systems and subsystems of automobile.
- CO3: Solve the problem of incorrect valve timing in automobile
- CO4: Select the method of power transmission in different vehicles
- CO5: Assemble various sub systems of engine in automobile

### Course Outcome to Program Outcome Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3			3	1	1	2					1	2		1
CO2	2			2	2	2	1	1					2		1

CO3	2			2	3	2				2			3		3
CO4	1			2	3	2						3	3		3
CO5	1			2	3	1			2				2		1

**\*High-3, Medium-2, Low-1**

### Introduction to Automobile Engineering

Course Title	Course Code	Type of Course	T-P-Pj	Pre-Requisite
Introduction to Automobile Engineering	CUAE2170	Theory+Practice	2-1-0	Nil

### COURSE CONTENT

#### Module I

**3 (hrs)**

**Automobile Architecture:** Definition and Classification of Automobiles, Major Units of the Automobile, Types of Automobile Layouts, Automobile Chassis Types and Components, Automobile Body Types and Components, Automobile Safety Parameters.

#### Module II

**6 (hrs)**

**Engine:** Classification of Engine, Engine Nomenclature, Components of Engine, Valve Timing Diagram of SI & CI Engines, Variable Valve Timing, Working Principles of Modern Engine Combustion Technologies (CRDI, GDI, HCCI, Dual Fuel Engine, Stratified Charge Engine).

#### Practice

- Valve Timing Diagram of SI Engine.
- Valve Timing Diagram of CI Engine.

#### Module III

**5 (hrs)**

**Carburetion:** Air-Fuel Ratio, Mixture Requirements for Different Load Conditions, Factors Affecting Carburetion, Principle of Carburetion, Limitations of Simple Carburettor, Additional Systems in Carburettor, Concept of Electronic Carburettor.

#### Practice

- Model Study of a Solex Carburettor

## Module IV

5 (hrs)

**Fuel Injection:** Classification of Injection Systems, Fuel Feed Pump, Injection Pump, Injection Pump Governor, Fuel Injector, Nozzle, Electronic Injection Systems, Multi-Point Fuel Injection (MPFI) System, Direct And Indirect Fuel Injection.

### Practice

- Study of Fuel Injection System of a Diesel Engine.

## Module V

5 (hrs)

**Transmission System:** Layout of Power Flow from Engine to Wheels, Brief Construction and Working Principles of - Clutch, Transmissions, Propeller Shaft, Final Drive and Differential, Front and Rear Axles.

### Practice

- Study of Transmission System of Automobile.
- Model Study of Differential of Automobile.

## Module VI

5 (hrs)

### Cooling and Lubrication System:

Direct Air Cooled and Indirect Liquid Cooled Cooling Systems, Types and Components of Liquid Cooled Cooling System, Engine Coolant and Antifreeze Solution, Desired Properties of Lubricants, Classification, Construction, Working Principles and Components of Various Types of Lubricating Systems.

### Practice

- Model Study of Air Cooling System.
- Model Study of Liquid Cooling System.

## Module VII

4 (hrs)

**Super Charging & Turbo Charging:** Naturally Aspirated and Forced Induction Engine, Effect of Forced Induction, Method of Supercharging, Types of Super Chargers, Basic Principle and Method of Turbo Charging, Types of Turbo Charging, Concept of Variable Geometry Turbocharging.

### Practice

- Study of Working Model of Supercharger
- Study of Working Model of Turbocharger.

## Text Books

1. Gupta R. B., Automobile Engineering, Satya Prakashan, New Delhi.
2. Giri N. K., Automobile Technology, Khanna Publishers.

## References

1. Gupta H. N., Fundamentals of Internal Combustion Engines, PHI Learning.

## Subsystems of Automobile

Course Title	Course Code	Type of course	T-P-Pj	Pre-Requisite
Subsystems of Automobile	CUAE2171	Theory + Practice	3-2-0	Nil

### COURSE CONTENT

#### Module I

**6 (hrs)**

**Engine Emissions:** Sources of Air Pollution from Automobiles and Their Control, Crank Case Emission Control System, Evaporative Emission Control System, Exhaust Emission Control System: Air Injection, EGR, Catalytic Converters, Selective Catalytic Reduction (SCR) Technology, EURO/Bharat Stage Norms: I, II, III, IV, V And VI, Road Map for Implementation of Bharat Stage Norms In India.

#### Practice

- Identification of Different Sub-Systems of Automobile.
- Studies of Exhaust Gas Recirculation System (EGR) in KNOW Vehicle.

#### Module II

**5 (hrs)**

**Ignition System:** Effect of Spark Timing on Emission and Ignition Timing Controls, Drawbacks of Conventional Ignition Systems, Electronic Ignition Systems (TCI And CDI), Engine Cylinder Numbering Scheme and Firing Order of Multi Cylinder Engines.

#### Practice

- Study of Battery Ignition and Magneto Ignition System.
- Disassembly and Assembly of 6-Cylinder Diesel Engine

#### Module III

**8 (hrs)**

**Transmission System:** Power Transmission in Automobile (Front Wheel Drive, Rear Wheel Drive, Four-Wheel Drive, All-Wheel Drive).

**Clutch System:** Key Design Considerations of Clutches, Types of Clutches, Construction and Working Principle of Single Plate Friction Clutch, Diaphragm Clutch, Cone Clutch, Centrifugal Clutch.

**Gear Box:** Purpose of Gear Box, Types of Automobile Gear Boxes, Construction and Working Principle of Sliding Mesh, Constant Mesh, Synchronizer Mechanism and Synchromesh Gear Boxes, Planetary Gear Mechanism, Fluid Coupling and Torque Convertor, Construction and Working Principle of Automatic Transmission, Construction and Working Principle of Continuously Variable Transmission (CVT) and Automated Manual Transmission (AMT).

#### Practice

- Study of Single Plate Friction Clutches (Coil Spring Type And Diaphragm Type).
- Study of Synchronizer Mechanism And Synchromesh Gear Box, Continuously Variable Transmission (CVT).

## Module IV

12 (hrs)

**Propeller Shaft and Differential:** Function and Need of Propeller Shaft, Hotchkiss Drive and Torque Tube Drive, Construction of Propeller Shaft, Universal/Hooke's Joints, Slip Joint, Constructional Features and Working Principle of Differential Mechanism, Types of Differentials (Locking Type Differential, Limited Slip Differential).

**Axles:** Types of Automotive Axles, Constructional Features, Types and Working Principle of Front Axles, Lift Axles, Rear Axle, Third Differential in Tandem Axle Vehicles, Construction and Working Principle of Manual Transaxles and Transfer Cases.

### Practice

- Study of Propeller Shaft, Universal Joints, Slip Joints, Centre Bearing.
- Study of Front Axle System.
- Study of Rear Axle System Including Differential Mechanism.
- Disassembly and Assembly of Manual Transaxle of Front Wheel Drive Car.

## Module V

10 (hrs)

**Steering System:** Purpose of Steering System, Components of Steering System, Steering Geometry (Castor, Camber, Toe-In, Toe-Out, King Pin Inclination), Types of Steering Gear Boxes and their Construction and Working Principles, Hydraulic and Electrically Power Assisted Steering Systems.

**Braking System:** Requirement and Key Design Parameters of Braking System, Classification and Types of Braking Systems, Mechanical Brake, Hydraulic Brake, Air Brake, Vacuum Brake, Disc Brake. Construction, Working Principle and Components of Anti-Lock Braking System (ABS)

### Practice

- Study of Steering Gear Box And Hydraulic Power Assisted Steering System.
- Identifying the Different Components and Working Of Drum Brake, Disc Brake, Hydraulic Brake, Air Brake System.
- Study of Anti-Lock Braking System (ABS) In KNOW Vehicle.

## Module VI

6 (hrs)

**Auto Electric System:** Wiring Diagram of Horn Circuit, Lighting Circuit, Cut-Out Circuit, Voltage and Current Regulator Circuit in Commutator Type Generator, Combined Three-Unit Regulator Circuit, Voltage and Current Regulator in Alternating Current Type Generator And Flasher Circuit (Sketch And Description), Common Ignition Troubles And Its Remedies, Basic Electronic Ignition Trouble Shooting Charts, Spark Plugs: Purpose, Construction and Specifications.

## Module VII

8 (hrs)

**Suspension System:** Purpose and Classification of Suspension Systems, Sprung and Unsprung Mass, Major Components of Suspension System, Description of the Conventional Suspension Systems for Rear and Front Axle. Panhard Rod, Macpherson Strut, Double Wishbone Suspensions. Description of Independent Suspension System Used In Cars (Coil Spring And Torsion Bars), Constructional Features and Working of Air Suspension System, Anti-Roll Bars, Constructional Features, Types and Working of Telescopic Shock Absorber.

### Practice

- Identification of Different Types of Suspension Systems: Coil Spring, Tension and Telescopic Suspension System.

### Text Books

1. Gupta R. B., Automobile Engineering, Satya Prakashan New Delhi
2. Giri N. K., Automobile Technology, Khanna Publishers

### References

1. Crouse William H and Donald Anglin, Automotive Mechanics, Tata Mcgraw Hill Publications.
2. Newton K., Steeds W, and Garrett T K, The Motor Vehicle, Butterworth Heinemann

## Electric Vehicles

Course Title	Course Code	Type of Course	T-P-Pj	Pre-requisite
Electric Vehicles	CUAE2172	Theory+ Practice	2-1-0	Nil

### COURSE CONTENT

#### Module I

**5 (hrs)**

**Introduction to Electric Vehicles:** Electric Vehicles Advantages and Disadvantages, EV Market and Promotion, Main Components of Electric Vehicle and Its Functions (Electrical and Mechanical).

**Practice:**

- Study of Different Components of E-Rickshaw and Assembling Methods.
- Working of Circuits in Controllers with respect to Current and Voltage Rating.

#### Module II

**3 (hrs)**

**Electric Vehicle Drive Trains:** EV Transmission Configurations, Basic Architecture of Electric Drive Trains, Single and Multi-Motor Drives, In Wheel Drives.

#### Module III

**6 (hrs)**

**Energy Sources:** Working Principle of Battery, Types of Batteries, Lead-Acid Battery, Nickel-Cadmium Battery, Nickel-Metal-Hydride (Nimh) Battery, Lithium Batteries, Battery Parameters, Fuel Cells,

**Practice:**

- Maintenance of Lead Acid Batteries.
- Wiring & Harnessing of Battery Circuit.

#### Module IV

**8 (hrs)**

**Electric Motors:** Classification of Electric Motors, DC Motor, Types of DC Motors, Brushless DC Motor, AC Motor, Types of AC Motors, Induction Motor, Synchronous Motor, Regenerative Braking.

**Practice:**

- Study of Different Parts of D.C. Motor and Make Connection.
- Performance Characteristics of a Shunt and Series DC Motor
- Load Test on Three Phase Induction Motor.
- Speed Control of DC Shunt Motor by Armature and Field Control.

## Module V

5 (hrs)

**Electric Vehicle Maintenance & Safety:** Maintenance & Trouble Shooting of Different Components of EV, High Voltage Electrical Safety, Tool and Equipment Usage, High Voltage Safety Rules, Electrical Isolation.

### Practice:

- Maintenance of BLDC Motor.
- Maintenance of Hub Motor.

## Module VI

3 (hrs)

**Design Concept of Electric Vehicle:** Power and Torque Calculation of Electric Vehicles, Sizing of Components, Initial Acceleration, Maximum Velocity, Maximum Gradability.

## Module VII

3 (hrs)

**Hybrid Electric Vehicles:** Types of Hybrids, Series and Parallel HEVs, Advantages and Disadvantages, Series-Parallel Combination, Hybrid Drivetrains, Sizing of Component

### Text Books

1. Hussein Iqbal, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press
2. Chau K. T., Electric Vehicle Machines and Drives: Design, Analysis and Application, Wiley.

### References

1. Chan C.C. and Chau K.T., Modern Electric Vehicle Technology, London: Oxford University.

## Maintenance of Automobile (2 Wheeler & 4 Wheeler)

Course Title	Course Code	Type of Course	T-P-Pj	Pre-Requisite
Maintenance of Automobile (2 Wheeler & 4 Wheeler)	CUAE2176	Practice	0-5-0	Nil

### Practice

- Safety Precautions in Automobile Maintenance.
- Identification and Functions of Various Tools and Equipments used in Automobile Workshop.
- Disassembling and Assembling of Engine of a Four Wheeler.
- Disassembling and Assembling of Engine of a Two Wheeler.
- Engine Troubleshooting.
- Nomenclature of a Spark Plug and Spark Plug Reading, Testing and Cleaning of Spark Plug.
- Checking and Replenishing Lubricating Oil, Engine Coolant, Power Steering Hydraulic Oil and Wind Screen Wiper Water.
- Overhauling and Servicing of Fuel System including Air Filter.
- Disassembling and Assembling Of Clutch, Clutch Troubles And Remedies.
- Repairing and Adjustment of Brake System.
- Disassembling and Assembling of Propeller Shaft.
- Inspection and Servicing of Gear Box.
- Inspection and Servicing Of CVT.
- Tire Change Operation, Wheel Balancing, Wheel Alignment, Tire Inspection (Tubeless & Tube) and Inflation.
- Overhauling of Suspension System.
- Disassembling and Assembling of Steering System and Adjustment of Drag Link.
- Preparation of Electrical Circuits using Switches and Fuses.
- Checking of Battery Terminal Voltage, Electrolyte Level and Specific Gravity.
- Inspection of Different Electrical Circuits and ECU.
- Checking of Ignition System Circuit & Components.

### Reference Book:

1. Training Manual of Four Wheeler Maintenance (Ashok Leyland)
2. Training Manual of Two Wheeler Maintenance (Yamaha).

**DOMAIN TITLE: Manufacturing (Conventional, CNC and Additive)  
CMCU2150**

Sl. No.	Course Code	Course Title	Course Type	T-P-Pj	Credits
1	CUCM2150	Manufacturing Requirements and Planning (Jigs & Fixtures; Process Planning & Cost Estimation)	Theory	2-0-0	2
2	CUCM2151	Conventional Machining for Cylindrical and Prismatic Shape Components	Practice+ Project	0-4-2	6
3	CUCM2152	CNC Machining (0-6-2)	Practice+ Project	0-6-2	8
4	CUCM2153	Non-Traditional Machining and 3D Printing 0-2-2	Practice+ Project	0-2-2	4
5	CUCM2154	Wood Engineering (0-2-0)	Practice	0-2-0	2
6	CUCM2155	Internship	Project	0-0-4	4
<b>Total</b>					<b>26</b>

**Domain Track Objectives:**

- To provide in-depth technical training & knowledge of machining technologies and machinery which would strengthen product development and industrial-institutional partnership.
- To know the different CNC codes.
- To learn advance manufacturing processes.

**Domain Track Course Outcomes:**

**After completion of the domain, students will be able:**

- CO1: Understand different machining effectively & efficiently.
- CO2: Identify and solve problems in product machining.
- CO3: Use of advanced CAD & CAM software
- CO4: Research in advancement in machining
- CO5: Create a new product using advance manufacturing processes.

### Course Outcome to Program Outcome Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	
CO1	3				3	1	1	2					1	2		1
CO2	2			2	2	2		1	1					2		1
CO3	2			2	3	2				2				3		3
CO4	1			2	3	2					3			3		3
CO5	1			2	3	1		2						2		1

\*High-3, Medium-2, Low-1

### Manufacturing Requirements and Planning (Jigs & Fixtures; Process Planning & Cost Estimation) 30 Hrs

Course Code	Course Title	Type of Course	T-P-Pj	Pre-Requisite
CUCM2150	Manufacturing Requirements and Planning (Jigs & Fixtures; Process Planning & Cost Estimation)	Theory	2-0-0	Nil

#### COURSE CONTENT (30 HRS)

##### Module I Introduction to Jigs & Fixtures (2 Hrs)

###### Theory

Fundamental Concept and Need of Jigs and Fixtures; Jigs and Fixtures design principles and factors; Materials used in jigs & Fixtures.

##### Module II Locators (3 Hrs)

###### Theory

General Principles of Degrees of Freedom and Constraints; Foolproofing; Basic rules for location; Locating methods, Types of locators.

##### Module III Clamps & Indexing Devices (3 Hrs)

###### Theory

Principles of clamping, Types of clamps, Liner indexing, precision linear indexing and rotary indexing

##### Module IV Various Jigs & Fixtures (3 Hrs)

## **Theory**

Components of Jigs, Types of Jigs, Selection of Jigs

## **Module V Types of Fixtures (3 Hrs)**

### **Theory**

Salient features of milling fixtures, Classification of milling fixtures, Facing fixtures, Slotting Fixtures. Turning (Standard chucks, Spring collets, Cylindrical liners, Mandrels, Turning Fixtures), Grinding, broaching, welding and modular fixtures

## **Module VI Process Planning: Introduction (3 Hrs)**

### **Theory**

Objectives and Approaches to Process Planning; Process Planning Activities; Process Planning & Production Planning; Operating Sequences, Setup Documents for Process Planning.

## **Module VI Introduction to Cost Estimation (3 Hrs)**

### **Theory**

Objectives of Cost Estimation; Components of a Cost Estimate; Cost Estimation Procedure; Classification of Costing; Elements of Cost; Expenses; Cost accounting, Types of Cost Estimates; Methods of Cost Estimates; Data Requirements and Sources of information; Allowances in Estimation (of Standard Time)

### **Text Books**

1. Joshi, P H, Jigs & Fixtures, 2010, 3<sup>rd</sup> Edition, McGraw Hill.
2. Nagpal, G R, Tool Engineering & Design, 2000, Khanna Publishers.

### **Reference Books**

1. Venkataraman, K, Design of Jigs, Fixtures & Press Tools, 2015, Wiley & Sons
2. Mehta, N K, Metal Cutting and Design of Cutting Tools, Jigs & Fixtures, 2015, McGraw Hill

## Conventional Machining for Cylindrical and Prismatic Shape Components (75 Hrs)

Course Title	Course Code	Type of course	T-P-Pr	Pre-Requisite
Conventional Machining for Cylindrical and Prismatic Shape Components	CUCM2151	Practice+ Project	0-4-2	

### COURSE CONTENT

#### Course Outline

1. Cylindrical Turning Operations ( Both Internal and External), Knurling, Thread Cutting, Stepped Turning)
2. Kinematic Study of Centre Lathe
3. Hole Making Operation in Turret Lathe
4. Work Holding and Tool Holding Devices For Turning Operations
5. Kinematic Study of Pillar Drilling Machine, Radial Drilling Machine and Boring Machine
6. Counter Boring , Counter Sinking and Threading Operations
7. Finishing Operations
8. Kinematic Study of Shaping Machines and Planning Machine
9. Work Holding and Tool Holding Devices Used for Shapers, Planers and Grinders
10. Machining Operations Using Flat Grooves, Flat and Bevel Surfaces, Dovetailed Surfaces
11. Kinematic Study of Horizontal Milling Machine, Vertical Milling Machine
12. Surface Grinding Machines
13. Work Holding and Tool Holding Devices Employed in Milling Machines
14. Flats, Grooves, Slots and Keyways Cutting Using Milling Machine
15. Gear Cutting Using Milling Machine
16. Process Planning of Prismatic Components, Logical sequencing of Operations
17. Estimation of Machining Operations Time and Cost

#### Text Books

1. Rajput, R K, A Text Book of Manufacturing Technology, 2007, 1<sup>st</sup> Edition, Laxmi Publications.
2. Rao, P N, Manufacturing Technology, Volume 2, 2009, 2<sup>nd</sup> Edition, McGraw Hill.

