

COURSE STRUCTURE AND SYLLABI

B.Tech in Civil Engineering

2025-26 Batch



Centurion
UNIVERSITY

Shaping Lives...
Empowering Communities...

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

Web Site: - 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 Civil Engineering of the School of Engineering and Technology is approved in the 15th Academic Council Meeting held on 22nd November 2025.

Dean
School of Engineering and Technology,
CUTM, Odisha

Pro-Vice Chancellor
CUTM, Odisha

Centurion University of Technology and Management Odisha

B.Tech. in Civil Engineering CHOICE BASED CREDIT SYSTEM

COURSE STRUCTURE & SYLLABUS



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*Shaping Lives...
Empowering Communities...*

School of Engineering & Technology

2025-2026

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Programme Objectives: At the end of the program, students will be able to;

PO	Outcomes
PO1	Engineering knowledge: Apply knowledge of mathematics, science, Engineering fundamentals, and civil engineering to the solution of engineering problems
PO2	Problem analysis: Identify, formulate, review literature and analyze civil engineering problems to design, conduct experiments, analyze data and interpret data
PO3	Design /development of solutions: Design solution for civil engineering problems and design system component of processes that meet the desired needs with appropriate consideration for the public health and safety, and the cultural, societal and the environmental considerations
PO4	Conduct investigations of complex problems: Use research based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions in civil engineering
PO5	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and tools including prediction and modelling to civil engineering activities with an understanding of the limitations
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 civil engineering practice
PO7	Environment and sustainability: Understand the impact of the civil engineering solutions in societal and environmental contexts, and demonstrate the knowledge and need for sustainable development
PO8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the civil engineering practice
PO9	Individual and team work: Function affectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings in civil engineering
PO10	Communication: Communicate effectively on complex engineering activities with the engineering committee and with society at large, such as, being able to comprehend and write affective reports and design documentation, make effective presentations in civil engineering
PO11	Project Management and finance: Demonstrate knowledge & understanding of the civil engineering principles 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 in civil engineering
PO12	Life- long learning: Recognize the need for, and the preparation and ability to engage in independent research and lifelong learning in the broadest context of technological changes in civil engineering

Programme Specific Outcomes (PSOs):

PSO1: Gain technical expertise in the field of civil engineering as well as fundamental knowledge in science and engineering to solve complicated issues by conducting advanced research and development work in the field of civil engineering.

PSO2: To study practical engineering issues and create applications in the field of civil engineering, by using contemporary engineering software tools.

PSO3: Acquire proficiency in effective verbal as well as written communication to collaborating within a team, and cultivating a sense of accountability within specified timelines, all while upholding professional ethics and acknowledging the significance of ongoing learning.

Course Outcomes Attributes

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

Bachelor of Technology (B. Tech in Civil)	
Programme Structure – Graduate Study	
Type of Course	4 Years
Major (Core)	80
Minor Stream	32
Multidisciplinary	9
Ability Enhancement Courses (AEC)	8
Skill Enhancement Courses (SEC)	9
Value Added Courses common for all UG	6-8
Summer Internship	2-4
Research Project / Dissertation	12
TOTAL	160