#### Reference Books

1. Abdel, H, Fundamentals of Machining Processes: Conventional and Nonconventional Processes, 2008, CRC Press.
2. Sharma, P C, A Text Book of Production Technology: Manufacturing Processes, 2009, S Chand Publishers.

## CNC Machining (100 Hrs)

Course Title	Course Code	Type of Course	T-P-Pr	Pre-requisite
CNC Machining	CUCM2152	Practice+ Project	0-6-2	8

### COURSE OUTLINE

#### Module I Introduction to CNC (5 Hrs)

Numerical control, Functions of Machine Tool, Concept of numerical control, Feature of CNC, Machine control unit for CNC, Classification of CNC Machine Tool.

#### Module II CNC Fanuc Controller (20 Hrs)

CNC Fanuc Controller: Fanuc Control Panel, Modes of Control Panel, Hard Key, Soft Key, Chock, Hard Jaw, Soft Jaw, Job setting.

#### Module III Cutting Tools (10 Hrs)

Nomenclature of CNC Cutting Tools, Identification of Cutting Tools, Manual Cutting Operations, Offsetting and its Types.

#### Module IV Production Drawing (15 Hrs)

Concept of Projection, Understanding the Views, Orthographic view & Isometric View, Reading of Dimensional Tolerance and Geometrical Tolerance.

#### Module V NC Programming (35 Hrs)

Developing program for Facing, Turning, Taper Turning, Drilling, Boring and Threading by following Process Plan.

#### Module VI CNC Milling (5 Hrs)

Fundamentals of CNC Milling, Tool Magazine, ATC, Manual Part Programming for Pocketing.

#### Module VII 5-Axis Machining (10 Hrs)

Fundamentals of 5-Axis Machining and Turn-Mill Machining.

#### Text Books

1. Groover, M P, CAD/CAM Computer-Aided Design and Manufacturing, 2008, Pearson Education.
2. Radhakrishnan, P, CAD/CAM/CIM, 2018, New Age International.

#### Reference Books

1. Jain, R K, Production Technology, 2008, 17<sup>th</sup> Edition, Khanna Publishers.
2. Agarwal, P M, CNC Fundamentals & Programming, 2014, 2<sup>nd</sup> Edition, Charotar Publishers.

## Non-traditional Machining and 3D Printing (50 Hrs)

Course Title	Course Code	Type of Course	T-P-Pr	Pre-Requisite
Non-traditional Machining and 3D Printing	CUCM2153	Practice + Project	0-2-2	Nil

### COURSE OUTLINE

#### Module I Introduction (5 Hrs)

Need of Non -traditional Machining, Classification of NTM

#### Module II Electric Discharge Machining (20 Hrs)

Electric Discharge Machining Fundamentals, Machine Structure, Machine Control Panel, Machine Input and Output Parameters.

#### Module III EDM Process Parameters (5 Hrs)

Machining Parameters, Plotting of Output graphs, Machining of Brass and Bright Steel. Performance Characteristics, Dielectric Fluid.

#### Module IV Additive Manufacturing (10 Hrs)

Concept, Rapid Prototyping Process, Various Rapid Prototyping Technologies: SLA, LOM, SLS and FDM.

#### Module V 3D Printing (10 Hrs)

Fundamentals of 3D Printing, Machine structure and its Controller. Advantage, Disadvantage and its Applications, Performance Evaluation.

#### Text Books

1. Pandey, P C, Modern Machining Processes, 2008, McGraw Hill
2. Jain, V K, Advanced Machining Processes, 2010, Allied Publishers

#### Reference Books:

1. Abdel, H, Advanced Machining Processes: Nontraditional and Hybrid Machining Processes, 2005, McGraw Hill
2. Rao, P N, Manufacturing Technology, Volume 1, 2009, Tata McGraw Hill Publication.

### Wood Engineering (25 Hrs)

Course Name	Code	Type of course	T-P-P	Prerequisite
Wood Engineering	CUCM2154	Practice	0-2-0	Nil

#### COURSE OUTLINE

- 1.Introduction, Safety and serviceability, Measurements & Marking
- 2.Identification of Timber & Hand Tools
- 3.Maintenance & Sharpening of Tools, Fasteners Carpentry hand tools and their maintenance.
- 4.Wood joints and Structural assemblies
- 5.Advanced Tools in Tool Engineering (Basic working principles and Operations)
- 6.Product Development: Interior Designs, Furniture, Structures & construction.

#### Text Books

1. Williamson, T G, Wood Engineering and Construction Handbook, 2016, McGraw Hill.
2. Garg, S K, Comprehensive Workshop Technology (Manufacturing Processes), 2008, Laxmi Publications.

#### Reference

1. John, K C, Mechanical Workshop Practice, 2<sup>nd</sup> Edition, 2010, PHI Learning Pvt.Ltd.
2. Hasluck, P N, Working with Hand Tools: Essential Techniques for Woodworking, 2012, Skyhorse Publishing.

## DOMAIN TITLE: Welding and Inspection (WICU2160)

### Domain Track Objectives:

- To develop understanding and skill of students for Welding Technology
- Students pursuing this domain will be ready for industrial employment
- The students develop passion for higher education and research in Welding Engineering

### Domain Track Course Outcomes:

After completion of the domain, students will be able to:

- CO1: Recognize with certification of Welding from various national and international levels industry.
- CO2: Understand skills to become an entrepreneur with small scale to a medium scale welding units.
- CO3: Suggest and handle various weld joints based on Strength, Failure and Reliability
- CO4: Analyze welding strength of various joints
- CO5: Create new product using various welding processes.

### Course Outcome to Program Outcome Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3				1	1	1	2				1	1		3
CO2	3			1	1	2		1	1				2		1
CO3	2			2	3	2				2			3		2
CO4	1			2	1	2					3		3		2
CO5	3			2	1	1		2					2		1

\*High-3, Medium-2, Low-1

## Joining Processes & Technology

Course Title	Course Code	Type of Course	T-P-Pj	Pre-Requisite
Joining Processes and Technology	CUWI1260	Theory+Practice + Project	2-2-2	Nil

### COURSE CONTENT

#### Module-I (29 Hours)

**Welding classification**, advantages, disadvantages and applications of various welding processes, Gas Welding & Cutting: Oxy-acetylene welding, flux and filler, types of gas flames, Gas welding techniques, Arc welding: Physics of arc welding, SMAW Principle and equipment, types of electrodes, functions of coatings, TIG (GTAW), MIG (GMAW) & flux-cored arc welding, submerged arc welding, weld cladding & surfacing, plasma cutting and spraying, atomic hydrogen welding.

**Practice:**

1. Identification and working of gas welding equipment
2. Identification and working of gas cutting equipment
3. Identification and working of arc welding equipment
4. Identification and working of TIG welding equipment
5. Identification and working of MIG welding equipment

#### Module-II (28 Hours)

**Resistance Welding:** Spot and seam welding parameter, flash butt welding, friction welding, explosive welding, thermit welding of rails, electro-slag welding, electro-gas welding, stud welding, projection welding. Other Welding Methods like plasma arc, laser beam, electron beam, ultrasonic, explosive welding, under water welding, high frequency induction welding.

**Practice:**

1. Identification and working of spot welding machine parts

#### MODULE-III (26 Hours)

**Welding Power Source:** Electricity in welding, power source and equipment used for AC, DC welding, AWS classification and coding, Welding positions, types of joints, Residual stress, Identifying defects and remedial measures for welded joints.

**Practice:**

1. Identification and working of power source for welding equipment in AC and DC
2. Practice in different welding positions 3
3. Practice for producing different types of welded joint

**Text Books:**

1. Welding & Welding Technology by R.L.Little.1976. Tata McGraw Hill Education Privet Limited
2. Welding Technology by R. S. Parmar, 3 rd Edition, Reprint 2011, Khanna Publishers,
3. AWS Hand Book, Volume- 1, 2 and 3 , 9th Edition, American welding society

**Reference Books:**

1. Manufacturing Engineering and Technology by Serape. K. Kalpak Jain, Pearson Edition

### Metal Transfer and Weld Metallurgy

Course Title	Course Code	Type of Course	T-P-Pr	Pre-Requisite
Metal Transfer and Weld Metallurgy	CUWI1261	Theory+Practice + Project	2-2-0	Nil

#### COURSE CONTENT

**Module-I (27 Hours)**

**Metal transfer** - Metal transfer in AC and DC arc welding, metal transfer in TIG, MIG and MAG welding, Study of different modes of metal transfer in MIG welding (Practice), Welding defects due to improper metal transfer and improper filler material, Diffusion in Soldering and Brazing. 343

**Practice:**

1. Metal transfer in TIG welding

2. Different modes of Metal transfer in MIG welding
3. Welding defects in TIG welding
4. Welding defects in MIG welding

### **Module-II (28 Hours)**

**Weld Metallurgy** - Fe-C equilibrium diagram, Cooling curve, HAZ, Microstructure, Preheat & post heat treatment, Stress relieving and normalizing, Weld-ability: concept and significance, Percentage equivalence of carbon in weld-ability.

#### **Practice:**

1. Practice on stress relieving and normalising in welding
2. Experiments for demonstrating weld-ability

### **MODULE-III (26 Hours)**

**Weld ability of other metals** - Defects in welded joints- hot cracks and cold cracks, porosity, embrittlement, lamellar tearing, distortion etc. weld ability of low carbon steels, HCS. Weld ability of stainless steels, weld ability of titanium and alloys, weld-ability of high strength low alloy steels. Heat treatment of welded structures, shot pinning, stress relieving through vibration. Ultra-sonic welding for dissimilar metals

#### **Practice:**

1. Identification of general welding defects
2. Heat treatment of welded structures

#### **Text Books:**

Welding Technology by R. S. Parmar. 3 rd Edition, Reprint 2011, Khanna Publishers, 2. Welding Metallurgy by J.F. Lancaster, 6th Edition, WOODHEAD Publishing Limited

Reference Books: 1. Manufacturing Engineering and Technology, Serape. K. Kalpak Jain Pearson  
Edison

## Design of Welded Joints

Course Title	Course Code	Type of Course	T-P-Pr	Pre-Requisite
Design of Welded Joints	CUWI1262	Theory + Practice + Project	2-2-2	Nil

### COURSE CONTENT

#### Module-I (16 Hours)

**Design of weld joints** - Introduction to design; engineering properties of steels; Type of welds and weld joints; description of welds: terminology, definitions and weld symbols; sizing of welds in structure, welding symbols and definition.

#### Module-II (14 Hours)

**Weld Calculations** - Design for Static loading, Weld Calculations in lap, butt and fillet welds; design for fatigue loading, Introduction to Fatigue; nature of the fatigue process; fatigue strength; factors affecting fatigue life; improvement methods for fatigue strength; reliability analysis and safety factors applied to fatigue design.

##### Practice:

1. Design of lap joint
2. Design of butt joint

#### MODULE-III (21 Hours)

**Mechanisms of Failure** - Failure mechanisms in welded joints, How to design various kinds of welding joints. Design of a butt joint, the main failure mechanism of welded butt joint, tensile failure of weld, Design of transverse fillet joint, Shear mechanism in fillet weld, Design stresses of welds. Use of CATIA Weld Design Module 345

##### Practice:

1. Tensile testing of welded joints
2. Bend test of welded joints

##### Text Books:

1. Lecture Notes
2. ASME section IX, IBR Software Used: CATIA

## Testing of Welding Joints

Course Title	Course Code	Type of Course	T-P-Pr	Pre-Requisite
Testing of welding joints	CUWI1263	Theory+Practice + Project	2-2-2	Nil

### COURSE CONTENT

Weld Defects and NDT Welded Joints.

ASME Section IX

WPS and PQR

#### Practice:

#### Destructive Tests:

- Experiment 1 Tensile test using Standard Equipment.
- Experiment 2 Impact test using Standard Equipment
- Experiment 3 Bend test using Standard Equipment
- Experiment 4 Hardness test using Standard Equipment

#### Non Destructive Tests:

- Experiment 5 Visual Inspection
- Experiment 6. Liquid Penetrant Test
- Experiment 7 Magnetic Particle Inspection

#### Microstructure:

- Experiment 8 Analysis of Microstructure by Image Analyzer
- Experiment 9 Analysis of Microstructure by SEM

**DOMAIN TITLE: Computational Fluid Dynamics (CFCU2180)**

Sl. No.	Course Code	Course Title	Course Type	T-P-Pj	Credits
1	CUCF2180	Introduction to CFD	Theory +Project	2+0+1	3
2	CUCF2181	Grid Generation	Practice	0+2+0	2
3	CUCF2182	Flow Solver Techniques-Simulia	Practice +Project	0+3+1	4
4	CUCF2183	Simulation and Validation	Practice	0+5+0	5
5	CUCF2184	Industry Specific Project and/or Internship		0+0+6	6
<b>Total</b>					<b>20</b>

**Domain Track Objectives:**

- To familiarise the students with different industrial fluid flow systems
- To educate fundamental skills utilized in various flow systems through the usage of CFD software platforms.
- To be familiar with the numerical elements and their implementation in many emerging Computational methods such as automobiles, aerospace, manufacturing, etc

**Domain Track Course Outcomes:**

After completion of the domain, students will be able to:

- CO1: Remember different fluid properties.
- CO2: Understand computer programs for solving elementary fluid dynamics/ heat transfer problems.
- CO3: Execute industry projects to produce Quality products for Clients.
- CO4: Generate competency in Numerical solution of problems in fluid dynamics.
- CO5: Create fluid flow simulation in various industrial applications.

**Course Outcome to Program Outcome Mapping:**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3		1	1	1	2						1		1	
CO2	3	1	1	2		1	1							2	
CO3	2	2	3	2				2						3	

CO4	1	2	1	2					3					3	
CO5	3	2	1	1		2								2	

**\*High-3, Medium-2, Low-1**

### Introduction to CFD

Course Title	Course Code	Type of Course	T-P-Pj	Pre-Requisite
Introduction to CFD	CUCF2180	Theory +Project	2+0+1	Nil

#### 1. Introduction to CFD (2-0-1)

##### Module-1

Fluid, Properties of Fluid (Temperature, Vapour Pressure, Viscosity, Specific Gravity, Compressibility, Speed of Sound, Density, Energy, Specific Heat, Newtonian and Non-Newtonian Fluids

##### Module-2

Lagrangian and Eulerian Approaches, Classification of Fluid Flow (Inviscid vs. Viscous, Laminar vs. Turbulent, Incompressible vs. Compressible, Internal vs. External, Steady vs. Unsteady, Rotational vs. Irrotational, 1D, 2D and 3D Flows)

**Project 1.** Case studies in industrial pipe flows.

##### Module-3

Governing Equations of Flow Field (Conservation of Mass, Momentum (Navier-Stoke Equation) and Energy)- Differential Form, Integral Form.

**Project 2.** Case studies and generation of drag and lift for flow over bodies.

##### Module-4

Flow Features (Stagnation, Boundary Layer (Laminar to Transition to Turbulent), Flow Separation), Types of Boundary Conditions.

**Project 3.** Case studies in different types of aerofoil and its applications.

### **Module-5**

Heat Transfer in Fluid (Conduction, Convection (Natural, Forced), Radiation), Non-dimensional Quantities, Flow Similarity between Prototype and Model.

**Project 4.** Case studies for various non-dimensional quantities and its importance in CFD.

### **Module-6**

CFD and its applications, Discretization methods for the CFD (FDM, FVM, FEM, Hybrid Methods).

**Project 5.** Case studies for the various applications of CFD and its significance.

### **Module-7**

Turbulence Modelling, CFD Solution Tool Chain

**Project 6.** Case studies for the different turbulence modelling in CFD.

### **Text Book:**

1. An Introduction to Computational Fluid Dynamics, by H.K.Versteeg & W.Malalasekera, Longman Scientific & Technical, England

## Grid Generation

Course Title	Course Code	Type of course	T-P-Pr	Pre-Requisite
Grid Generation	CUCF2181	Practice	0+2+0	Nil

2.1 Introduction to Meshes- CFD Meshing Basics

2.2 Different Element Shapes- Creating, Managing & Updating Meshes

2.3 CFD Meshing- 2D Mesh, 3D Mesh, Mapped Face Meshing,

**Practice 1.** 2D mapped Mesh for rectangular pipe

**Practice2.** 2D mapped Meshing for Aerofoil.

2.4 Structured Meshing, Un-Structured Mesh, Sweep 3D Mesh

**Practice 3.** 3D structure mesh of Circular Cylinder

**Practice 4.** 3D unstructured mesh with prim layers for Aerofoil

**Practice 5.** 3D coarse/ medium/ fine sweep mesh for pipe

**Practice 6.** 3D coarse/ medium/ fine unstructured Octree Tetrahedron mesh for Aerofoil.

**Practice 7.** 3D hex- dominant mesh for rectangular Duct.

2.5 Visualization the Mesh- Visualization Management, Mesh Visualization Options, Section, Clipping Box, Mesh colour, Element shrink

2.6 Reviewing the Mesh- Quality Analysis, free Edges, Interfaces, Duplicate Checker, Isolate Node Checker

**Practice 8.** 3D hex-dominant with surface mesh, Boundary prim mesh for DS car.

**Practice 9.** 3D Tetrahedron filler mesh Narrowing pipe.

**Practice 10.** 3D Tetrahedron, surface, for Electronics Module.

**Practice 11.** 3D Sweep mesh for circular cylinder.

**Practice 12.** 3D mesh generation for Subsonic Converging-diverging Nozzel.

**Practice 13.** 3D Sweep mesh generation for U-Bend pipe.

**Practice 14.** 3D mesh generation of Dimple Ball.

**Practice 15.** 3D mesh generation of a wedge body.

### Text Book:

1. HandBook of Grid Generation, by J.F.Thompson, B.K.Soni & N.P.Weatherill, CRC Press, New York.

## Flow Solver Techniques-Simulia

Course Title	Course Code	Type of Course	T-P-Pr	Pre-requisite
Flow Solver Techniques-Simulia	CUCF2182	Practice +Project	0+3+1	Nil

### 3.1 Overview-Fluid Dynamics Engineer Essentials

- Connecting to the platform, Assigning roles and Apps, Platform Interface, Importing 3D XML file, Simulation Conventions in the 3DEXperience Platform

**Practice 1.** Getting Started with the 3DEXperience Platform.

### 3.2 Import an assembly

- Explore the imported assembly, Renamed the assembly, Search for parts/assemblies in the database, open parts/ assemblies found through search, duplicate, delete and save entities, Import a 3D XML file containing fluid materials, Create and save a new material.

### 3.3 Fluid Dynamics Engineer Role Overview

- Exploring Fluid Dynamics Engineer Role Apps, CFD simulations work flow, Model preparations, Material definitions, Meshing, CFD analysis, Analysis convergence, co-simulation Analysis, Post processing results, CFD solver validations.

**Practice 2.** CFD analysis of steady state internal Laminar Pipe flow.

**Project 1.** Analysis of pipe flow at  $Re= 500$ .

### 3.4 Getting Started with CFD Simulations

- Fluid Model Creation, Fluid Scenario Creation App Interface, Model setup, applying meshing, Scenario Setup, Results visualizations, Reviewing Simulation Features,

**Practice 3.** CFD analysis Steady-state external flow over an Airfoil.

**Project 2.** Analysis of 2D cylinder in a rectangular domain with varying radius and height.

### 3.5 Geometry for CFD Simulations

- Geometry Preparation- Check and Repair, Defeature Idealize, Create, Healing, Join, Local Join, surface connection Checker, Face checker, Mid surface

**Practice 4.** Modeling of Air intake system.

**Practice 5.** Extracting Fluid volume for Engine Manifold.

### 3.6 Material and Section Properties of Fluid

- Understanding materials, working with materials, Creating a new Material, Applying a Material, Adding New Domains, Editing a Material Domain, Simulation Domain, Material Behaviors in a Simulation Domain, Section Properties, working with Imported Meshes

### 3.7 Defining Physics of Fluid

- Analysis Procedures- Enabling Temperature, Compressible, Coupled vs Segregated solver, Gravity effects.
- Turbulence Modelling- SST k-w, Realizable k-e, Spalart-Almaras, Radiation Modeling, Steady-state Analysis, Transient Analysis- Courant-Freidrichs-Levy (CFL) condition, Grid Independence Study, Bad cell Treatment

**Practice 6.** Grid Independence study for above cases (pipe / airfoil) using different solver schemes.

**Project 3.** Analysis of flow an over a circular cylinder at  $Re=10^7$ .

**Practice 7.** Conjugate Heat Transfer (CHT) Analysis of an Electronics Module.

**Project 4.** Analysis of temperature rise through cross flow heat exchanger.

### 3.8 Boundary and Initial Conditions

- Boundary Conditions, wall boundary conditions, Thermal wall boundary, Initial Conditions, Initializing Compressible flows, Turbulence Specifications at Boundaries, Surface- to – surface Radiation specification at Boundaries, Time- dependent Boundary Conditions, Spatially-Varying Boundary conditions, User defined Boundary conditions.

### 3.9 Turbulence Modeling & Modeling Techniques.

**Practice 8.** Aerodynamics analysis of DS car.

**Practice 9.** Unsteady Flow across a Circular Cylinder.

**Practice 10.** Transonic Flow over an Airfoil.

**Project 5.** Analysis and estimation of Drag lift coefficients flat plate at  $Re=10,000$ .

### 3.10 Solution Convergence

**Practice 11.** Cavitating Flow through a Narrowing Pipe.

**Project 6.** Analysis of compressible flow nozzle with atmospheric pressure at the nozzle exit.

### 3.11 Post-processing Results.

**Practice 12.** Creating Post processing reports for all the above cases.

### Simulation and Validation

Course Title	Course Code	Type of Course	T-P-Pr	Pre-Requisite
Simulation and Validation	CUCF2183	Practice	0+5+0	Nil

#### Practice

- 4.1 Fluid flow in the rear duct of an automotive HVAC system.
- 4.2 CFD Analysis of an Air intake system.
- 4.3 CFD Steady-state External flow over a Drone in cruise.
- 4.4 DE featuring of a Lens Component.
- 4.5 CFD analysis for Conjugate Heat Transfer in a fan –cooled CPU Board.
- 4.6 CFD analysis Energy computations in a Contact Analysis.
- 4.7 Thermo-mechanical Analysis of a Laser Powder Bed Fusion Build.
- 4.8 CFD analysis in Turbulent pipe flow.
- 4.9 CFD Supersonic flow analysis for 3D cone.
- 4.10 CFD analysis over a Ahmed body.

**DOMAIN TITLE: Composite Design and Manufacturing**

Sl. No.	Course Code	Course Title	Course Type	T-P-Pj	Credits
1	CUCD2130	Introduction to Composite	Theory	2-0-0	2
2	CUCD2131	Biovia - Composite materials and characterization techniques	Practice	0-2-0	2
3	CUCD2132	Catia-Composite design	Practice	0-4-0	4
4	CUCD2133	Composite product validation Simulia Abaqus FEA	Practice	0-4-0	4
5	CUCD2134	Machineries and technologies used for manufacturing of composite	Theory	2-0-0	2
6	CUCD2135	Quality control and fabrication of composite structure	Theory + Practice	2-2-0	4
7	CUCD2136	Project	Practice	0-0-6	6
Total					24

**Domain Track Objectives:**

- To learn the type of composite material and different technique to fabricate
- To design of a composite part and simulate the design.
- To test the composite part and validate the materials with quality check.

**Domain Track Course Outcomes:**

**After completion of the domain, students will be able:**

- CO1: Remember names of different composites
- CO2: Understand the manufacturing concept of composites.
- CO3: Identify and solve problems in composite manufacturing
- CO4: Analyze strength of different composites.
- CO5: Create a new composite product.

**Course Outcome to Program Outcome Mapping:**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3				3	1	1	2				1	2		1
CO2	2			2	2	2		1	1				2		1



CO3	2			2	3	2				2			3		3
CO4	1			2	3	2					3		3		3
CO5	1			2	3	1			2				2		1

**\*High-3, Medium-2, Low-1**

### Introduction to composites

Code	Course Title	T-P-Pj (Credit)	Prerequisite
CUCD2130	Introduction to composites	3-0-1	

#### Module –I (7 Hours)

Introduction to polymer, Introduction to composite, Classification: Particulate composite, Classification: Fiber reinforced composite, Polymer matrix composites, Metal matrix composites, Ceramic matrix composites, Nature-made composites,  
Applications: Fiber glass Applications: Fiber glass Applications: Silica Applications: Kevlor, Carbon Applications: Boron, Silicon Carbide

#### Module-II (6Hours)

Constituent materials for composite, Basic structural application of Composite, Advanced structural application of Composite,

#### Module-III(6Hours)

Multifunctional Applications of Composites, Fabrication Processes, Elements of Mechanical Behavior of Composites, Review of Basic Mechanics of Materials Equations

#### Book Suggested:

1. Composite material and structure, By PK Sinha, Wiley Publications
2. Introduction to composite Ever J. Barbero, Wiley Publications

### Biovia - Composite materials and characterization techniques

Code	Course Title	T-P-Pj (Credit)	Prerequisite
CUCD2131	Biovia - Composite materials and characterization techniques	0-2-0	Nil

#### Module –I (25 Hours) Practice

Polymer menu

Build menu using new molecule Blends menu Synthia menu

Polymer-polymer composite

Nanoparticle-polymer composite

Inorganic composite

SEM analysis

FTIR analysis

XPS analysis

Gaussian menu

Reflex menu

## CATIA-Composites Design

Code	Course Title	T-P-Pj (Credit)	Prerequisite
CUCD2132	CATIA-Composites Design	0-4-0	Nil

### Module –I (35 Hours) Practice

Composite Part Design topics: Preliminary design, Manual Ply Creation, Zone Design, ply Management, Mirroring, Creating IML's & Solids, Analyzing Drop Off and Slicing, composite Grid Design, Grid Panel Definition, Grid Definition,  
 Composite Grid Design, Grid Panel Definition, Grid Definition, Virtual Stacking Management, Plies Generation, Grid Ramp Support Definition, Remove Useless Ramp Supports, Swap Edge, Reroute Ply Contour, define Local Drop Off, Create Standard Contour, Define No Drop Off Area, Synchronize Stacking, Limit Plies from Panel Limits,  
 Creating a Manufacturing Document, Synchronizing, Skin Swapping, Defining the Edge of Part, Material Excess, Producibility Flattening, Flatten Optimization, Geometry Transfer, Producibility Inspection, Fibre Direction, Unfold Entity, Splicing and Splice Zones,  
 Darting, Exporting, Exporting Ply Data as IGES or DXF, XML Export, Drafting Standards, Creating a Ply Book, Adding Material to Plies, Stagger Origin Points, Grid Angle Cut.

### Composite Product Validation; Simulia(Abaqus FEA)

Code	Course Title	T-P-Pj (Credit)	Prerequisite
CUCD2133	Composite Product Validation; Simulia(Abaqus FEA)	0-4-0	

### Module –I (7 Hours)Practice

Defining a Problem

Defining anisotropic elasticity with Hookean models for combining the fiber-matrix response

Defining composite layups using Abacus/CAE

Defining discrete or layered reinforcing within an element using rebar

Membrane elements and truss elements

Achieving the correct material orientation of the layers of composite shells

Modeling sandwich composite structures

Modelling stiffened composite panels

Define No Drop Off Area, Synchronize Stacking, Limit Plies from Panel Limits

Modeling progressive damage and failure in composites

Modeling delamination of composite structures

Modelling low cycle fatigue of composite structures

### Machineries and Technologies used for Manufacturing of Composites

Code	Course Title	T-P-Pj (Credit)	Prerequisite
CUCD2134	Machineries and Technologies used for Manufacturing of Composites	2-0-0	

#### Module –I (7 Hours)

Introduction

Basics of Laminates, which have layers bonded together

Sandwiches

Open Mold Processes-

Hand layup process

#### Module –II (7 Hours)

Spray Bag, Vacuum Bagging

Automated tape laying machine,

Pressure bag molding

Closed Mold Processes

Filament Winding

Pultrusion Processes

#### Module –III (7 Hours)

PMC Shaping Processes.

Application of Pultrusion Process

Comparison between open and closed mold process

#### Book Suggested:

1. Machining Composites Materials, JP Davi, Wiley Publication
2. Mechanics of Composite Materials, Autar K. Kaw, Taylor and Francis

## Quality control and Fabrication of Composite Structure

Code	Course Title	T-P-Pj (Credit)	Prerequisite
CUCD2135	Quality control and Fabrication of Composite Structure	2-2-0	Nil

### Module –I (7 Hours)

Define minimum standards for aerospace grade fiber, resin, fabric/braid  
 Define minimum standards for aerospace prepare – Material qualification, material specification, process control document  
 Factors affecting Quality of Composites made by hand lay-up

### Module –II (7 Hours)

Factors affecting fabrication factors, stacking sequence, fiber volume fraction, cure  
 Material selection criteria for new generation aircraft  
 Structural Requirements for Certification,  
 Material Qualification Procedures, Material Property Development  
 Material Screening and Selection,  
 Material and Process Specification Development

### Module –III (7 Hours)

Material and Process Control, QCs for Composite Part Manufacturing, Material Acceptance  
 Mechanical test of laminates and sandwiches  
 Test for adhesives and sealants  
 Chemical and physical tests for material composition  
 Thermal analysis for composite materials

### Module –IV (7 Hours)

Aging tests by chemical aging  
 Thermal and humidity aging  
 Radiation aging test  
 Reappear test, fire and smoke test  
 Non-destructive test, Ultrasonic Phased Array test, 2D X-Ray test on field

### Practice

- Fabrication using Natural Fibre
- Fabrication using glass fiber
- Fabrication using carbon fiber
- Fabrication processes for polymer matrix composites (PMC)
- Matched Die mold
- Contact Mould, Filament Winding
- Pultrusion
- Fabrication processes for metal matrix composites (MMC)

- Diffusion Bonding, Powder Metallurgy Process, Casting
- Fabrication processes for ceramic matrix composites (CMC)
- Hot Press Sintering, Liquid Infiltration
- Sintering, Chemical Vapour Deposition Process

**Suggested Book:**

1. Composite Materials and Structural Analysis, NGR Iyengar, My learning publication
2. Composite Structures: Effects of Defects, Rani Elhajjar, Wiley Publication

## Signals and Systems (Total Hours: 33)

Subject	Code	Type of course	TH-PRA- PROJ	Prerequisite
<i>Signals and Systems</i>	<i>CUTM4341</i>	<i>Theory + Practice</i>	<i>3-1-0</i>	<i>Nil</i>

### Course Objective:

*The objectives of this subject are to*

- Introduce the student to the idea of signals, system analysis and its characterization.
- Provide a foundation to numerous other courses that deal with signal and system concepts directly or indirectly: viz: communication, control, instrumentation etc.

### Course Outcome:

Upon successful completion of this subject, students should be able to:

- Understand about various types of signals, classify them, analyze them, and perform various operations on them.
- Understand about various types of systems, classify them, analyze them and understand their response behavior.
- Appreciate use of transforms in analysis of signals and system.
- Carry simulation on signals and systems for observing effects of applying various properties and operations.
- Create strong foundation of communication and signal processing to be studied in the subsequent semester

### Course Outcome to Program Outcome Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												2	2	2
CO2		3											3	2	2
CO3			2		2								3	2	2
CO4	3												2	2	2
CO5	3												3	2	2

## SYLLABUS

### MODULE – I (4 Hours)

#### Continuous-Time Signals and Systems:

Continuous and discrete time signals: Some Elementary Continuous-time and Discrete-Time signals. Classification of Signals – Periodic and a periodic even – odd – energy and power signals – Deterministic and random signals – Causal and non causal signals and anti causal signals -- complex exponential and sinusoidal signals ---Simple Manipulations of Continuous and discrete time signals

### MODULE – II (5 Hours)

#### Continuous-Time Systems:

Continuous-Time Systems: Mathematical equation governing LTI Continuous-Time systems, Block diagram and signal flow graph representation, response of LTI Continuous-Time system in time domain, classification of Continuous-Time systems, convolution of Continuous-Time signals.

### MODULE – III (5 Hours)

**Discrete-Time Signals and Systems:** Input-Output Description, Block Diagram Representation, Classification, Interconnection; Analysis of Discrete-Time LTI Systems: Techniques, Response of LTI Systems, Properties of Convolution, Causal LTI Systems, Stability of LTI Systems; Discrete-Time Systems Described by Difference Equations; Implementation of Discrete-Time Systems; Correlation of Discrete-Time Signals: Cross correlation and Autocorrelation Sequences, Properties.

#### **MODULE – IV (4 HOURS)**

##### **The Continuous-Time Fourier Series and Fourier Transform:**

Basic Concepts and Development of the Fourier series, Calculation of the Fourier Series, Properties of the Fourier Series.

##### **The Continuous-Time Fourier Transform:**

Basic Concepts and Development of the Fourier Transform, Properties of the Continuous-Time Fourier Transform. Discrete-time Fourier series

#### **MODULE – V (6 Hours)**

**Discrete time Fourier transform (DTFT) :**The discrete time Fourier transform of Aperiodic signal, Convergence of Fourier transform, the Fourier transform of signal with poles on unit circle, frequency domain and time domain signal properties, properties of DTFT.

#### **MODULE- VI (4 Hours)**

##### **The Laplace transforms and its application to system analysis:**

The Laplace Transform: Laplace Transform as a generalization of FT, Region of convergence, properties of Laplace transform, poles and zeros of rational functions of  $s$ , Inverse Laplace transform by partial fraction method and convolution method, Analysis of LTI Continuous-Time system, stability in  $s$ -domain,

#### **MODULE- VII (5 Hours)**

##### **The Z-Transform and Its Application to the Analysis of LTI Systems:**

The Z-Transform: The Direct Z-Transform, The Inverse Z-Transform; Properties of the Z-Transform; Rational Z-Transforms: Poles and Zeros, Pole Location and Time-Domain Behavior for

Causal Signals, The System Function of a Linear Time-Invariant System; Inversion of the Z-Transforms: The Inversion of the Z-Transform by Power Series Expansion, The Inversion of the Z-Transform by Partial-Fraction Expansion; The One-sided Z-Transform: Definition and Properties, Solution of Difference Equations.

**Text Books:**

1. Signals and Systems--- Alan V. oppenheim and Alan S. Willsky, PHI
2. Signals and Systems – A Nagoor Kani, TMH

**Reference Book:**

1. Digital Signal Processing – Principles, Algorithms and Applications by J. G. Proakis and D. G. Manolakis, 4th Edition, Pearson.
2. Fundamentals of Signals and Systems - M. J. Roberts, TMH
3. Signals and Systems - P. R. Rao, TMH.

**Web resources:**

1. Signals and Systems by Prof. T.K.Basu, IIT Kharagpur,  
<http://nptel.ac.in/courses/108105065/>
2. Signals and Systems, Prof. K.S. Venkatesh, IIT Kanpur  
<http://nptel.ac.in/courses/117104074/>
3. Digital Signal Processing, Prof. S.C.Dutta Roy, IIT Delhi,  
<http://nptel.ac.in/courses/117102060/>
4. MIT([ocw.mit.edu](http://ocw.mit.edu)).

**List of Open Source Software/learning website:**

1. Software: SCILAB/MATLAB/LABView
2. Learning Website: NPTEL Videos ,MIT open course ware website

**Domain: Electronics Hardware Design and Automation ( Total Hours: 162)**

**Credits: 18 (0+08+10)**

**Domain Code: EHCU2090**

Sl. No.	Subject Name	Credits	Subject Code
1.	Electronics Circuit and PCB Design	3 (0+2+1)	CUEH2090
2.	FPGA Systems: Verilog Design and Application Development	3 (0+2+1)	CUEH2091
3.	Embedded Programming	3 (0+2+1)	CUEH2092
4.	Electronic Product Design Engineering	3 (0+2+1)	CUEH2093
5.	Project	6 (0+0+6)	CUEH2094

**1. Electronics Circuit and PCB Design [0-2-1]**

**Course Objective**

- Understand circuit design and simulation using PSPICE for effective circuit analysis.
- Gain skills in PCB design, fabrication, and testing for practical, high-quality results.

**Course Outcome**

CO1: Analyse complex electronic circuits using PSPICE simulations to evaluate their performance and identify potential improvements.

CO2: Design effective PCB layouts that meet industry standards and address real-world design challenges.

CO3: Apply knowledge of semiconductor devices and analog components to create functional and optimized circuit designs.

CO4: Evaluate PCB manufacturing and assembly processes to ensure high quality and manufacturability of final products.

CO5: Create comprehensive reports on circuit simulations and PCB designs, demonstrating clear communication of technical findings and solutions.

### **Module 1: Introduction to Circuit Design Using PSPICE**

Introduction to PSPICE: Overview of PSPICE: Features and Capabilities, Setting Up the PSPICE Environment, Introduction to the PSPICE User Interface.

Basic Circuit Elements in PSPICE: Creating and Simulating Resistor, Capacitor, and Inductor Circuits, Voltage and Current Sources: Configurations and Usage.

Circuit Simulation Basics: DC Circuit Analysis: Simulating DC Circuits in PSPICE, AC Circuit Analysis: Frequency Response and Sinusoidal Inputs, Transient Analysis: Time-Domain Simulation of Circuits.

Practice Activities:

- Build and simulate basic RC, RL, and RLC circuits in PSPICE
- Perform DC and AC analysis on simple circuits.

### **Module 2: Advanced Circuit Design Techniques Using PSPICE**

Semiconductor Device Modelling: Diodes and Transistors: Creating and Simulating Models in PSPICE, Analysing Diode Circuits: Rectifiers, Clippers, and Clampers, Transistor Circuits: Biasing and Amplifier Configurations.

Operational Amplifiers in PSPICE: Creating Op-Amp Circuits: Inverting, Non-Inverting, and Differential Amplifiers, Feedback and Stability Analysis using PSPICE, Simulating Filters and Oscillators with Op-Amps.

Advanced Simulation Techniques: Harmonic Distortion and Noise Analysis in PSPICE

Practice Activities:

- Design and simulate a transistor amplifier circuit
- Perform harmonic distortion analysis on an amplifier circuit.

### **Module 3: Introduction to PCB Design**

PCB Basics: Layers, Components, and Track Layout.

Schematic Capture: Using tools like KiCAD or Eagle to create schematics from circuit designs.

PCB Design Rules: Design rules and constraints: Understanding and applying them.

Basic PCB Layout: Component placement, signal routing, and design checks.

Practice Activities:

- Create a schematic for a simple circuit using PCB design software.
- Perform basic routing and layout for a single-layer PCB.

#### **Module 4: Advanced PCB Design Techniques**

Multi-Layer PCB Design: Concepts, advantages, and challenges of multi-layer PCBs

High-Speed Design Considerations: Signal integrity, crosstalk, and impedance matching

Thermal Management in PCBs: Heat dissipation strategies, thermal vias, and cooling

Power Distribution: Power and ground plane design, decoupling capacitors

Practice Activities:

- Design a multi-layer PCB with attention to signal integrity.
- Implement thermal management techniques in a PCB design.