Course Code	Course Title	Credits	T+P+J	NcRF Level
Basket -I				
CUTM1001	Differential Equations and Linear Algebra	3	2+0+1	4.5
CUTM1002	Laplace & Fourier Transforms	3	2+0+1	4.5
CUTM1003	Complex Analysis & Numerical Methods	3	2+0+1	4.5
CUTM1004	Discrete Mathematics	3	2+0+1	4.5
CUTM1005	Probability & Statistics	3	2+0+1	4.5
CUTM1925	Calculus	3	2+0+1	4.5
CUTM1006	Mechanics for Engineers	3	2+1+0	4.5
CUTM1007	Optics and Optical Fibres	3	2+1+0	4.5
CUTM1008	Applied Analytical Chemistry	3	2+1+0	4.5
CUTM1009	Applied Engineering Materials	3	2+0+1	4.5
CUTM1010	Environmental Studies	2	0+0+2	4.5
Basket -II				
CUTM1011	Optimisation Techniques	2	0+2+0	4.5
CUTM1012	Engineering Economics and Costing	3	2+0+1	4.5
CUTM1013	Project Management	3	2+0+1	4.5
CUVA4060	Gender, Human Rights and Ethics	3	1.5+0+1.5	4.5
CUVA4056	Climate Change, Sustainability and Organisation	3	2+0+1	4.5
CUTM1016	Job Readiness	6	0+6+0	4.5
Basket -III				
CUTM1017	Industrial IOT and Automation	6	3+2+1	5
CUTM1018	Data Analysis and Visualisation using Python	4	0+1+3	4.5
CUTM1019	Machine Learning using Python	4	1+2+1	5
CUTM1020	Robotic automation with ROS and C++	4	1+2+1	5.5
CUTM1021	Basics of Design Thinking	2	0+0+2	5
CUTM1022	System Integration with DYMOLA	2	0+0+2	5
CUTM1023	Smart Engineering Project (G2M)	3	0+0+3	5.5
Basket -IV				
CUCV1001	Geotechnical Engineering	3	2+1+0	5
CUCV1002	Geometric Modeling	3	0+3+0	4.5
CUCV1003	Integrated Electrical and Plumbing Systems with BIM	3	0+2+1	6
CUCV1004	Design of RCC Structures	4	2+2+0	5.5
CUCV1005	Analysis of Structure	4	2+2+0	5
CUCV1006	BIM using 3d Experience	3	0+2+1	6
CUCV1007	Ground Improvement technique	2	1+1+0	5.5
CUCV1008	Pre-Engineered Structures	2	1+1+0	6
CUTM1058	Programming in Java	3	2+1+0	5.5
CUTM1059	Database Management Systems	3	2+1+0	5.5
CUTM1062	Theories of Failure analysis using FEA	4	2+2+0	5
CUTM1063	Quantity Estimation & Costing	3	2+1+0	5
CUTM1066	Concrete Technology	3	1+1+1	4.5
CUTM1089	Fluid Mechanics with FVM	3	2+1+0	5
CUTM1090	Hydraulic Machinery	2	1+1+0	5.5

CUTM1907	Disaster Preparedness & Planning Management	2	2+0+0	5
CUTM2369	Surveying Technique	3	1+2+0	4.5
CUTM2371	Transportation Engineering	3	2+1+0	5
CUTM2372	Hydrology and Irrigation	3	2+1+0	5
CUTM2373	Water Supply and Sanitary Engineering	2	1+1+0	5
CUTM2989	Construction Materials	2	0+2+0	4.5

Basket - V (Domain)

Course Title	Type T+P+PJ	Credits
Construction Planning, Monitoring and Project Management	4+6+6	16
Aerial Surveying and Remote Sensing Applications	4+10+4	18
Renewable Energy Applications	4+8+10	22
Operation and Maintenance of Electrical Grid System & Transformers	7+11+6	24
Industrial Automation	5+13+6	24
Embedded System Design	4+10+6	20
Communication Systems Domain	4+8+6	18
Chip Design and Fabrication Using VLSI	6+8+6	20
GTM – Domain	4+10+8	22
Automobile Engineering	7+9+8	24
Manufacturing (Conventional, CNC and Additive)	2+14+10	26
Welding and Inspection	8+8+6	22
Computational Fluid Dynamics	2+10+8	20
Composite Design and Manufacturing	6+12+6	24
Architectural and Structural Design	0+15+5	20
Data Science and Machine Learning	2+9+15	26
Software Technology	0+9+11	20
Cloud Technology	4+8+6	18
Cyber Security	6+10+4	20
Gaming and Immersive Learning (AR & VR)	5+5+10	20

BASKET-I

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, 8th 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 equations.

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 2π 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, John Wiley & 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 2nd& 4th 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 qualitatively

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 to 8.5, 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 38th reprint, 2010.
2. Discrete and Combinatorial Mathematics by R.P.Grimaldi Publisher: Pearson, 5th 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, 5th 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
CO1	3.00		2.0	1			2.0	2.0				3.0	3.0	3.0	3.0
CO2	2.00	2.0	3.0	2.0	1.0		1.0	2.0				1.0	2.0	1.0	3.0
CO3	2.00	1.0	3.0	1.0			2.0	2.0				3.0	3.0	2.0	2.0
CO4			2.0	1.0	3.0		3.0	2.0				3.0	1.0	2.0	2.0
CO5		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
CO1	3.00	2.0		1.0	2.0							3.0	3.0	3.0	2.0
CO2	3.00	1.0		3.0	1.0		2.0					3.0	3.0	2.0	2.0
CO3	3.00	2.0		2.0	2.0		2.0					2.0	2.0	1.0	1.0
CO4	3.00			2.0			2.0					2.0	1.0	2.0	2.0
CO5	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 CO₂ 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/ Quin Hydrone 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 21st Edn-2018, Satya Publications 4.