#### **Module 5: PCB Fabrication and Assembly Process**

PCB Manufacturing Process: From design files to physical boards: Steps involved

Component Placement: Manual vs. automated assembly processes

Soldering Techniques: Soldering methods: Surface-mount and through-hole components

Quality Control and Testing: Inspection methods, common manufacturing issues

Design for Manufacturability (DFM): Guidelines to ensure producibility

Practice Activities:

- Prepare design files for manufacturing.
- Identify and troubleshoot common PCB manufacturing issues.

#### **Module 6: Real-World Applications and Case Studies**

Real-World PCB Projects: Case studies: Automotive, consumer electronics, IoT

Industry Standards: IPC standards, RoHS compliance, and other relevant guidelines

Practice Activities:

- Review and follow IPC standards in a PCB design.

- Analyze case studies of real-world PCB designs.

## **Module 7: Future Trends in PCB Design**

Emerging Technologies: Flexible PCBs, HDI designs, and other innovations

Advanced Materials: New materials for PCBs: Advantages and challenges

Automation in PCB Design: CAD tools, AI-driven design, and automation trends in PCB design

Practice Activities:

- Explore the design of flexible PCBs using advanced tools.
- Study the impact of new materials on PCB performance.

### **Textbooks**

1. "Analog Circuit Design: A Tutorial Approach" by R. M. S. Prasad, Comprehensive guide on analog circuit design with practical examples and simulation techniques.
2. "PCB Design for Real-World EMI Control" by Bruce Archambeault, Focuses on PCB design with an emphasis on minimizing electromagnetic interference and real-world applications.

### **Reference Books**

1. "The Art of Electronics" by Paul Horowitz and Winfield Hill, An authoritative and widely-used reference for both analog and digital circuit design.
2. "High-Speed Digital Design: A Handbook of Black Magic" by Howard Johnson and Martin Graham

## **2. FPGA Systems: Verilog Design and Application Development [0-2-1]**

### **Course Objective**

1. To provide the knowledge and skills necessary to design, implement, and evaluate FPGA-based systems using Verilog for both combinational and sequential logic circuits.
2. To apply FPGA technology in real-world applications, including IoT, image processing, and machine learning, by effectively integrating hardware and software components.

### **Course Outcome:**

**CO1:** Understand the FPGA design flow and explain the role of different tools and techniques in FPGA development.

**CO2:** Apply Verilog modeling techniques to design and implement combinational and sequential logic circuits.

**CO3:** Analyze and evaluate the performance of FPGA-based designs in real-time applications like IoT and image processing.

**CO4:** Design and create FPGA-based systems with various peripheral interfaces, demonstrating integration of hardware and software components.

**CO5:** Develop and implement machine learning algorithms on FPGA platforms, demonstrating practical applications in image processing and data analysis

### **Module 1: Introduction to FPGA and Verilog**

Introduction to FPGA, FPGA Design Flow, Overview of popular FPGA toolchains (e.g., Xilinx Vivado, Intel Quartus Prime), Integrated Development Environments (IDEs) for FPGA design, Simulation tools (e.g., ModelSim, Vivado Simulator), FPGA Design Techniques, PGA Configuration and Operation

#### **Practice:**

- Design flow: Design entry, synthesis, implementation, simulation, programming in FPGA development tools: Xilinx Vivado, Intel Quartus Prime.

### **Module 2: Verilog Modelling Techniques for combinational logic design**

RTL Design using Verilog: Verilog Syntax and Structure, Modules, Ports, and Wires, Behavioral and Structural Modeling, Data Types (reg, wire, integer), Design Methodologies: Top-Down and Bottom-Up Design Approaches,

#### **Practice:**

- Implement a Verilog model using data flow modelling for a basic digital circuit
- Create a Verilog structural model for combinational circuit.

### **Module 3: Verilog Modelling Techniques for Sequential Logic**

Flip-flops, Registers, Memory, Finite state machine: Meelay and Moore Model

#### **Practice:**

- Implement a Verilog model using behavioral modelling for flip-flops
- Create a Verilog structural model for a simple Resister.
- Develop a behavioural Verilog model for ROM and RAM

- FSM Design using Meelay and Moore Model

#### **Module 4: FPGA Board Design and Basic Interfaces**

How to Design an FPGA Board, LED, Switch, Relay, and Buzzer Interface with FPGA, UART Interface LCD and Seven-Segment Interface with FPGA, DAC Interface with FPGA, Internet of Things using FPGA, Motor Control using FPGA

##### **Practice:**

- Design and implement an FPGA board with basic interfaces (LED, Switch, Relay, Buzzer).
- Interface an LCD and a seven-segment display with an FPGA.
- Implement DAC interface and develop a basic audio output application on FPGA
- Design and implement motor control using FPGA

#### **Module 5: IOT Applications with FPGA**

Role of FPGA in IoT: Data processing, real-time operation, Real-time data acquisition and processing, Data filtering and transformation using FPGA, Implementing algorithms for data analysis

##### **Practice:**

- Develop an IoT application using FPGA for data acquisition and control.
- Median Filter using FPGA

#### **Module 6: Fundamentals of Image Processing**

Introduction to Image Processing, Overview of image types and formats, Basic image operations: filtering, transformation, and enhancement, Image pre-processing techniques for machine learning, Introduction to image segmentation techniques, FPGA implementation strategies for image segmentation

##### **Practice:**

- Implementation of Edge Detection on FPGA
- Introduction to image segmentation techniques
- FPGA implementation of image segmentation

#### **Module 7: Machine Learning on FPGA**

Overview of machine learning models for image processing, Convolutional Neural Networks (CNNs) Model training and evaluation. Machine Learning using FPGA (PYNQ), YOLO Object Detection using FPGA

##### **Practice:**

- Implementation of LAN detection using FPGA (Image and Video)
- Discrete Wavelet Transform using FPGA (C)
- Real-Time Moving Object Detection using PYNQ

#### **Text Book:**

1. "Verilog HDL: A Guide to Digital Design and Synthesis" by Samir Palnitkar
2. "Digital Design: With an Introduction to the Verilog HDL" by M. Morris Mano and Michael D. Ciletti
3. "Machine Learning on FPGAs for High-Performance Computing" by Heiko Weber

#### **Reference Book:**

1. "Verilog HDL Synthesis: A Practical Primer" by J. Bhasker
2. "FPGA Design: Best Practices for Team-based Reuse" by Philip Simpson

### **3. Embedded Programming (2+1+0)**

**Credits:** 3 (Theory: 0, Practice: 2, Project: 1)

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#### **Course Objectives:**

- To provide hands-on experience in developing embedded systems using microcontrollers.
- To enable students to understand and implement real-time system constraints and develop efficient embedded software.
- To familiarize students with various embedded system components, communication protocols, and their interfacing techniques.
- To impart knowledge on designing and optimising embedded systems for real-world applications.
- To cultivate problem-solving skills through practical projects involving real-time embedded applications.

#### **Course Outcomes:**

By the end of the course, students will be able to:

1. Develop and deploy embedded systems using microcontrollers and peripheral devices.
2. Write efficient Embedded C, Python, and MicroPython programs for real-time applications.
3. Interface and control various sensors, actuators, and display devices.
4. Implement and manage multitasking applications using RTOS.
5. Design and optimize embedded systems with power consumption, performance, and cost considerations.

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## Module 1: Introduction to Embedded Systems

- Overview of Embedded Systems
- Components of Embedded Systems (Microcontroller, Sensors, Actuators, etc.)
- Real-time systems and their applications
- Embedded software development lifecycle

### Practice Programs:

1. Blinking an LED using GPIO.
2. Reading a push-button input.
3. Interfacing a seven-segment display.

## Module 2: Microcontroller Architecture, Programming, and IDE Usage

- Microcontroller architecture (e.g., ARM Cortex-M, AVR, PIC)
- Memory organization and addressing modes
- Introduction to interrupts and timers
- Power management features in microcontrollers
- Integrated Development Environment (IDE) for Embedded Systems (e.g., Keil, MPLAB, Arduino IDE, STM32CubeIDE)
  - Overview of popular IDEs used in embedded development
  - Setting up the development environment
  - Writing, compiling, and debugging embedded code using an IDE
  - Code uploading and testing on hardware

### Practice Programs:

1. Setting up and using an IDE for microcontroller programming.
2. Programming timers to generate precise delays.
3. Implementing a simple interrupt-driven LED toggle.
4. Configuring power-saving modes in a microcontroller.

## Module 3: Embedded C, Python, and MicroPython Programming

- Overview of Embedded C, Python, and MicroPython
- Input/output operations in Embedded C and MicroPython
- Bitwise operations and direct register manipulation
- Memory management in embedded systems
- Using Python and MicroPython for embedded systems:
  - Introduction to MicroPython for microcontrollers (e.g., ESP32, Raspberry Pi Pico)
  - Writing and running Python/MicroPython scripts on microcontrollers

### Practice Programs:

1. Write a program to control an LED brightness using PWM in C and MicroPython.
2. Develop a program to read and display sensor data using Python/MicroPython.
3. Implement UART-based communication between two microcontrollers using MicroPython.

## **Module 4: Interfacing and Peripherals**

- Interfacing LEDs, switches, and keypads
- ADC/DAC converters and their interfacing
- Communication protocols (I2C, SPI, UART)
- Display interfacing (LCD, OLED)

### **Practice Programs:**

1. Interfacing an analog temperature sensor and displaying the result on an LCD.
2. Implementing I2C communication between microcontrollers.
3. Interfacing an external EEPROM with SPI communication.

## **Module 5: Real-Time Operating Systems (RTOS)**

- Introduction to RTOS concepts
- Task scheduling and management
- Inter-task communication and synchronization
- RTOS-based application development

### **Practice Programs:**

1. Implementing a simple multitasking application using an RTOS.
2. Creating and managing tasks with priorities.
3. Implementing semaphore and mutex for resource sharing.

## **Module 6: Wireless Communication in Embedded Systems**

- Basics of wireless communication (Bluetooth, ZigBee, Wi-Fi)
- Interfacing wireless modules (e.g., HC-05, ESP8266)
- Data transmission and reception techniques
- Security aspects in wireless communication

### **Practice Programs:**

1. Interfacing and communicating with a Bluetooth module.
2. Setting up and using Wi-Fi for data transmission.
3. Implementing a simple wireless sensor network.

## **Module 7: Embedded System Design and Optimization**

- Power management in embedded systems
- Code optimization techniques

- Embedded system design methodologies
- Case studies of real-world embedded systems

### Practice Programs:

1. Power down modes and energy-saving techniques.
  2. Code size optimization and efficient coding practices.
  3. Designing a low-power embedded system for battery-operated devices.
- 

### Textbooks:

1. "Embedded Systems: Architecture, Programming and Design" by Raj Kamal
2. "Embedded C Programming and the Atmel AVR" by Richard H. Barnett, Sarah Cox, and Larry O'Cull

### Reference Books:

1. "The Art of Embedded Systems Programming" by Jack Ganssle
2. "Microcontrollers: Theory and Applications" by Ajay V. Deshmukh
3. "Programming with MicroPython: Embedded Programming with Microcontrollers and Python" by Nicholas H. Tollervey
4. "Python for Microcontrollers: Getting Started with MicroPython" by Donald Norris

## 4. Electronic Product Design Engineering (0+2+1)

### Module 1: Introduction to Electronic Product Development

- **Overview of Ansys Software:** Introduction to Ansys Electronics Desktop, Overview of the Ansys suite relevant to electronic design, Understanding the workflow: from design to simulation
- **Basic Concepts in Electronics Design:** Introduction to Electronic Components and Circuits, Overview of Signal Integrity, Power Integrity, and EMI/EMC, Introduction to RF and Microwave Design
- **Getting Started with Ansys:** Installation and set up of Ansys software, Navigating the Ansys user interface, Overview of pre-processing, solving, and post-processing stages

### Module 2: Signal Integrity Analysis

- **Fundamentals of Signal Integrity:** Signal Integrity challenges in high-speed PCB design, Crosstalk, Reflection, and Ground Bounce
- **Using Ansys for Signal Integrity Analysis:** Setting up Signal Integrity simulations in Ansys HFSS, Modeling and simulating transmission lines, Simulation of via structures and interconnects

- **Practical Applications:** Case studies of signal integrity issues and their solutions

Lab exercises: Designing and simulating high-speed PCB traces

### Module 3: Power Integrity Analysis

- **Understanding Power Integrity :** Importance of Power Integrity in electronic design, Factors affecting Power Integrity: Voltage drop, noise, etc.
- **Power Integrity with Ansys SIwave:** Setting up Power Integrity simulations Decoupling capacitor selection and placement, Power distribution network (PDN) analysis
- **Advanced Topics in Power Integrity:** PDN impedance profile optimization

PI analysis in multi-layer PCB designs, Case studies and practical lab exercises

### Module 4: Electromagnetic Interference (EMI) and Electromagnetic Compatibility (EMC)

- **Introduction to EMI/EMC :** Basics of Electromagnetic Interference and Compatibility, Regulatory standards and testing for EMI/EMC
- **EMI/EMC Simulation with Ansys:**

Overview of Ansys tools for EMI/EMC: HFSS, SIwave, Setup and analysis of EMI/EMC in electronic designs

- **Simulation and Mitigation Techniques:** EMI reduction techniques, EMC compliance through design optimization

Practical lab: Simulating and mitigating EMI in a PCB design

### Module 5: RF and Microwave Design

- **Basics of RF and Microwave Engineering:** Introduction to RF systems and components, Transmission lines, S-parameters, and network theory
- **Using Ansys HFSS for RF Design:** Setting up RF simulations: Antennas, Filters, and Waveguides, Simulation of complex RF systems, Optimizing RF performance
- **Advanced Topics in RF Design:** Coupling and Crosstalk in RF circuits Multi-physics considerations in RF design, Lab exercises: Designing and simulating RF components

### Module 6: Thermal and Structural Analysis

- **Thermal Management in Electronic Products:** Importance of thermal analysis in electronics, Overview of thermal simulation tools in Ansys
- **Thermal Analysis with Ansys Icepak:** Setting up thermal simulations for PCBs and enclosures, Thermal management techniques: Heat sinks, fans, etc., Simulation of thermal effects on component performance
- **Structural Analysis of Electronic Products:** Structural integrity considerations in electronics, Vibration and mechanical stress analysis using Ansys Mechanical Practical lab: Thermal and structural simulations of a PCB

## Module 7: Optimization and Design Automation

- **Design Optimization Techniques:** Introduction to optimization methods in Ansys

Sensitivity analysis and parametric studies

- **Automation with Ansys:** Scripting and automation in Ansys using Python

Using Design of Experiments (DoE) for optimization

- **Final Project**

Comprehensive project integrating signal integrity, power integrity, EMI/EMC, thermal, and structural analysis

Optimization of an electronic product design using Ansys tools

## Communication Systems Domain

Code	Course Title	T-P-Pj (Credit)	Prerequisite
CSCU2080	Communication Systems Domain	4-8-6 (18)	NIL

### Course Division

1. Microwave & RADAR Communications (2-1-0)
2. Satellite & TV Communications (1-2-0)
3. Cell Site and BTS Operation, Maintenance and Troubleshooting: RF Planning and Drive Test (0-3-0)
4. Optics and Wireless Sensor Networks (1-2-0)
5. Project (0-0-6)

### Course Objective

- Develop the skills required to design a next generation wireless networks
- To involve the students in the theory and practice of optical and wireless sensor networks

### Course Outcomes

- **CO1:** Gain Knowledge on microwave communication, fibre optics communication and wireless sensor network
- **CO2:** Analyze the concept of antenna design for various applications
- **CO3:** Examine the communication systems parameters performance mathematically
- **CO4:** Design and Simulation of microwave components and BTS installation
- **CO5:** Estimate the performance analysis and optimization of various communication systems parameters

### Course Outcome to Program Outcome Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1									2	2	2
CO2	3	3	2	2									3	2	2
CO3	3		2		2								3	2	2
CO4	3	2	3	2									2	2	2
CO5	3	2	3	2	3			2				2	3	2	2

## COURSE CONTENT (TOTAL HOURS: 134)

### 1. Microwave & RADAR Communications (2-1-0) (33 Hours )

- Introduction to Microwaves: Microwave frequencies
- Scattering matrix formulation
- Passive microwave devices
- Active Microwave Devices
- Study of field pattern of various modes inside a rectangular waveguide
- Microwave Measurements
- Transit time limitations in Microwave Bipolar Transistors
- Power frequency limitations Microwave Field Effect Transistors
- Gunn Effect
- IMPATT diodes
- TRAPATT diodes
- Microwave vacuum tube based devices
- Limitations of conventional tubes at UHF
- Microwave Klystron
- Reflex klystron,
- Traveling wave tube
- Magnetron
- Introduction to Smith chart and its application for the unknown impedance measurement
- Scattering Matrix Parameters
- Introduction to radar and RADAR Parameters
- MTI RADAR
- FMCW RADAR
- Tracking RADAR
- Monpulse RADAR
- RADAR Receiver
- Synthetic Aperture RADAR

#### Text Book:

1. R E Collin, “Foundation for Microwave Engineering”, John Wiley & Sons, 2nd Edition, 2007
2. S Y LIAO, “Microwave Devices and Circuits”, PHI, 3rd Edition, 2003.
3. Merrill I skolnik, “Introduction to Radar Systems’, McGraw Hill, 2nd Edition, 2007.
4. G S N Raju, “Radar Engineering and Fundamentals of Navigational Aids”, IK international Publishers, 2008
5. G S N Raju, “Microwave Engineering ”, IK international Publishers, 2008.

6. Radar Systems Analysis And Design Using Matlab® Third Edition, Bassem R. Mahafza Decibel Research Inc. Huntsville, Alabama, Usa ,Crc Press Taylor & Francis Group

## 2. Satellite & TV Communications (32 Hours) (1-2-0)

- Configuration of a satellite communications system
- Types of orbit
- Radio regulations
- Keplerian orbits
- Useful orbits for satellite communication
- Perturbations of orbits
- Digital video broadcasting via satellite (DVB-S)
- Second generation DVB-S
- Digital transmission of telephony
- Digital broadcasting of television
- Configuration of a link
- Uplink received power
- Downlink received power
- Additional losses
- Noise power spectral density at the receiver input
- Individual link performance
- Influence of the atmosphere
- Mitigation of atmospheric impairments
- Overall link performance with transparent satellite
- Overall link performance with regenerative satellite
- Study of 5G new radio (NR) standard, modulation Techniques used for 2G-5G

**Case Study: A field report as a part of practice will be submitted by visiting the Nearest center and observing the satellite links and TV transmission techniques .**

### **Text Book**

1. Satellite communications systems / Gerard Maral, Michel Bousquet. — 5th ed, wiley , 2010.
2. Satellite Communications, by Dennis Roddy (Fourth edition), McGraw Hill
3. Satellite Communication, by Timothy Pratt, Charles Bostian, Jeremy Allnutt (Second Edition), John Wiley & Sons

### **Cell Site and BTS Operation, Maintenance and Troubleshooting: RF Planning and Drive Test ( 36 Hours) (0-3-0)**

- Antennas for mobile Tower
- Power supply at BTS
- Equipment used in the Shelter
- Power Interface Unit (PIU)
- Line Conditioning Unit (LCU)

- Free Cooling Unit (FCU)
- Preventive Maintenance (PM) & site management
- Basic functioning of alarm box and the interface
- Concept on TRX & Baseband receiver unit.
- RF Propagation path loss
- 3.11 Frequency hopping and Planning
- RF Optimization
- GSM RF Drive Test
- 3G Optimization
- EMF Radiation Calculation and testing
- 4G Optimization

#### **Text Book:**

1. “Telecom Tower Maintenance” Vol. 1, Navkar Center for Skills, 2014.
2. Advanced cellular network planning and optimization 2G/2.5G/3G. . . evolution to 4G , Author: Ajay R Mishra, Nokia Networks, John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex PO19 8SQ, England
3. Radio Network Planning and Optimisation for UMTS, Second Edition, Jaana Laiho and Achim Wacker, Nokia Group, Finland, Tomaz Novosad, Nokia Networks, Nokia Group, USA, John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex PO19 8SQ, England
4. Material: E1-E2 Upgradation Course – Consumer Mobility, RF Planning and Drive Test
5. Material: GTL , RF Optimisation.

#### **Optical and Wireless Sensor Networks (1-2-0) (33 Hours )**

- Propagation of signals in optical fiber:
- Transmission characteristics of optical fiber
- Optical fiber Transmitters.
- Optical Components.
  - Optical fiber loss measurement using power meter, LASER and OTDR.
- Layered Protocol Model in the Transport Network.
- SONET and SDH, Architecture of Optical Transport Networks (OTNs)
- Implementation and performance analysis of TCP/IP protocols. Tools to be used: NS2 Simulator and Socket Programming
- Challenges for Wireless Sensor Networks.
- Single-Node Architecture - Hardware Components.
- Network Architecture - Sensor Network Scenarios
- Physical Layer and Transceiver Design Considerations.
- Routing Protocols.
- Topology Control, Clustering.
- Arduino and Wireless Communications
- Sensor Tasking and Control.
- WSN using Arduino with Wireless modules
- MATLAB Experiments Related to Compressed Sensing for Energy Efficient WSN
- Sensor Node Hardware – Berkeley Motes, Programming Challenges.

- Node-level Software platforms, Node-level Simulators.

### **TEXT Books**

1. John M. Senior, "Optical fiber communication", Pearson edition, 2000
2. Uyles Black "Optical Networks ", Pearson Education , 2011.
3. Holger Karl and Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley, 2005
4. KazemSohraby, Daniel Minoli, &TaiebZnati, "Wireless Sensor Networks-Technology, Protocols, and Applications", John Wiley, 2007. Anna Hac, "Wireless Sensor Network Designs", John Wiley, 2003

### **Reference books:**

1. Rajiv Ramswami and K. N. Sivarajan, "Optical Networks", Morgan Kaufman Publishers, 2008.
2. Gerd Kaiser, "Optical fiber Communication Systems", John Wiley, New York, 2009.
3. Feng Zhao and Leonidas J. Guibas, "Wireless Sensor Networks- An Information Processing Approach", Elsevier, 2007.

## Chip Design and Fabrication Using VLSI (Total Hours: 172)

Code	Course Title	T-P-Pj (Credit)	Prerequisite
VLCU207 0	Chip Design and Fabrication Using VLSI	6-8-6	NIL

### Courses Division:

- ASIC Design (2-1-0)
- Digital VLSI (2-2-0)
- Analog VLSI (2-1-0)
- VERIFICATION USING SYSTEM VERILOG & UVM (0-4-0)
- Project (0-0-6)

### Course Outcomes

- **CO1:** To acquire knowledge and become familiar with modern VLSI circuits
- **CO2:** To develop critical thinking to solve issues involved in ASIC design, including technology choice, Timing analysis, tool-flow, testability.
- **CO3:** To acquire problem solving skill to design CMOS amplifiers in deep submicron technology.
- **CO4:** Students will acquire the technical skill to become Industry-ready RTL Design/Physical design/Testing/Verification Engineer.
- **CO5:** Students will acquire the technical skill to become Industry-ready RTL Design/Physical design/Testing/Verification Engineer.

### Course Outcome to Program Outcome Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3		3		3								2	2	2
CO2	3				3								3	2	2
CO3	3	3											3	2	2
CO4	3			3	3			1				3	2	2	2
CO5	3											3	3	2	2

## **ASIC Design (2-1-0)**

- 1.1 Custom IC Design, Cell-Based Design Methodology, Array Based Implementation Approaches.
- 1.2 Traditional and Physical Compiler Based ASIC Flow
- 1.3 Logic Synthesis Environment
- 1.4 Technology library: technology libraries, logic library basics, delay calculations
- 1.5 Static Time Analysis , Critical Path, Timing Exceptions
- 1.6 Multi Cycle Paths, False Paths and Timing Constraints
- 1.7 Floor Planning Place and Route Optimization
- 1.8 Partitioning: Partitioning For Synthesis and coding guidelines
- 1.9 Optimization and Mapping Constraints (Clock, Delay, Area, Design)
- 1.10 Design Methodology for Logic Cores
- 1.11 Architecture of The Present-Day Soc
- 1.12 Design Issues of SoC, Hardware & amp
- 1.13 Software Design, Core Libraries
- 1.14 EDA Tools SoC Design Flow Guidelines for Design Reuse
- 1.15 Design Process for Soft and Firm Cores
- 1.16 Design Process for Hard Cores, System Integration
- 1.17 Design Methodology for Memory & Analog Cores Embedded Memories
- 1.18 Design Methodology for Embedded Memories
- 1.19 Specification of Analog Circuits
- 1.20 Core Level Validation, Core Interface
- 1.21 Verification, SoC Design Validation

### **Text Books:**

1. Verilog HDL, 2/E By Samir Palnitkar, Pearson Education
2. Himanshu. Bhatnagar, “Advanced ASIC Chip Synthesis” (2/e).KAP.2002
3. Rochit Rajsuman, ‘System-on-a-Chip: Design and Test’, Artech House, 2000

### **Reference Books:**

1. Maheshwari, Naresh, Sapatnekar, “Timing Analysis and Optimization of Sequential Circuits”. 1998, Springer. ISBN: 978-0-7923-8321-5
2. Modern Digital Electronics. Author, R P Jain. Edition, 3. Publisher, Tata McGraw-Hill Education

### **Software Tool::**

- Microwind
- Cadence
- Xilinx ISE

## **2.Digital VLSI (2-2-0):**

- 2.1 Issues in Digital IC Design
- 2.2 Quality Metrics of A Digital Design

- 2.3 Manufacturing CMOS Integrated Circuits
- 2.4 Design Rules. Layouts
- 2.5 The Metal Oxide Semiconductor (MOS) Structure
- 2.6 The MOS System Under External Bias
- 2.7 Structure And Operation of MOS Transistor (MOSFET)
- 2.8 MOSFET Current-Voltage Characteristics
- 2.9 MOSFET Scaling And Small-Geometry Effects, MOSFET Capacitance
- 2.10 Static CMOS Inverter: Static And Dynamic Behavior Practices of CMOS Inverter
- 2.11 Components Of Energy And Power: Switching, Short-Circuit And Leakage Components
- 2.12 Technology Scaling And Its Impact On The Inverter Metrics
- 2.13 Static CMOS Design: Complementary CMOS, Ratioed Logic, Pass Transistor Logic
- 2.14 Dynamic CMOS Design: Dynamic Logic Design Considerations
- 2.15 Speed And Power Dissipation Of Dynamic Logic
- 2.16 Signal Integrity Issues, Cascading Dynamic Gates
- 2.17 CMOS Sequential Logic Circuit Design Introduction, Bi-Stable Circuit Elements
- 2.18 SR & JK Latch Circuits
- 2.19 Clocked Latch And Flip-Flop Circuits
- 2.20 CMOS D-Latch And Edge-Triggered Flip-Flop
- 2.21 Semiconductor Memory Design: Introduction, MOS Decoders
- 2.22 SRAM Design, DRAM Design
- 2.23 Memory Architecture And I/O Circuitry

#### **Text Books**

- 1.Sung-Mo Kang and Yusuf Leblebici, CMOS Digital Integrated Circuits: Analysis and Design, Tata McGraw-Hill Publishing Company Limited
- 2.Jan M,Rabaey, AnanthaChandrakasan, BorivojeNikolic, Digital Integrated Circuits–A Design Perspective, PHI

#### **Reference Books:**

- 1.Wayne Wolf, Modern VLSI Design System – on – Chip Design, PHI
- 2.K,Eshraghian and N,H,E,Weste, Principles of CMOS VLSI Design – a Systems Perspective, 2nd Edn., Addison Wesley

#### **Software Tool::**

- Microwind
- Cadence

#### **3.Analog VLSI (2-1-0):**

- 3.1 Independent Sources: MOS Current Sources and Sinks
- 3.2 Current Mirror: Basic Current Mirrors, Cascode Current Mirrors
- 3.3 Current and Voltage Reference Circuits
- 3.4 Amplifier Design : Basic Concepts of Amplifier, Common Source Stage
- 3.5 Common Gate Stage, Cascode Stage
- 3.6 Differential Stage: Single Ended and Differential Operation
- 3.7 Basic Differential Pair
- 3.8 Frequency Response of Amplifiers: Miller Effect, Frequency Response of Common Source Stage
- 3.9 Common Gate Stage, Cascode Stage and Differential Pair

- 3.10 CMOS Op-Amps: Differential and Common Mode Circuits
- 3.11 Op-Amp CMRR Requirements, Need for Single and Multistage Amplifiers
- 3.12 Effect of Loading in Differential Stage
- 3.13 Digital To Analog Converters:( Binary Weighted Resistor, R-2R Ladder Network)
- 3.14 Analog To Digital Converters: (Dual Slope, Successive Approximation Type)
- 3.15 Frequency Compensation: Concepts and Techniques for Frequency Compensation
- 3.16 Dominant Pole, Miller Compensation, Compensation of Miller RHP Zero
- 3.17 Nested Miller, Compensation of Two Stage OP-Amps

**Text Books:**

- 1.Behzad Razavi, “Design of Analog CMOS Integrated Circuits”, McGraw-Hill, 2000.
- 2.Phillip E. Allen and Douglas R. Holberg, “CMOS Analog Circuit Design”, (Second Edition) Oxford University Press, February 2002.

**Reference Books:**

- 1.Gray, Hurst, Lewis, and Meyer: “Analysis and design of Analog Integrated Circuits”, (4/e), John Wiley and Sons.

**Software Tool::**

- Microwind
- Cadence

**4.Verification Using SystemVerilog (0-4-0):**

- 4.1 Verification Concepts
- 4.2 Introduction to System Verilog Language
- 4.3 Basic SV TB - Connecting to your design
- 4.4 SV-OOPs concepts and Randomization
- 4.5 Threads and Inter Process Communication
- 4.6 Introduction to Verification Methodologies
- 4.7 Case Study : Design and Verification of a SRAM Memory Cell Using UVM Methods

**Software Tool::**

- Questa Sim

**Text Books**

1. Sutherland, Stuart, Simon Davidmann, and Peter Flake, “SystemVerilog for Design Second Edition: A Guide to Using System Verilog for Hardware Design and Modeling”, Springer Science & Business Media, 2006
2. Spear, Chris. “SystemVerilog for verification: a guide to learning the testbench language features,” Springer Science & Business Media, 2008

**Reference Book**

- 1.System Verilog, 3.1a, Language reference manual
- 2.Vijayaraghavan, Srikanth, and Meyyappan Ramanathan. A practical guide for SystemVerilog assertions. Springer Science & Business Media, 2005

3. Bergeron, J. "Writing Testbenches Using SystemVerilog.—NY: Springer Science and Business Media." (2006)

**Web Source:**

[Verification Using SystemVerilog](#)

## Embedded System Design

Course Code	Course Title	Credits	T-P-PJ
ESCU2050	Embedded System Design	20	4-10-6

### Course Objective

- Develop a skilled workforce with the Knowledge of the latest trending technologies to meet the Embedded Industry needs.
- To make the student industry-ready with prompt hands-on in the various Real-Time Embedded Systems.

### Course Outcome

**CO1:** Gain and apply knowledge about the architectural features and instructions of 32-bit ARM microcontrollers to develop the embedded system.

**CO2:** Identify, analyze, formulate, develop and design various product-based applications based on Embedded Systems.

**CO3:** A diversified team will learn, configure and build a customized Linux Kernel and also be able to set up and use the Cross Development platform, which will help them in lifelong learning.

**CO4:** Employ testing, debugging, and validation techniques to ensure embedded system reliability and performance under various conditions.

**CO5:** Apply the techniques and knowledge gained in Embedded Systems to become an entrepreneur for sustainable development.

### Course Outcome to Program Outcome Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												2	2	2
CO2		2	3										3	2	2
CO3	3	3							3				3	3	2
CO4	3			3	3			1					3	2	2
CO5					2		3						3	3	2

## Domain Syllabus (Total Hours: 172.5)

### 1. Microcontroller-Based Embedded System Design (57.5 Hrs)

1. Introduction to Embedded System
2. Embedded System Development Life Cycle
3. Introduction to ARM
4. AMBA & AHB
5. Features of ARM7, ARM9, ARM 11, ARM Cortex
6. Datasheet analysis
7. GPIO programming – LED, Seven Segment Display, LCD, Matrix keypad, Actuators( Relay, Motors and valves)
8. System control block-
9. ADC & DAC -- Sensors(Analog and Digital),
10. Timer/Counter
11. Pulse Width Modulation(PWM)
12. Vectored Interrupt Controller(VIC)
13. Real Time Clock (RTC)
14. Watch Dog timer (WDT)
15. Debugging with JTAG
16. Inter System Protocols – UART, USART, USB, Bluetooth, BLE, GPS, GSM
17. Intra System Protocols – I2C, SPI, CAN
18. Wireless Protocols and its Complete setup – NFC/ RFID, ZigBee, Bluetooth, Wi-Fi, MQTT, LORA,

### 2. Real-Time Operating System & Porting (57.5 Hrs)

1. Real-Time OS
2. Types of RTOS
3. GPOS vs RTOS
4. FreeRTOS
5. VxWorks
6. Task Management & its API
7. Scheduling Algorithms & its API
8. Inter Task Communication & its API
9. Resource Management & its API
10. AWS IoT Core for FreeRTOS
11. AWS IoT Green Grass setup on Raspberry Pi

### 3. Embedded Linux for ARM (57.5 Hrs)

1. Embedded Linux Overview
2. Linux File System
3. Types of Kernel
4. Shell Commands
5. Shell Scripting
6. Process Management System calls
7. Inter-Process Communication System calls

8. Linux Booting Sequence
9. Toolchains Configuration and Cross Compilation
10. Configuring & Installing Bootloaders (U-Boot)
11. Kernel Configuration and Compilation
12. Creating Custom Root File system
13. Remote Debugging Embedded Applications using GDB
14. Device Drivers- Char drivers
15. Static Linking & Dynamic Linking
16. Adding Static Module to the Kernel

#### **4. AUTOSAR Design using CAN, CAN Analyser, and LIN (14 hours)**

1. Introduction to Automotive System
2. Introduction to AUTOSAR
3. Details on CAN Protocols
4. SBUS CAN Analyser
5. LIN Protocol

#### **Software Handling**

1. Keil  $\mu$  vision 5
2. Arduino IDE
3. ARM GCC Compiler
4. FreeRTOS, Raspbian OS, Ubuntu OS
5. VxSim
6. Proteus Professional 8.9
7. Node-RED

#### **MPU Handling**

1. Arduino
2. ESP8266
3. LPC2148/LPC2129
  - Raspberry Pi
  - STM32
  - Beagle Bone Black

#### **List of Projects/ papers/jobs/products to be done in the domain:**

##### **(To follow the Gate Process)**

1. IoT-based Apparel Tracking System
2. IoT-based Smart Agriculture Monitoring & Controlling
3. Color-based Product Sorting Machine using IoT
4. IoT-based Smart Energy eter.

## DOMAIN TRACK TITLE: RENEWABLE ENERGY APPLICATIONS

Track Total Credits (4-8-10): 22 Credits

### COURSES DIVISION:

1. CURE2190 Materials for Renewable Energy applications (1-1-0)
2. CURE2191 Renewable Energy Technology for Industrial Process (1-2-0)
3. CURE2192 Micro-grid Design & Implementation (0-2-0)
4. CURE2193 Hybrid Renewable Energy Systems (1-2-0)
5. CURE2194 Solar Off-grid Entrepreneur (1-1-0)
6. CURE2195 project (0-0-6)
7. CURE2196 Internship (0-0-4)

### DOMAIN TRACK OBJECTIVES:

- To gain the knowledge on different types of materials used in Renewable Energy.
- To understand the importance of Renewable Energy technology and its applications.
- To know the applications of solar thermal technology.

### DOMAIN TRACK COURSE OUTCOMES

- CO1 Able To gain the knowledge on different types of materials used in Renewable Energy.
- CO2 To know the applications of solar thermal technology, off-grid , on-grid and hybrid renewable energy systems.
- CO3 To become an expert in Entrepreneurship.

### COURSE OUTCOME TO PROGRAM OUTCOME MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	2	3	3				2	1		2	3	2	1
CO 2	3	3	1	3	3				1			1	3	3	2
CO 3	2	3	1	3	3				2	1		3	3	2	3
CO 4	3	3	1	3	3				1			3	2	2	2
CO 5	3	3	1	3	3				1			3	1	1	2

- \*HIGH-3, MEDIUM-2, LOW-1

## 1. Material for Renewable Energy application (30 hrs)

- 1.1 Basic fundamentals of different types semiconductors (Energy band, charge carriers and their motion, generation, recombination, doping)
- 1.2 Practice: Crystal structure, phase identification and crystallite size determination of PV materials by XRD (using Biovia MS and phase identification by using relevant software)
- 1.3 Photovoltaic Cell - Construction & Working (Si based)
- 1.4 Practice: UV visible analysis of photovoltaic material
- 1.5 Concept of various types PN junction.
- 1.6 Practice: Measurement of photo luminescence (PL) behaviour of photovoltaic material
- 1.7 Role of materials for sustainable development of next generation photovoltaic cells
- 1.8 Practice: To study crystallites (grain) size and strain through *Williamson-Hall plot* method  
<https://www.youtube.com/watch?v=LJ9h77fN4-E&t=1308s>
- 1.9 Efficiency calculation of solar cell
- 1.10 Practice: To determine the resistivity of semiconductors by Four probe Method.  
<http://vlab.amrita.edu/?sub=1&brch=282&sim=1512&cnt=1>
- 1.11 Nano-Photovoltaic (Graphene/CNT, ZNO, TIO<sub>2</sub>)
- 1.12 Practice: Study of Hall effect (Determination of nature of charge carriers in a semiconductor)  
<http://vlab.amrita.edu/?sub=1&brch=282&sim=879&cnt=4>
- 1.13 Composite materials for solar cell (Graphene/Al, TiO<sub>2</sub>-SiO<sub>2</sub> composite for solar cell)
- 1.14 Perovskite based solar cell (transition metal doped PbTiO<sub>2</sub>)
- 1.15 Dye-sensitized solar cells
- 1.16 Materials (Al/hybrid glass-carbon fiber) for wind energy conversion

### Text Book:

1. Vincent, D. , Materials for Sustainable Energy, Nature publishing group, 2010.
2. Paranthaman, M. Parans, Wong-Ng, Winnie, Bhattacharya, Raghu N (Eds.), Semiconductor Materials for Solar Photovoltaic Cells, Springer, 2015.

### Reference Book:

1. Sabu, T., El HadjiMamour, S., Nandakumar, K., Samuel, O., Jihuai, W., Nanomaterials for Solar Cell Applications, Elsevier, 2019.
2. Peter, P. Rogers, Kazi F. Jalal, John A. Boyd, An introduction to sustainable development, Glen Educational Foundation, 2008.