Reference Books

- Applied Chemistry By Aruna Kumari-2nd Edition, Paramount publications, 2016
- Engineering chemistry by OG Palanna, McGraw Hill Education (India) Private Limited, 2009
- Engineering chemistry by K. Sesha Maheswaramma, Mridula Chuch. Pearson India Education services Pvt Ltd, 2016
- Engineering chemistry by Prasanth Rath, Cengage Learning India Pvt Ltd, 2013
- Engineering chemistry by R.V. Gadag, A. Nityananda, Shetty, I.K. International Publishing house, 2006
- Engineering chemistry – Fundamentals and applications, By Shika Agarwal-Cambridge University Press Edition, 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 TiO₂ and ZnO nanoparticles by Sol Gel ,Sonication and Precipitation 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

BASKET-II

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, Kedarnath Ramnath & 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

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 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	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)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	-	-	2	-	2	3	-	-	-
CO2	3	3	3	-	2	-	-	-	-	2	-	-
CO3	-	3	-	3	3	-	-	-	-	-	-	2
CO4	3	3	3	-	-	2	-	-	3	-	-	-
CO5	3	3	3	-	-	2	-	-	3	2	-	-

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

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, 6th 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), 3rd 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
- 9) <https://www.youtube.com/watch?v=aqEKLQxIUEY>
- 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_wIVnpJmAh3QYArAEAAAYASAAEgIYrfD_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)
CUVA4060	Gender, Human Rights and Ethics	3	3+0+0

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)
CUVA4056	Climate Change, Sustainability and Organisation	3	2+0+1

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.

BASKET-III

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
CO1	3	3	2	2	3	1	3			2	2	2	3	2	3
CO2	3	3	1	1	3	2	2		2	2	2	1	3	3	2
CO3	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 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, ES8266, 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 VISUALISATION 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

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

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 Turtlbot.
- 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 Turtlbot 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. 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

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

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.

15

Session 16

Project

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_YI3RiTI14

16

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:

	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
CO 1	3	3	2	2	3				1			1	3	2	1
CO 2	3	3	1	1	3				1			1	3	3	1
CO 3	3	3	1	3	3				2	1		1	3	2	2
CO 4	3	3	1		3				2	1		3	2	2	2
CO 5	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 Knüller 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 webserver
- 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

- Haroldddyday 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

BASKET-IV

Geotechnical Engineering (60 Hours)

Code	Course Title	Credit	T-P-PJ
CUCV1001	Geotechnical Engineering	3	2+1+0

Course Objectives:

- To understand the principles of soil mechanics and their application in engineering.
- To develop practical skills in soil testing and analysis for accurate characterization of soil properties.
- To apply soil mechanics principles to design, analyze and evaluate soil stability, slope, and solve geotechnical engineering problems.

Course Outcome:

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

- **CO1:** Understand the fundamental engineering knowledge of soil mechanics, including identifying the nature and behavior of soil, soil classification, and compaction investigation for low quality soil.
- **CO2:** Hands-on practice for design the geo-environmental problem and be able to think of its solution related to soil.
- **CO3:** Develop skill to analyse the stress and slope considering the behavioural investigation of soil.
- **CO4:** Enhance project formulation skill for the soil-structure interaction design using modern tools.
- **CO5:** Assess the stability of slopes and retaining structures by analyzing earth pressures based on engineering solutions and environmental contexts.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	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	2										2			
CO2			3					1							
CO3				3									3		
CO4					3				1					2	
CO5				2			3								

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

Course Syllabus:

Module 1: Soil Classification (10 hours)

Theory:

Soil Structure, Basic definitions; Phase relations, Index properties; Grain size distribution; Soil aggregate properties. Indian standard soil classification system.

Practice:

- Experiment 1.1: Determination of water content and specific gravity of soil
- Experiment 1.2: Grain size analysis by sieving (Dry sieve analysis)
- Experiment 1.3: Determination of Atterberg limits of soil

Module 2: Soil Exploration and Effective stress (10 hours)

Theory:

Methods of soil exploration, Boring and Sampling methods, Field tests, Non – invasive tests, planning of Programme, preparation of soil investigation report. Principle of effective stress; Capillarity, quicksand condition; Total, effective and neutral pressures.

Practice:

- Experiment 2.1: Standard Penetration Test (SPT)
- Experiment 2.2: Cone Penetration Test (CPT)

Module 3: Permeability and Seepage (5 hours)

Theory:

One-dimensional flow; Darcy's law; Laboratory methods for permeability determination; Field pumping tests for permeability determination; Permeability as a function of soil type, permanent, void ratio, soil fabric, and effective stress; Two-dimensional flow; Flow nets and their characteristics; Uplift pressure, exit gradient, and piping; Criteria for filters

Practice:

- Experiment 3.1: Constant and falling head permeability
- Experiment 3.2: Water seepage coefficient test

Module 4: Compaction and Consolidation (10 hours)

Theory:

Compaction; Factors affecting compaction; Structure and engineering behavior of compacted cohesive soils; Field compaction; Compaction specifications and field control. Components of total settlement; Effects of soil type, stress history, and effective stress on compressibility; Normally consolidated and over-consolidated soils; Terzaghi's theory of one dimensional consolidation; Time-rate of consolidation.

Practice:

- Experiment 4.1: Determination of field density by sand replacement method
- Experiment 4.2: Determination of california bearing ratio of soil

Module 5: Soil Stress and Shear (10 hours)

Theory:

Two to one method, Boussinesq's theory for point, circular loads and Newmark's chart Stress Distribution for Rectangular Line and Strip Loads. Mohr's stress circle; Mohr Coulomb failure criterion; Laboratory tests for shear strength determination; Effective and total stress shear strength parameters; Shear strength characteristics of clays and sands.

Practice:

- Experiment 5.1: Analysis and calculation using Boussinesq's theory and Newmark's chart

Module 6: Slope Stability (5 hours)

Theory:

Slope stability: Infinite and finite earth slopes – types of failures – factor of safety of infinite slopes: stability analysis- Swedish Arc Method – Taylor's Stability Number- Stability of slopes of earth dams under different conditions.

Practice:

- Experiment 6.1: Direct Shear Test

Module 7: Earth Pressure & Retaining Structures (10 hours)

Theory:

Types of Earth pressure. Rankine's Active and passive earth pressure, Smooth Vertical wall with horizontal backfill. Extension to Soil, Coulombs wedge theory, Different types of retaining structures.

Practice:

- Experiment 7.1 Triaxial set for both cohesive and non-cohesive soil

E Books:

- Jain A K and Jain A K. 2005. Soil Mechanics and Foundations. Laxmi Publications (P) Ltd. New Delhi.
- Ranjan Gopal and Rao A S R. 1993. Basic and Applied Soil Mechanics. Welley Easters Ltd., New Delhi.
- Singh Alam. 1994. Soil Engineering Vol. I. CBS Publishers and Distributions, Delhi.

Geometric Modeling (90 Hours)

Code	Course Title	Credit	T-P-PJ
CUCV1002	Geometric Modeling	3	0+3+0

Course Objectives:

- To introduce the students to the basic theory and concepts of Auto Cad, Revit, BIM and the classical methods for analyzing building drawings.
- To know the process of making sketches, dimensions, 3D Modeling, and rendering.
- Students will gain an understanding of techniques for visualizing and rendering geometric models, including shading, texture mapping, and lighting models.

Course Outcome:

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

- **CO1:** Use CAD in Civil structure, basic knowledge of operating software & commands.
- **CO2:** Do the architectural modelling design and understand how to solve complex design problems.
- **CO3:** Gain experience with different geometric representations used in computer graphics.
- **CO4:** Apply geometric transformations to manipulate and reposition geometric objects in 2D and 3D space.
- **CO5:** Explore algorithms for performing geometric operations and implement these algorithms in computer programs.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2	PS O1	PS O2	PS O3
CO1	2				3							1			
CO2			3	2		2			1				3		
CO3		3						1				2		2	
CO4		3		2						1					
CO5						2			1						

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

Course Syllabus:

Module 1: 2D Sketches and Dimensioning (10 hours)

Practice:

- Experiment 1.1: Study for Drafting and Modeling – Coordinate systems (absolute, relative, polar).
- Experiment 1.2: Drawing sectional views of prism, pyramid, cylinder, cone, etc.

Module 2: Building Plan and Truss (20 hours)

Practice:

- Experiment 2.1: Drawing of a plan for a residential building (Two bedrooms, kitchen, hall, etc.)
- Experiment 2.2: Drawing of a Section and elevation for a duplex building with dimensions.
- Experiment 2.3: Drawing of a simple steel truss.