## 2. Renewable Energy Technology for Industrial Process (48 hrs)

- 2.1 Relevance of economic and financial viability evaluation of renewable energy technologies, Renewable Energy Policies of India and in the state of Odisha
- 2.2 Practice: Site visit for acquire knowledge on different renewable energy technologies and it's system
- 2.3 Basics of light to energy conversion and Concept on solar PV
- 2.4 Practice: Measurements and estimation of solar radiation
- 2.5 Concept of mono-crystalline, poly-crystalline, amorphous

- 2.6 Practice: Identify and specify different types of components used in a solar PV system
- 2.7 New generation of Solar cell, working principle and applications
- 2.8 Practice: Simulation of solar cell by using PVSOL software
- 2.9 Effects of parameters on PV module power and efficiency
- 2.10 Practice: VI characteristics of solar cell/module
- 2.11 Concept on Concentrated solar thermal (CST)
- 2.12 Practice: Temperature tracking of solar cell/module
- 2.13 Concentrated solar power (CSP), new technology of solar thermal
- 2.14 Practice: Performance of Solar PV module at varying tilt angle
- 2.15 Concept of wind energy, Basic laws and efficiency limit for wind energy conversion
- 2.16 Practice: Modelling of solar cooker
- 2.17 Concept of aerodynamics effects
- 2.18 Practice: Modelling of solar flat plate collector
- 2.19 description of horizontal and vertical axis wind turbine
- 2.20 Practice: Generation of electricity by wind machines
- 2.21 Concept on Biomass, Electricity generation from biomass.
- 2.22 Practice: Maximum power point tracking of a wind turbine
- 2.23 Practice: Performance testing of bio diesel in VCR machine

**Text Books:**

1. D. P. Kothari, K. C. Singal and R. Ranjan, Renewable Energy Sources and Emerging Technologies, Second Edition, PHI Learning Pvt. Ltd, New Delhi, 2011.
2. C. S. Solanki, Photovoltaic – Fundamentals, Technologies and Applications, PHI Learning Pvt. Ltd., 2011.

**Reference Book:**

1. V. V. N. Kishore, Renewable Energy Engineering and Technology: principles and practice, Teri, India, 2008.
2. Hakeem, Khalid Rehman, Jawaid, Mohammad, Rashid, Umer (Eds.), Biomass and Bioenergy Applications, Springer, 2014.
3. S. S. Das, D. D. Behera, and A. Pradhan, Clean Energy Products: A Path for Attaining Livelihood Security, Notion Press, and ISBN: 9781636691602, 2020.
4. S. S. Das, D. D. Behera, and N. C. Giri, Clean Energy Applications in Modern World, Notion Press, ISBN: 9781638069560, 2021.

**3. Micro-grid Design and Implementation (36 hrs)**

- 3.1 Practice: Site survey (1 kW or 1MW)
- 3.2 Practice: Sizing of micro grid system (1kW/1MW)
- 3.3 Practice: Single line diagram of micro grid system
- 3.4 Practice: Identify and specify different components used in a micro grid system
- 3.5 Practice: Connection practice of solar modules in a micro grid system
- 3.6 Practice: Designing of micro grid system
- 3.7 Practice: Analysis of micro grid system
- 3.8 Practice: Designing of micro grid system with battery storage
- 3.9 Practice: Performance calculation of micro grid system

- 3.10 Practice: Connection practice of CCR/Inverter in a micro grid system
- 3.11 Practice: Test, record and verify the power quality of a micro grid system
- 3.12 Practice: O & M of micro grid system

**Text Books:**

- 1. Suneal Deambi, Photovoltaic System Design: Procedures, Tools and Applications, CRC Press, 2018.
- 2. Miguel Castilla, Antonio Carlos Zambroni de Souza, Microgrids Design and Implementation, Springer, 2019.

**Reference Books:**

- 1. S. S. Das, D. D. Behera, and N. C. Giri, Clean Energy Applications in Modern World, Notion Press, ISBN: 9781638069560, 2021.
- 2. Federico Delfino, Renato Procopio, Massimo Brignone, Michela Robba, Mansueto Rossi, Stefano Bracco, Microgrid Design and Operation: Toward Smart Energy in Cities, Artech House, London, 2018

**4. Hybrid Renewable Energy System (48 hrs)**

- 4.1 Global scenario of Hybrid renewable energy system, integrated renewable energy systems with input sources
- 4.2 Practice: Modelling of renewable energy systems
- 4.3 integrated renewable energy systems with input sources
- 4.4 Practice: Connection practice of Solar PV-T System
- 4.5 Selection of technology and components for hybrid renewable systems.
- 4.6 Practice: Designing of solar PV system (On-grid/Off-grid)
- 4.7 Concept of hybrid solar PVT system
- 4.8 Practice: Designing of hybrid solar-thermal system
- 4.9 Selection of Components for Hybrid solar PV-T system
- 4.10 Practice: Analysis of hybrid solar-thermal system
- 4.11 Synchronization process of renewable systems.
- 4.12 Practice: Connection practice of PV-wind system
- 4.13 Operation of hybrid PV and wind system
- 4.14 Practice: Modelling of wind power system
- 4.15 Concept of hybrid PV and wind system and its components
- 4.16 Practice: Demonstration of Load curve in the plant
- 4.17 Load curve
- 4.18 Practice: Study the dynamic behavior of wind turbines
- 4.19 Concept of Hybrid PV and hydro system and its components
- 4.20 Practice: Modelling of hydro power system
- 4.21 Concept of hybrid PV and Biomass system and it's components
- 4.22 Practice: Chemical composition of biomass system
- 4.23. Practice: Emission testing of bio diesel/bio ethanol in gas analyzer

**Text Books:**

1. S. Sukhatme and J. Nayak: Solar Energy: Principle of Thermal collection and storage, Third Edition ( Tata McGraw-Hill, 2008)
2. C. S. Solanki: Solar Photovoltaic – Fundamentals, Technologies and Applications, PHI.

### **Reference Books:**

1. Ersan Kabalci, Hybrid Renewable Energy Systems and Microgrids,
2. V. N. Kishore, Renewable Energy Engineering and Technology: principles and practice, Teri, India, 2008.
3. N. C. Giri, S. R. Nayak, S. P. Mishra, and S. N. Sahu, Project Management and Smart Electrical Systems, ISBN 9798587652200, Amazon; 1st edition, 27 December 2020.

### **5. Solar Off-grid Entrepreneur (30 hrs)**

- 5.1 MNRE schemes and state wise subsidy process
- 5.2 Practice: Identify and specify different types of Solar PV Off grid products
- 5.3 Cost of different solar off grid systems components
- 5.4 Practice: Costing sheet preparation
- 5.5 Selection criteria of suitable components
- 5.6 Practice: Proposal preparation with payment terms and condition
- 5.7 Assessment of business development
- 5.8 Practice: Analysis and assessment of project cost
- 5.9 Economic profile and power consumption trends
- 5.10 Practice: Customer financial strength calculation
- 5.11 Government and private bank funding systems
- 5.12 Practice: Identify the customer requirements for solar home lightening systems
- 5.13 Solar off grid system manufacturers and suppliers
- 5.14 Right equipment should be installed in right place
- 5.15 Attend and resolve customer queries
- 5.16 Entrepreneurship skill

### **Text Books:**

1. Rameshwari Pandya, Skill Development and Entrepreneurship in India, 2016.
2. Joseph P. Oconneor, Off Grid Solar, Second edition, Old Sequoia Publishing, 2016.
3. Poornima Charantimath, Entrepreneurship Development and small Business Enterprises, Third edition, Pearson, 2018.

### **Reference Books:**

1. C. S. Solanki: Solar Photovoltaic – Fundamentals, Technologies and Applications, PHI Learning Pvt. Ltd., 2011.
2. Michael Boxwell -- Solar Electricity Handbook - 2014 Edition: A Simple Practical Guide to Solar Energy.

### **Session Plan for the Entire Domain:**

#### **1. Material for Renewable Energy Application (30 hrs)**

Session 1. Basic fundamentals of different types semiconductors (Energy band, charge carriers and their motion, generation, recombination, doping)

<https://www.youtube.com/watch?v=ethnHSgVbHs>

<https://www.youtube.com/watch?v=Yu2YpVtuOds>

Session 2. Practice: Crystal structure, phase identification and crystallite size determination of PV materials by XRD (using Biovia MS and phase identification by using relevant software)

<http://vlab.amrita.edu/?sub=1&brch=282&sim=370&cnt=1>

Session 3 .Photovoltaic Cell - Construction & Working (Si based)

<https://www.youtube.com/watch?v=sXcsKzJylrA>

Session 4. Practice: UV visible analysis of photovoltaic material

<https://www.youtube.com/watch?v=s5uIVQGFDE4>

<https://www.youtube.com/watch?v=a9fSg2TREag>

Session 5. Concept of various types PN junction

<https://www.youtube.com/watch?v=4SIfaocMfdA>

Session 6. Practice: Measurement of photoluminescence (PL) behaviour of photovoltaic material

<https://www.youtube.com/watch?v=GqivfoW32rg&t=7s>

<https://www.youtube.com/watch?v=uZqXXafYoME>

Session 7. Role of materials for sustainable development of next generation photovoltaic cells

<https://www.youtube.com/watch?v=HEgYLOoE5MQ&feature=youtu.be>

Session 8. Practice: Make a solar cell TiO<sub>2</sub>/Raspberry based

<https://www.youtube.com/watch?v=WHTbw5jy6qU>

Session 9. Efficiency calculation of solar cell

<https://www.youtube.com/watch?v=IxFIewx54Ok>

<https://www.youtube.com/watch?v=IkVLQALtdQw>

Session 10. Nano-Photovoltaic (Graphene/CNT, ZNO, TIO<sub>2</sub>)

<https://www.youtube.com/watch?v=j4u09hi9DXI&t=150s>

<https://www.youtube.com/watch?v=BKomGuejwRA&t=55s>

<https://www.youtube.com/watch?v=Y2vvTPc30fE>

Session 11. Practice: Calculate the sun position at a given place and time and thereby study the variation in power production in a solar photovoltaic panel with respect to the change in incidence angle

<http://vlab.amrita.edu/?sub=77&brch=298&sim=1629&cnt=1>

Session 12. Composite materials for solar cell (Graphene/Al, TiO<sub>2</sub>-SiO<sub>2</sub> composite for solar cell)

<https://www.youtube.com/watch?v=BKomGuejwRA>

<https://www.youtube.com/watch?v=qDviZVbf7AA>

<https://www.youtube.com/watch?v=qvxHORuaTpY&feature=youtu.be>

Session 13. Practice: Specific charge/discharge characteristics of a Lithium- ion (Li- ion) battery

<http://vlab.amrita.edu/?sub=77&brch=270&sim=1540&cnt=1>

Session 14. Perovskite based solar cell (transition metal doped PbTiO<sub>2</sub>)

<https://www.youtube.com/watch?v=NSItaUCG46E>

Session 15. Dye-sensitized solar cell

<https://www.youtube.com/watch?v=8hertoGXWtE>

[https://www.youtube.com/watch?v=CWEKfxBc4\\_8](https://www.youtube.com/watch?v=CWEKfxBc4_8)

Session 16. Materials (Al/hybrid glass-carbon fiber) for wind energy conversion.

<https://www.youtube.com/watch?v=0uLmVDTwsno>

<https://www.youtube.com/watch?v=xyjLd957ITk>

**2. Renewable Energy Technology for Industrial Process (48 hrs)**

Session 18. Relevance of economic and financial viability evaluation of renewable energy technologies

[https://youtu.be/X9x\\_fSU2a6U](https://youtu.be/X9x_fSU2a6U)

Session 19. Practice: Site visit for acquire knowledge on different renewable energy technologies and it's system

Session 20. Basics of light to energy conversion and Concept on solar PV

<https://youtu.be/vzBkgMONIFo>

<https://youtu.be/1gta2ICarDw>

Session 21. Practice: Measurements and estimation of solar radiation

Session 22. Concept of mono crystalline, poly crystalline, amorphous

<https://youtu.be/Fip520UdeNU>

Session 23. Practice: Simulation of solar cell

Session 24. New generation solar cell, working principle and applications

[https://youtu.be/8t\\_DFI4O6v4](https://youtu.be/8t_DFI4O6v4)

Session 25. Practice: Identify and specify different types of components using in a solar PV system

Session 26. Practice: VI characteristics of Solar cell/module

Session 27. Working principle and applications

<https://youtu.be/ZYO83TkM0To>

Session 28. Practice: Temperature tracking of solar cell/module

Session 29. Effects of parameters on PV module power and efficiency

<https://youtu.be/JTDSPjDSrS8>

Session 30. Practice: Performance of Solar PV module at varying tilt angle

Session 31. Concept on Concentrated solar thermal (CST)

<https://youtu.be/tdivW7inP0k>

[HAND-NOTES-ON-SOLAR-THERMAL-ENGINEERING-pdf](#)

Session 32. Practice: Modelling of solar cooker

<https://www.youtube.com/watch?v=WPwDwjsAp4U&t=84s>

Session 33. Concentrated solar power (CSP)

<https://youtu.be/N1-zjbRqYXk>

Session 34. Practice: Modelling of solar flat plate collector

<https://www.youtube.com/watch?v=XWvr3OT1E1c>

<https://www.youtube.com/watch?v=s-Ysg6Xaf3c>

<https://www.youtube.com/watch?v=70Z5UNoywyE&t=223s>

Session 35. Concept of wind energy, Basic laws and efficiency limit for wind energy conversion.

[https://www.youtube.com/watch?v=qSWm\\_nprfqE](https://www.youtube.com/watch?v=qSWm_nprfqE)

Session 36. Practice: Generation of electricity by wind machines

Session 37. Concept of aerodynamics effects,description of horizontal and vertical axis wind turbine

<https://www.youtube.com/watch?v=65k2Nh8YHFI>

<https://www.youtube.com/watch?v=A-k2YGrpATo&t=13s>

Session 38. Practice: Maximum power point tracking of a wind turbine

Session 39. Practice: Performance testing of bio diesel in VCR machine

[https://www.youtube.com/watch?v=b1PbQ7jjVVM&list=PLniBGjZYcl478NRpoWh-YF\\_f2E90HZzda](https://www.youtube.com/watch?v=b1PbQ7jjVVM&list=PLniBGjZYcl478NRpoWh-YF_f2E90HZzda)

<https://www.youtube.com/watch?v=rrldwVGmmy4&t=161s>

[https://www.youtube.com/watch?v=KZ35K05SA7g&list=PLniBGjZYcl478NRpoWh-YF\\_f2E90HZzda&index=7](https://www.youtube.com/watch?v=KZ35K05SA7g&list=PLniBGjZYcl478NRpoWh-YF_f2E90HZzda&index=7)

### 3. Micro grid Design and Implementation (36 hrs)

- Session 41. Practice: Site survey (1 kW or 1MW)
- Session 42. Practice: Sizing of micro grid system (1kW/1MW)
- Session 43. Practice: Single line diagram of micro grid system
- Session 44. Practice: Identify and specify different components used in a micro grid system
- Session 45. Practice: Connection practice of solar modules in a micro grid system
- Session 46. Practice: Designing of micro grid system
- Session 47. Practice: Analysis of micro grid system
- Session 48. Practice: Designing of micro grid system with battery storage
- Session 49. Practice: Performance calculation of micro grid system
- Session 50. Practice: Connection practice of CCR/Inverter in a micro grid system
- Session 51. Practice: Test, record and verify the power quality of a micro grid system
- Session 52. Practice: O & M of micro grid system

### 4. Hybrid Renewable Energy Systems (48 hrs)

Session 53. Global scenario of Hybrid renewable energy system, integrated renewable energy systems with input sources

[https://youtu.be/j\\_fViOJbJLk](https://youtu.be/j_fViOJbJLk)

<https://youtu.be/TD0jZciQcaE>

Session 54. Practice: Modelling of renewable energy systems

Session 55. Selection of technology and components for efficient hybrid renewable systems

<https://youtu.be/ALsOcGkrev0>

Session 56. Practice: Connection practice of Solar PV-T System

Session 57. Concept on hybrid solar PVT system and its components

<https://youtu.be/hseYnkOQghI>

Session 58. Practice: Designing of solar PV system (On-grid/Off-grid)

Session 59. Synchronization process of renewable systems

[https://youtu.be/COz\\_w5l0nOw](https://youtu.be/COz_w5l0nOw)

Session 60. Practice: Designing of hybrid solar-thermal system

Session 61. Operation of hybrid solar-thermal system

<https://youtu.be/Lm7kmCaoeC4>

Session 62. Practice: Analysis of hybrid solar-thermal system

Session 63. Concept of hybrid PV and wind system and its components

<https://youtu.be/rPm-JHeD5Z0>

Session 64. Practice: Connection practice of PV-wind system

<https://www.youtube.com/watch?v=elZsUKcq3tw&t=9s>

Session 65. Operation of hybrid PV and wind system

<https://youtu.be/s458bCI8u2Q>

Session 66. Practice: Modelling of hybrid PV and wind power system

<https://www.youtube.com/watch?v=gzwDdo3iuSY>

Session 67. Load curve

[https://youtu.be/OQsk\\_4oqFmc](https://youtu.be/OQsk_4oqFmc)

Session 68. Practice: Demonstration of Load curve in the plant

<https://www.youtube.com/watch?v=b-ka2qObhzk>

Session 69. Concept of hybrid PV and hydro system and its components

<https://youtu.be/9qu5ryJBIII>

Session 70. Practice: Modelling of hydro power system

<https://www.youtube.com/watch?v=gdOaG8cKLuw>

Session 71. Concept of hybrid PV and Biomass system and it's components

<https://youtu.be/XboxQHzJPD4>

Session 72. Practice: Chemical composition of biomass system

Session 73. Practice: Study the dynamic behavior of wind turbines

<https://www.youtube.com/watch?v=aSwGUVqrBMQ>

Session 74. Practice: Emission testing of bio diesel/bio ethanol in gas analyser

### 5. Solar Off-Grid Entrepreneur (36 hrs)

Session 75. MNRE schemes and state wise subsidy process

<https://www.youtube.com/watch?v=xKxrkht7CpY>

<https://www.youtube.com/watch?v=xIXZmNUYcfI>

Session 76. Practice: Identify and specify different types of Solar PV Off grid products

<https://www.youtube.com/watch?v=JJYyD3oNd8w>

Session 77. Cost of different solar off grid systems components and Selection criteria of suitable components.

<https://youtu.be/bxFX7C383ig>

Session 78. Practice: Costing sheet preparation

Session 79. Selection criteria of suitable components

<https://youtu.be/HLV07G37rh0>

Session 80. Practice: Proposal preparation with payment terms and condition

Session 81. Assessment of business development

[https://youtu.be/RgNV2D2c5\\_w](https://youtu.be/RgNV2D2c5_w)

Session 82. Practice: Analysis and assessment of project cost

Session 83. Economic profile and power consumption trends

[https://youtu.be/L5v9jt4\\_ho](https://youtu.be/L5v9jt4_ho)

Session 84. Practice: Customer financial strength calculation

Session 85. Government and private bank funding lightening systems

<https://youtu.be/dJLbD7f5cDk>

Session 86. Practice: Identify the customer requirements for solar home lightening systems

Session 87. Solar off grid system manufacturers and suppliers

<https://youtu.be/2R3ahfcB68g>

Session 88. Right equipment should be installed in right place

<https://youtu.be/cG3bkKJGzoc>

Session 89. Attend and resolve customer queries

[https://youtu.be/hiIb4v\\_dnck](https://youtu.be/hiIb4v_dnck)

Session 90. Entrepreneurship skill

[https://youtu.be/CFtN\\_S1ekF4](https://youtu.be/CFtN_S1ekF4)

List of Projects/papers/jobs/products to be done in domain:

1. Study on Perovskite based material for the application of Solar cell
2. Preparation of solar based material and it's characterization
3. Efficiency enhancement of solar cell using rare earth materials
4. Design and development of solar powered lamps/street lights.
5. Design and development of of solar auto tracking system
6. Design and development of solar powered water pumping system
7. Design and development of solar operated grass trimmer
8. Design and development of solar powered pesticide sprayer

9. Design and development of solar powered leaf plate making machine
10. Design and development of solar powered bicycle
11. Design and development of solar powered sugarcane juice machine
12. Design and fabrication of solar dryer
13. Design and development of solar parabolic trough concentrator for water heating purpose
14. Design and development of solar cooker (box type or dish type)
15. Design and development of solar powered poly house system
16. Design and development of solar desalinization system
17. Design and development of solar operated blacksmith blower
18. Design and development of portable solar mobile charging station
19. Design and development of solar tree
20. Design and development of evacuated type of solar collector of water heating system
21. Design and development of torque control of wind turbine using energy analysis method
22. Analysis and design of generator side control of wind turbine
23. Design and development of micro-hydro power plant
24. Design and development of wind power system
25. Performance testing and comparison test of bio diesel in VCR Engine

## Operation and Maintenance of Electrical Grid System & Transformers

Domain Name	Code	Type of course	T-P-P	Pre-requisite
Operation and Maintenance of Electrical Grid System & Transformers	EGCU2090	Theory + Practice + Project	6-14-4	Nil

### TRACK TOTAL CREDITS:

Theory + Practice + Project: [6+14+4] (24)

### DOMAIN OBJECTIVES:

- To create technically trained manpower readily available for recruitment to the power/energy Companies & Transformer Manufacturing firms in the Electrical Sector.
- Develop digital prototypes of the products and validate them and innovate for design efficiency

### DOMAIN OUTCOMES:

- CO1 Able to gain Knowledge of making commercially used distribution transformer
- CO2 Able to identify and resolve the problem in manufacturing of transformers.
- CO3 Able to develop skills in the design of transformers and report generation of making commercially used distribution transformer
- CO4 Hands-on experience in Transformer Maintenance & Testing
- CO5 Implement different Software-Controlled (MATLAB) tools to validate the theory and practical studies

### COURSE OUTCOME TO PROGRAM OUTCOME MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	2	3	3				2	1		2	3	2	1
CO 2	3	3	1	3	3				1			1	3	3	2
CO 3	2	3	1	3	3				2	1		3	3	2	3
CO 4	3	3	1	3	3				1			3	2	2	2
CO 5	3	3	1	3	3				1			3	1	1	2

- \*HIGH-3, MEDIUM-2, LOW-1

## DOMAIN STRUCTURE:

The Domain will consist of following components and these components will be reflected in the grade sheet.

- CUEG 2090: Introduction, Power Scenario, Power Quality & Faulty clearance, [1-1-0]
- CUEG 2091: Switchyard & substation Networks, [1-2-0]
- CUEG 2092: Protection scheme & Switchgear, [1-2-0]
- CUEG 2093: Cable system & Testing, [1-2-0]
- CUEG 2094: Power Markets, [1-0-0]
- CUEG 2095: Grid Safety, [0-2-0]
- CUEG 2096: Transformer Manufacturing, [1-5-0]
- CUEG 2097: Project, [0-0-4]

The Domain will be delivered through case studies, assignments and product development Product Development Stack :

1. Distribution Transformer ( Full product)
2. Smart Energy Meter ( Modular Platform design and electric power train design , BIW)

### Session Plan for the Entire Domain:

#### Course 1: Generation, Transmission & Distribution scenario in India

[Interactive + Modelling], [1-1-0], [20 Hrs]

1. Types of generation: Conventional and Non-conventional,
2. Thermal Power Plant, Hydro Power Plant,
3. Gas Power Plant, Nuclear Power Plant,
4. Co-generation Various sources Non-conventional Energy Sources.
5. Role of computers in distribution system planning-Load modelling
6. characteristics: definition of basic terms and loss factor
7. Classification of loads and their characteristics.
8. Distribution Feeders and Substations: Design consideration of Distribution feeders: Radial and loop types of primary feeders, voltage levels, and feeder-loading.

#### Video Links

- [https://www.youtube.com/watch?v=lh5\\_7sHyLU4](https://www.youtube.com/watch?v=lh5_7sHyLU4)
- [Hydro Power](#)
- [Gas Power Plant](#)
- [Nuclear Power Plant](#)
- 1.4.1 [Co-Generation](#)

#### Practice

1. Load Modeling
2. Substation Modeling

#### Course 2: Switchyard/Substation Types

[Lab Practice in Own Distribution Network, Modelling], [1-2-0], [20 Hrs]

1. Single line diagram/equipments [Equipments-transformer, CB, fuse etc.]
2. Relays, Relaying schemes and auxiliaries Wiring Diagram
3. Layout of Sub-Station(33/11KV S/S, 220/33KV S/S)
4. Indoor and outdoor busbars — bus-bar mountings and their clearances.
5. Designing Electrical Transmission Tower Types and Design

### Video Links

- [Substation layout](#)
- [Transmission Tower Design](#)

### Practice

1. Design 33/11 KV substation
2. Single Line layout of substation

### Course 3: System Protection & Auxiliaries

[Field Visit+ Lab Practice in Own Distribution Network] [1-2-0] [20 Hrs]

1. CT & PTs, Local & Back-up Protection. Protection Schemes,
2. New Generation Relays, Different types of indoor and outdoor CB, Breaker Maintenance,
3. Lightening Arrestors/Surge Arrestors, Isolators And Insulators,
4. Grounding system, Auxiliary System in Switchyard/Substation

### Video Links

- [CT, PT, Relay](#)
- [Distance Protection](#)
- [Grounding/Earthing](#)

### Practice

1. Design Over current Protection for sub-station Feeder.
2. Measuring Earth Insulation Resistance

### Course 4: Cables in Electrical System

[Visit to Standard Testing Lab, Workshop Practice], [1-2-0], [20 Hrs]

1. Modern trends in Underground Cabling Basic Concepts,
2. Materials Used in Cables, Conductors,
3. Testing and Commissioning of cables,

### Video Links

- [Under Ground Cable](#)
- [Cable Laying](#)

### Practice

1. IR Test of Cable
2. Cable Jointing

### Course 5: Power System Market, Markets For Electrical Energy, Energy Conservation

[Interactive], [1-0-0] [3 Hrs]

1. Electricity Business
2. Electricity Market Models
3. Power Transfer, Inter & Intra State
4. Energy Efficiency in Grid
5. Energy conservation measures

### Video Links

- [Power Market Fundamental](#)
- [Power Exchange](#)
- [Energy Conservation](#)

### Practice

1. Developing Market Model for electricity trading

## **Course 6: GRID Safety Norms, Electrical Accidents and prevention, Electricity Costing & Audit,**

[Field Survey], [0-2-0], [5 Hrs]

6.1 Safety Requirement, Hazards, Electrical Accidents and prevention, First Aid

6.2 Safety : Safety Philosophy, Safety Procedures, GRID Safety Norms, Procedures for issuing L.C.P. and cancellation, Maintenance of Safety records.

6.3 First Aid : Places of Potential Hazards, Electric Shock Treatment, Artificial Respiration, Handling Emergency Conditions, Treatment of Wounds, Injuries & Burns.

6.4 Fire Fighting: Causes of Fire, Fire Extinction, Classification of Fires, Fire Fighting, Equipment: their

operation – maintenance & refilling, Fire prevention.

6.5 Energy Audit.

### **Video Link**

- [General Grid Safety](#)
- [Industrial Safety](#)
- [Electrical Shock First Aid](#)
- [Fire Extinguisher](#)

### **Practice**

Hazard Analysis & Mitigation

## **Course 7: Principles of transformer**

[DS Tools, Workshop Practice], [1-5-0], [20 Hrs]

7.1 Inner & Outer Part of Transformer,

7.2 Manufacturing of Transformer,

7.3 Transformer Test,

7.4 Conditions leading to faults in Transformer,

7.5 Maintenance of transformer

### **Practice**

1. Transformer Manufacturing
2. Transformer Testing
3. Fault Finding & Corrective action
6. **List of Projects/products to be done in domain: [200 Hrs]**
  1. Substation layout & Placement of equipment.
  2. Protection System of 33/11/0.4 KV substation.
  3. O & M of distribution substation.
  4. Energy Audit
  5. Safety Practice.

6. Transformer Manufacturing & Testing.

EVALUATION: As per Central QA system policy

## Industrial Automation

Code	Course Title	(Credit)	T-P-PJ
IACU2100	Industrial Automation	24	5-9-10

Course Code	Course Title	Credits	Type T-P-PJ
CUIA2100	Introduction to Industrial Automation	1	1-0-0
CUIA2101	Advanced Programming & Control Blocks of PLC	3	1-2-0
CUIA2102	Control & Signal Wiring of PLC	2	0-2-0
CUIA2103	SCADA based advanced features	2	1-1-0
CUIA2104	SCADA & PLC based sequential control	1	0-1-0
CUIA2105	Human Machine Interface	3	1-2-0
CUIA2106	OPC server base data fetching & control	2	1-1-0
CUIA2107	Project	6	0-0-6
CUIA2108	Internship	4	0-0-4
	<b>Total Credits</b>	<b>24</b>	

### Domain Track Objectives

- To upgrade knowledge levels needed for modern industries.
- Process & sequential control logic of industry.
- Project-based training.

### Domain Track Course Outcomes

- CO1 Able to gain knowledge on the installation of Industrial Automation concept
- CO2 Understand automation technologies and identify advantages, limitations and applications of the same
- CO3 Able to identify and resolve the hardware/software problems of automation
- CO4 Analyze & explain different functions of PLC
- CO5 Able to develop the skill of create automatic control systems and controllers for a particular application.

### COURSE OUTCOME TO PROGRAM OUTCOME MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	2	3	3				2	1		2	3	2	1
CO 2	3	3	1	3	3				1			1	3	3	2
CO 3	2	3	1	3	3				2	1		3	3	2	3
CO 4	3	3	1	3	3				1			3	2	2	2
CO 5	3	3	1	3	3				1			3	1	1	2

- \*HIGH-3, MEDIUM-2, LOW-1

### DOMAIN SYLLABUS

#### Course – 1: INTRODUCTION TO INDUSTRIAL AUTOMATION

- 1.1 Automation Uses
- 1.2 Automation - PLC Basics
- 1.3 Mechanical relays versus PLC
- 1.4 Functions of various blocks and working principle of advanced blocks.

#### Course – 2: ADVANCED PROGRAMMING & CONTROL BLOCKS OF PLC

- 2.1 CPT, ADD, SUB, MUL, DIV, SQR, NEG, TOD, FRD
- 2.2 MOV, MVM, AND, OR, XOR, NOT. CLR.
- 2.3 BSL, BSR, SQC, SQL, SQO, FFL, FFU, LFL, LFU
- 2.4 JMP, LBL, JSR, MCR
- 2.5 Connecting PLC software with SCADA software

#### Practice:

- P2.1 - Comparison of industry based analog signals.
- P2.2 - Detecting different product output of an industry
- P2.3 - Sequential control of an industry by using advanced blocks.
- P2.4 - Emergency control system of an industry

P2.5 - Connecting PLC software with SCADA software

### **Course – 3: CONTROL & SIGNAL WIRING OF PLC**

- 3.1 Control wiring of PLC.
- 3.2 PLC, Sensor and field instruments signal flow wiring.
- 3.3 Device connectivity

#### **Practice:**

- P3.1 PLC input/output wiring concept.
- P3.2 Connecting relay, contactor, sensors and other field instruments.
- P3.3 Controlling an industry motor using STAR-DELTA connection

### **Course – 4: SCADA BASED ADVANCED FEATURES**

- 4.1 Alarms
- 4.2 Trends, Data base connectivity & Report generation
- 4.3 Recipe management
- 4.4 Security

#### **Practice:**

- P4.1 - Data fetching and representing on graph and excel
- P4.2 - Advanced controlling of industry by using SCADA

### **Course – 5: SCADA & PLC BASED SEQUENTIAL CONTROL**

- 5.1 Script
- 5.2 Networking
- 5.3 Device connectivity.

#### **Practice:**

- P5.1 Script
- P5.2 Networking
- P5.3 Device connectivity

### **Course – 6: HUMAN MACHINE INTERFACE**

- 6.1 What is HMI. Use of HMI
- 6.2 Concept of different operational features
- 6.3 Connectivity of HMI and PLC.

#### **Practice:**

- P6.1 Alarms
- P6.2 Security
- P6.3 Recipe manager

## **Course – 7: OPC SERVER BASE DATA FETCHING & CONTROL**

- 7.1 Study of Open Platform Communications
- 7.2 OPC to control PLC, SCADA.
- 7.3 OPC based different protocol concept.
- 7.4 Data handling using OPC.

### **Practice:**

- P7.1 Installation of OPC
- P7.2 OPC protocols
- P7.3 Connectivity of PLC, SCADA & ARDUINO to OPC.

## DOMAIN TRACK TITLE: ELECTRIC VEHICLE DESIGN

### TRACK TOTAL CREDITS (8-8-6): 22 CREDITS

#### COURSES DIVISION:

1. CODE: CUEV2460 Electric Vehicle Technology	(1-1-0)
2. CODE: CUEV2461 Electric Vehicle Powertrain Design	(2-2-0)
3. CODE: CUEV2462 Electric Vehicle Battery Design	(2-2-0)
4. CODE: CUEV2463 Autonomous Electric Vehicle	(2-2-0)
5. CODE: CUEV2464 AUTOSAR and VCU/ECU Design for EV	(1-1-0)
6. CODE: CUEV2465 Project	(0-0-6)

#### DOMAIN TRACK OBJECTIVES:

- Selection of E – Motors for Electric Vehicles- BLDC/PMSM/INDUCTION/SYNCHRONOUS MOTOR.
- Motor Control Technology for Electric Vehicle applications.
- Lithium Batteries and Battery Pack Design for Electric Vehicle Applications.

#### DOMAIN TRACK COURSE OUTCOMES:

After the completion of the course, students will be able to

- **CO1** Understand the fundamentals of electric Vehicle technology.
- **CO2** gain Knowledge on the working of an electric vehicle powertrain design.
- **CO3** Gain a basic understanding of the design of Battery management systems for electric vehicles.
- **CO4** Design the basic requirement of autonomous electric vehicle design
- **CO5** Explore the basic AUTOSAR architecture platform to design the electric vehicle.

#### COURSE OUTCOME TO PROGRAM OUTCOME MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
<b>CO1</b>	3	3	2	2	3	1	3			2	2	2	3	2	3
<b>CO2</b>	3	3	1	1	3	2	2		2	2	2	1	3	3	2
<b>CO3</b>	2	3	1	3	3	2	2		2	1	1	3	3	2	2



CO4	3	3	1		3	2	2		2	2	1	3	2	2	2
CO5	3	3	1	2	3	1	1		3	1	1	3	1	1	1

- **\*HIGH-3, MEDIUM-2, LOW-1**

### Course-I (1-1-0)-30 Hrs

#### ELECTRIC VEHICLE TECHNOLOGY

This essential level course will help you understand vehicle dynamics, drivetrain systems, battery management systems, and auxiliary systems. Topics covered include:

#### DOMAIN TRACK OBJECTIVES:

- Selection of E-Motors for Electric Vehicles-  
BLDC/PMSM/INDUCTION/SYNCHRONOUS MOTOR
- Motor Control Technology for Electric Vehicle applications

#### DOMAIN TRACK COURSE OUTCOMES:

After the completion of the course, students will be able to

- CO1 Understand the fundamentals of electric Vehicle technology.
- CO2 Gain knowledge on the selection of different electric motors to configure electric vehicles
- CO3 Implement different topologies to make their own electric vehicles.
- CO4 Gain a basic understanding of the design of battery management systems for electric vehicles.
- CO5 Design the different Electric Vehicles with MATLAB and Dymola

#### MODULE-I

##### Introduction to EV

- What is an Electric Vehicle?
- History of Electric Vehicles
- Types of Electric Vehicles
- Working Principles of Different Electrical Vehicles (EV)
- Components of an Electric Vehicle
- How does an Electric Vehicle Work?

- How does the electrical motor in an EV operate?
- How is charging carried out in EVs?
- Features of Electric Vehicles
- Advantages of Electric Vehicles
- Disadvantages of Electric Vehicles
- EV charging systems

## **MODULE-II**

### **EV Configuration**

- Electric propulsion
- Energy source
- Auxiliary system
- Conventional Driveline with multi-gear transmission and clutch
- Single gear transmission without gear and clutch
- Integrated fixed gear and differentials
- Two separate motors and fixed gears with their drive shafts
- Direct drive with two separate motors and fixed gears
- Two separates in wheel motor drive
- The electric propulsion subsystem comprises of:
  - The electronic controller
  - Power converter
  - Electric Motor (EM)
  - Mechanical transmission
  - Driving wheels

### **Main Parts of EV**

- Battery
- Controller
- Gearbox
- Differential
- Breaking Arrangements
- Wheels

## **MODULE-III**

### **Types of EV**

- Plug-in Electric Vehicle
- On- and Off-road Electric Vehicles

- Space Rover Vehicles
- Seaborne Electric Vehicles
- Airborne Electric Vehicles
- Electrically Powered Spacecraft
- Range-extended electric vehicle
- Railborne Electric Vehicles

## **MODULE-IV**

### **Introduction to EV Motors**

- Electric Motors
- Synchronous Motor
- Induction Motor
- DC Motor
- BLDC Motor
- PMSM Motor

## **MODULE-V**

### **Introduction to EV controller**

- Motor Control Circuitry
- Control Sequence of BLDC Part 1
- Control Sequence of BLDC Part 2
- Hall Sensor vs Back EMF Feedback

## **MODULE-VI**

### **Introduction to Energy Systems and Batteries**

- Battery Introduction
- Introduction to Lithium Ion Battery
- Types of Cells
- Types of Lithium Polymer Batteries

### **References:**

1. [https://www.slideshare.net/venkateshkumarchsm/configuration-of-ev-2?from\\_action=save](https://www.slideshare.net/venkateshkumarchsm/configuration-of-ev-2?from_action=save)

## **COURSE-II (2-2-0)-36 HRS**

## **ELECTRIC VEHICLE POWER TRAIN DESIGN**

A comprehensive course that takes you through the design, Modeling, and simulation of EV powertrain and components. Topics covered include:

### **COURSE OBJECTIVES:**

- Design electric powertrain for Electric Vehicles.
- Selection of different parameters for powertrain design
- Calculation of power requirements to drive an EV

### **DOMAIN TRACK COURSE OUTCOMES:**

After the completion of the course, students will be able to

- CO1 Get knowledge on various types of EV configuration
- CO2 Assemble all types of Hybrids electric EVs
- CO3 Make an efficient combination of Battery and Powertrain to achieve better EV performances
- CO4 Select the appropriate electric motor and speed performance
- CO5 Design a proper controller to drive the EV motor

## **MODULE-I**

### **Fundamentals of Electric Vehicle**

- Vehicle Basics
- vehicle model
- Vehicle Resistance:
  - Rolling Resistance
  - Aerodynamic Drag
  - Grading Resistance
  - Dynamic Equation Tire–Ground Adhesion
  - Maximum Tractive Effort
  - Power Train Tractive Effort and Vehicle Speed
  - EV Powertrain Component Sizing

### **Hybridization of the Automobile:**

- Basics of the EV,
- Basics of the HEV,

- Basics of Plug-In Hybrid Electric Vehicle (PHEV) and vehicle architectures: Series Hybrid Vehicle, Parallel Hybrid Vehicle, Basics of Fuel Cell Vehicles (FCVs).

## **MODULE-II**

### **Electric Machines and Drives:**

- Working principle of motors
- Motors for EVs
  - BLDC
  - PMSM
  - Hub Motor
  - Mid-Drive Motor
  - Synchronous Reluctance Motor
- Motor selection
  - Traction Force
  - Rolling Force
  - Force due to Air Drag (Fad)
  - Gravitational Force
  - Inertia Force
- Calculation of motor power
- Motor RPM, Torque, and Voltage estimation
  - Torque on Wheel
  - Torque on Motor
  - RPM on Wheel
  - RPM on Motor
- Motor wiring diagram

## **MODULE-III**

### **Controller Selection**

- **Selection of Control Parameters for Motors**
  - Controller Peak DC current
  - Trapezoidal or Field Oriented Controller
  - Speed Control mode or Torque Control mode
  - Communication Protocols
  - Operation Control

## MODULE-IV

### Battery Selection

- Introduction
- Factors influencing the operation of a battery
- How climate conditions can affect the operation of traction batteries
- Battery working currents in electric vehicles
- Battery pack architectures
- Battery pack calculation

## MODULE-V

### Motor Control methods

- Controller introduction
- Controller wiring and Convertor

## MODULE-VI

### EV Transmission

- Single Speed Transmission
- Two Speed Transmission
- Comparison between Single speed and Multispeed Transmission
- Torque Vs Speed
- Efficiency

### References:

1. <https://mpcomagnetics.com/blog/the-many-types-of-ev-motors/>
2. <https://www.engineering.com/story/the-many-types-of-ev-motors>

## COURSE III (2-2-0)-36 HRS

### ELECTRIC VEHICLE BATTERY DESIGN

The course deals with designing, modelling, and running simulation tests of EV batteries and components. Topics covered include:

## **DOMAIN TRACK OBJECTIVES:**

- Lithium Batteries and Battery Pack Design for Electric Vehicle Applications.
- Lithium-Ion Battery Management Systems.

## **COURSE OBJECTIVES:**

- Design their own battery assembly unit
- Selection of Battery Management System for Electric Vehicles
- Calculation of Requirement of Battery
- To know the application of different batteries available for electric Vehicle

## **DOMAIN TRACK COURSE OUTCOMES:**

After the completion of the course, students will be able to

- CO1 Gain a basic understanding of the design of battery chemical properties for electric vehicles.
- CO2 Make a Battery Management System for different battery pack
- CO3 Design the different Li-Ion Battery assembly
- CO4 Design Digital Prototype using MATLAB
- CO5 Setup own Battery Manufacturing and Assembly Unit

## **MODULE-I**

### **Electric Vehicles Battery Technology**

- Introduction
- What is a Battery, and why it is used?
- Cell, Power capability
- Nominal voltage
- Charging current
- Charging Voltage
- Charging Current
- Shelf Life
- Cut-off Voltage
- Cycle life,
- Power density

## **MODULE-II**

### **Battery Types**

- Types of Batteries
- Non-rechargeable Battery-Alkaline Batteries
- Coin cells Batteries
- Rechargeable Batteries-Lead-acid Batteries
- Ni-Cd Batteries
- Ni-MH batteries
- Li-ion batteries
- Li-Po batteries
- Why do we Use LI-ion batteries?
- Advantages of Lithium-ion
- Disadvantages of Lithium-ion
- Caution, Fuel cells
- Super-capacitors
- Flywheels

### **MODULE-III**

#### **Battery Pack Topology**

- Battery Pack Topology
- Parallel-cell Module (PCM)
- Series -Cell Module (SCM)
- Thermal Runaway
- Cell Degradation
- Incomplete charging of Pack
- Incomplete use of Pack energy
- SOC Imbalance
- Temperature
- Internal resistance variation

### **MODULE-IV**

#### **Cell Balancing**

- Why do we need Cell Balancing?
- What causes Cell unbalancing in battery packs?
- Cell Balancing During Discharge
- Cell Balancing While Charging
- Types of Battery Cell Balancing
- Passive: Fixed shunt Resistor
- Passive: Switched Shunt Resistor
- Active cell balancing-Active:
  - Multiple Switched capacitors

- One switched capacitor
- Switched Transformer
- Shared Transformer

## MODULE-V

### BMS Design Considerations

- Introduction,
- Why do we need a BMS?
- General BMS functionality,
- BMS Architecture,
- BMS Slave Role,
- BMS Master Role,
- Is slave design reusable?
- Is master design reusable?
- The issue of cost

### PRACTICE

- Lead-acid cell design.
- 1c Li-ion cell design.
- 3c Li-ion cell design.
- Cells series connection.
- Cells parallel connection.
- Fixed shunt Passive cell balancing.
- Switched Shunt Resistor Passive cell balancing
- Battery pack design.
- Battery thermal cooling.
- BMS design
- Charging system design using MATLAB

### References

1. **Li-Ion Battery Pack Design for Electric Vehicles (2023) by Udemy**
2. **The Handbook of Lithium-Ion Battery Pack Design: Chemistry, Components and Type and Terminology by John Warner, ELSEVIER**

## **COURSE IV (2-2-0)**

### **AUTONOMOUS ELECTRIC VEHICLE**

An autonomous vehicle (robotic car, driverless car) is an automobile capable of transporting passengers without the need for human direction or interaction.

#### **COURSE OBJECTIVES:**

- To design and build a vehicle that will be able to navigate from one location to another along the sidewalks without human intervention.
- To create autonomous EVs with proper drive and transmission systems
- To develop a design skill with level six automation standards.

#### **DOMAIN TRACK COURSE OUTCOMES:**

After the completion of the course, students will be able to

- CO1 Understand the fundamentals of electrical vehicle navigation system and its use in Autonomous EV
- CO2 Analyse the different transmission parameters required for Autonomous EVs
- CO3 Solve the mechanical problems related to the design of the drive systems the Autonomous EVs.
- CO4 Develop critical thinking skills to make a control strategy for guiding Autonomous EVs
- CO5 Design and analysis of different components used in Autonomous EVs using software and micro controllers.

### **MODULE-I**

#### **Introduction to Autonomous Vehicles.**

- Definition
- Levels of driving automation
- How Do Autonomous Cars Work?
- What are the Challenges with Autonomous Cars?
- What are the Benefits of Autonomous Cars?

### **MODULE-II**

#### **Introduction to Proteus software.**

- Concept of controllers (Arduino, Node-MCU, and Teensy)

#### **PRACTICE:**

- Use of Arduino IDE software and programming
- Use of Node-MCU and programming.
- Use of Teensy and programming.
- Hardware and software handshaking concept using Proteus.
- Different sensor connectivity with controllers.
- Applications of sensors for E-Vehicles using controllers.

### **MODULE-III**

#### **Vehicle tracking system**

- What is a Vehicle Tracking System?
- What is GPS?
- What is GPRS (General Packet Radio Service)
- How does the Vehicle Tracking System work?
- What are the objectives of the vehicle tracking system?
- What is tracking and types?

#### **PRACTICE:**

- GPS tracking.

### **MODULE-IV**

#### **Vehicle guiding and control system.**

- Navigation, guidance, and control (NGC) system

#### **PRACTICE:**

- IOT guiding system.
- Battery management for the power train.

### **MODULE-V**

#### **Transmission of power from prime mover to load.**

- Working of differential
- Torque and Power calculations
- RPM at the Wheel

### **MODULE-VI**

#### **Gear system and chain transmission.**

- Gear arrangements and the wheel
- Gear arrangement at the differentials

- Direct motor drive system or Chain drive system

## MODULE-VI

### Electrical harnessing.

#### PRACTICE:

- Electrical fittings control using a controller.
- Vehicle harnessing by adding a controller.
- Autonomous Vehicle Controls using MATLAB and Simulink.

#### References:

1. <https://www.synopsys.com/automotive/what-is-autonomous-car.html#:~:text=Autonomous%20cars%20rely%20on%20sensors,different%20parts%20of%20the%20vehicle.>
2. <https://www.arvento.com/en/what-is-a-vehicle-tracking-system#:~:text=With%20its%20simplest%20definition%2C%20a,basis%20tanks%20to%20GPS%20satellites.>

### Course V-(1-1-0)-30 Hrs

### AUTOSAR and VCU/ECU for EV

#### Course Objectives:

- To fulfil future vehicle requirements, such as availability and safety, SW, upgrades/updates, and maintainability
- To increase scalability and flexibility to integrate and transfer functions
- To improve containment of product and process complexity and risk
- To accelerate development and maintenance.

#### Domain Track Course Outcomes:

After the completion of the course, students will be able to

COs	Course outcomes
CO1	Understand the fundamentals of such AUTOSAR architecture, methodology, configuration, etc.
CO2	Develop software components and integrate them into the AUTOSAR architecture
CO3	Develop the logic for the hardware components of automotive systems such as microcontrollers, sensors, and actuators
CO4	Develop AUTOSAR Classic & Adaptive Applications with Model-Based Design

## MODULE-I

### Introduction

- Introduction to AUTOSAR
- Need for AUTOSAR
- Objectives of AUTOSAR

### PRACTICE:

- Simulink for Adaptive AUTOSAR

## MODULE-II

### AUTOSAR Layered Architecture

- AUTOSAR Architecture and layers
- Simplified AUTOSAR layered architecture

### PRACTICE:

- Design software architectures by Modeling AUTOSAR architectures in Simulink

## MODULE-III

### Types of AUTOSAR

- Classic Platform
- Adaptive Platform

### PRACTICE:

- Develop AUTOSAR Classic & Adaptive Applications with Model-Based Design
- AUTOSAR Classic & Adaptive Made Easy with Model-Based Design

## MODULE-IV

### AUTOSAR Basic Software (BSW) Tutorial

- AUTOSAR BSW layers
  - Microcontroller Abstraction Layer (MCAL),
  - ECU Abstraction,
  - Services layers and Complex device driver (CDD)
- AUTOSAR Interfaces
  - AUTOSAR Interface,
  - Standardised AUTOSAR interface,
  - Standardised Interface

### PRACTICE:

Simulate and Generate Code for Adaptive AUTOSAR Methods in Simulink

## MODULE-V

### Virtual Function Bus

- Communication between SWCs across different ECUs with the help of VFB

## MODULE-VI

### AUTOSAR Run Time Environment (RTE)

- AUTOSAR RTE Layer (Run Time Environment)
- RTE APIs for Sender Receiver and Client Server Interface
- RTE Layer Communication and Scheduling
- RTE Generator and Tools overview
- Uses Or Application Of RTE
- Generation Of RTE
- Relationship Between Files After RTE Generation

### References:

1. <https://www.autosar.org/>
2. <https://www.udemy.com/course/autosar-architecture/>
3. <https://ch.mathworks.com/help/autosar/ug/example-simulate-autosar-basic-software-services.html>
4. <https://ch.mathworks.com/help/autosar/ug/autosar-platform-comparison.html>
5. <https://autosartutorials.com/autosar-run-time-environment/>

Course VI (0-0-6)-200 Hrs

Projec

## POWER SYSTEM OPERATION & CONTROL (2+1+0)

Code	Course Title	(Credit)	T-P-PJ
CUTM 2582	Power System Operation & Control	3	2-1-0

### OBJECTIVE

- To learn the basic control technique involved in power system operation
- To demonstrate the economic operation of power systems, hydrothermal scheduling
- To provide a solid foundation in mathematical and engineering fundamentals required to control the governing system in turbine models

### COURSE OUTCOME

After the completion of the course, students will be able to

- CO1 Know the fundamentals of the per-unit system and its importance
- CO2 Design the load flow solution by using different techniques
- CO3 Assess the stability problems of a power system
- CO4 Determine the economical load distribution between the generating buses incorporating the transmission losses
- CO5 Describe automatic generation control schemes and methods to analyze active and reactive power control on a power system using simulation tools

### COURSE OUTCOME TO PROGRAM OUTCOME MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	2	2	3	1			1			2	3	2	1
CO 2	3	3	1	1	3	1			1			1	3	3	2
CO 3	2	3	1	3	3	1			2	1		2	3	2	3
CO 4	3	3	1		3	1			2	1		3	2	2	2
CO 5	3	3	1	2	3	1			1			3	1	1	2

**\*High-3, Medium-2, Low-1**

### Course Content

#### Module – I (5 Hours)

Per- Unit Quantities, The Single Line or One Line Diagram, Impedance and Reactance Diagrams, The Admittance Models & Network Calculations, Branch and Node Admittances, Mutually Coupled Branches in Ybus, Modification of Ybus.

### **Module II (6 Hours)**

The Power-Flow Problem, The Gauss-Seidal Method, The Newton-Raphson Method, The Newton-Raphson Method, Power-Flow Studies in System Design and Operation, Regulating Transformers, The Decoupled Method.

### **Module-III (7 Hours)**

Power System Stability, Swing equation, Equal area criterion for stability, critical clearing angle, point by point Methods of improvement of transient stability, Symmetrical and unsymmetrical fault analysis for power system, L-G, L-L-G, three phase fault, analysis, Z bus Algorithm, Z bus method in fault analysis.

### **Module-IV (6 Hours)**

Economic Operation of Power System: Distribution offload between units within a plant, Transmission losses as function of plant generation, Calculation of loss coefficients, Distribution of loads between plants with special reference to steam and hydel plants, Automatic load dispatching. Optimal Power Flow.

### **Module-V (6 hours)**

Load frequency control, PF versus QV control, Modelling of speed governing system, Division of power system into control areas, Single area control and two area control. On load tap changing transformer and block regulating transformer, effects of regulating transformers.

### **HARDWARE-BASED**

1. To determine the negative and zero sequence synchronous reactance of an alternator.
2. To determine the sub-transient direct axis and sub-transient quadrature axis synchronous reactance of a 3-ph salient pole alternator.
3. To determine fault current for L-G, L-L, L-L-G and L-L-L faults at the terminals of an alternator at very low excitation.
4. To study the IDMT over-current relay and with different plug settings and time setting multipliers and plot its time-current characteristics.
5. To determine the operating characteristics of biased differential relays with different % of biasing.
6. To determine the location of fault in a cable using a cable fault locator.
7. Insulation test for Transformer oil.

### **SOFTWARE PRACTICE**

1. To obtain steady-state, transient, and sub-transient short circuit currents in an alternator.
2. To study the load flow analysis using Newton Raphson method.
3. To compute voltage, current, power factor, regulation at the sending end of a 3-  $\emptyset$  transmission line when the voltage, power, current is given at the receiving end line. Using  $\pi$  model.
4. Designing of transmission line parameters using MATLAB
5. Designing of Insulators and calculation of voltages using MATLAB/ Calculation of Y-Bus Matrix.
6. Root-locus calculation using MATLAB.

## Recommended Books:

- [1]. John J Grainger, W. D. Stevenson, “Power System Analysis”, TMH Publication
- [2]. P. Kundur, “Power System Stability and Control”, TMH Publication
- [3]. C. L. Wadhwa, “Electric Power System”, New Age Publishers.
- [4]. An Introduction to Electric Energy System Theory- By O. I. Elgerd, TMH Pub, 2nd Edition

## ENERGY AUDITING & DEMAND SIDE MANAGEMENT

Code	Course Title	(Credit)	T-P-PJ
CUEE1012	Energy Auditing & Demand Side Management	3	2-1-0

### COURSE OBJECTIVES:

- The growing worldwide concern for the conservation of energy has reawakened interest in ecological sustainability, processes, and sources of energy.
- The better ways to conserve energy from energy audit concepts, Representations and energy conservation schemes.
- Evaluation of the lifetime of the machine based on time value money and demand, economic analysis with respect to demand side management models

### COURSE OUTCOME

After the completion of the course, students will be able to

- CO1 Understand the fundamentals of the current energy scenario, energy management, auditing, conservation, economic analysis, and demand-side management.
- CO2 Gain Knowledge on the skills in assessing energy efficiency, energy auditing, and energy management.
- CO3 Gain a basic understanding of designing controllers for a particular application in demand-side management.
- CO4 Solve the basic problem related to Demand Side Management using MATLAB and other power system simulation software
- CO5 Secure the energy deficiency and overload that occurs to the power system by optimizing the distribution strategies

## COURSE OUTCOME TO PROGRAM OUTCOME MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	2	2	3				1			1	3	2	1
CO 2	3	3	1	1	3				1			1	3	3	2
CO 3	2	3	1	3	3							1	3	2	
CO 4	3	2	1		3				3	1		2	2	2	2
CO 5	3	3	1	2	3				2	1		2	1	1	2

**\*High-3, Medium-2, Low-1**

### Course content

#### Module I: ENERGY AUDITING (6 Hours)

- Energy Situation — World and India, Energy Consumption, Conservation, Codes, Standards and Legislation. Energy Audit- Definitions, Concept, Types of Audits, Energy Index, Cost Index, Pie Charts, Sankey Diagrams, Load Profiles, Energy Conservation Schemes. Measurements in Energy Audits, Presentation of Energy Audit Results.

#### Practice:

- **Proposed Practice for EA and DSM Lab**
- **Energy audit of buildings and proposed energy consumption reduction techniques.**

#### Module II: ENERGY EFFICIENT MOTORS (10 Hours)

- Energy Efficient Motors, Factors Affecting Efficiency, Loss Distribution, Constructional Details, Characteristics - Variable Speed, Variable Duty Cycle Systems, RMS - Voltage Variation-Voltage Unbalance- Over Motoring- Motor Energy Audit.

#### Practice:

- Energy audit of workshops and proposed energy consumption reduction techniques.

### **Module III: POWER FACTOR IMPROVEMENT (8 Hours)**

- Power Factor — Methods of Improvement, Location of Capacitors, pf with Non-Linear Loads

#### **Practice: .**

- Time-of-use load shifting and intelligent load management.

### **Module IV: LIGHTING AND ENERGY INSTRUMENTS (4 Hours)**

- Good Lighting System Design and Practice, Lighting Control Lighting Energy Audit – Energy Instruments- Watt Meter, Data Loggers, Thermocouples, Pyrometers, Lux Meters, Tongue Testers, Application of PLCs

### **Module V: ENERGY ECONOMIC ANALYSIS (5 Hours)**

- The Time Value of Money Concept, Developing Cash Flow Models, Payback Analysis, Depreciation, Taxes and Tax Credit — Numerical Problems. Management and Organization of Energy Conservation Awareness Programs.

#### **Practice:**

- **HVAC System: Cost Saving through Heat Transfer and Cooling**

### **Module VI: DEMAND SIDE MANAGEMENT (5 Hours)**

- Introduction to DSM, Function of load dispatch centre (SLDC and RLDC), Concept of DSM, Benefits of DSM, Different Techniques of DSM — Time of Day Pricing, Multi-Utility Power Exchange Model, Time of Day Models for Planning. Load Management, Load Priority Technique, Peak Clipping, Peak Shifting, Valley Filling, Strategic Conservation, and Energy Efficient Equipment.

#### **Practice:**

- **Load-side implementation of DSM**

#### **TEXTBOOKS:**

1. Industrial Energy Management Systems, Array C. White, Philip S. Schmidt, David R.

Brown, Hemisphere Publishing Corporation, New York.

2. Fundamentals of Energy Engineering - Albert Thumann, Prentice Hall Inc, Englewood Cliffs, New Jersey.

#### **REFERENCE BOOKS:**

1. Electrical Power distribution, A S. Pabla, TMH, 5th edition, 2004

2. Demand Side Management, Jyothi Prakash, TMH Publishers.

3. Energy management by W.R. Murphy & G. McKay Butter worth, Heinemann publications.

4, Energy management by Paul o' Callaghan, Mc-Graw Hill Book company-1\* edition, 1998

5. Energy Management Handbook by W. C. Turner, John Wiley, and Sons

6. Energy management and good lighting practice: fuel efficiency- booklet12-EEO
7. Recent Advances in Control and Management of Energy Systems, D.P. Sen, K. R. Padiyar, IndraneSen, M. A. Pai, Interline Publisher, Bangalore, 1993.
8. Energy Demand — Analysis, Management and Conservation, Ashok V. Desai, Wiley Eastern, 2005.