Module 3: Introduction and Inserting Drawing File into BIM (10 hours)

Practice:

- Experiment 3.1: Definition of BIM: Key concepts, importance, and applications.
- Experiment 3.2: Detailed Architectural BIM Modeling.
- Experiment 3.3: Industry Standards: Introduction to ISO 19650 and other relevant standards.
- Experiment 3.4: Creating grids and levels. Working with labels and detailing.

Module 4: 3D Sketches and Projection of Duplex (10 hours)

Practice:

- Experiment 4.1: Drawing of front view and top view of simple solids like prism, pyramid, cylinder, cone, etc, and dimensioning.
- Experiment 4.2: Drawing front view, top view and side view of objects and projection of duplex building

Module 5: Introduction of RIVET Architecture (10 hours)

Practice:

- Experiment 5.1: Install Autodesk Revit architecture and understand the user interface.
- Experiment 5.2: Creation of a plan for a project by using level and sketching elements.

Module 6: 3D Modeling with RIVET (BIM Software) (20 hours)

Practice:

- Experiment 6.1: Drawing isometric projection of simple objects.
- Experiment 6.2: Creation of 3-D models of simple objects and obtaining 2-D multiview drawings from 3-D model.
- Experiment 6.3: Creation of 3d frame and truss.
- Experiment 6.4: Assembly drawing & attribute text - Annotation
- Experiment 6.5: Block & w-block & leader.

Module 7: Working with Project and Work Planes (10 hours)

Practice:

- Experiment 7.1: Working with building components, site design and massing studies.
- Experiment 7.2: Setting color for wall, sectioning libraries.

Text Books:

- Groover M.P. and Zimmers E.W. Jr., “CAD/CAM, Computer Aided Design and Manufacturing”, Prentice Hall of India Ltd, New Delhi, 1993.
- Krishnamoorthy C.S. Rajeev S., “Computer Aided Design”, Narosa Publishing House, New Delhi, 1993.
- Sikka V. B., A Course in Civil Engineering Drawing, 4th Edition, S.K. Kataria and Sons, 1998.
- George Omura, "Mastering in AUTOCAD 2002", BPB Publications, 2002.

Reference Books:

- Shah.M.G., Kale. C.M. and Patki. S.Y., "Building Drawing with an Integrated Approach to Built.
- Verma.B.P., "Civil Engineering Drawing and House Planning", Khanna Publishers, 1989.
- Marimuthu V.M., Murugesan R. and Padmini S., "Civil Engineering Drawing-I", Pratheebea Publishers, 2008.
- A Guide to building information modeling for Owners, Managers, Designers, Engineers, and Contractors, John Wiley and Sons. Inc., 200.

Integrated Electrical and Plumbing Systems with BIM (90 Hours)

Code	Course Title	Credit	T-P-PJ
CUCV1003	Integrated Electrical and Plumbing Systems with BIM	3	0+2+1

Course Objectives:

- To understand the installation of electrical systems in a building.
- To study carpentry work in the building, such as the installation of doors, windows, etc.
- To understand and demonstrate installation of plumbing systems in the building.

Course Outcomes:

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

- **CO1:** Understand and identify timber defects, diseases, and characteristics, and properly select and utilize carpentry holding modern tools.
- **CO2:** Develop analytical woodworking techniques, including for sharpening and setting saw blades and planer blades/cutters considering health and safety.
- **CO3:** Develop problem-solving competency in electrical work planning and execution to solve complex problems as an individual or a team.
- **CO4:** Develop technical skill on the application of different types of electrical appliances with the knowledge and need for sustainable development.
- **CO5:** Develop skill in plumbing work in the construction field through experiments or research or referring to manuals.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3				2				1			2		2	
CO2			2			3					1				
CO3			2						2						3
CO4	2						3						2		
CO5		3			2						1	2			

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

Course Syllabus:

Module 1: Plumbing Tools and Materials (10 hours)

Theory

Materials Used in Plumbing, Different Types of Pipes, Urinals, Port Kitchen Sinks, Bathtubs, and Washbasins. Integration of Plumbing Components in BIM Models, Analyzing Plumbing System Performance using BIM Tools.

Practice

- Experiment 1.1: Perform a simple pipe connection using G.I. pipes, sockets, elbows, tees, reducing elbows, G.I. unions, and G.I. nipples.
- Experiment 1.2: BIM software for Sanitary Layout Planning
- Experiment 1.3: Creating Detailed Plumbing Layouts in BIM Software

Module 2: Plumbing Pipe Fitting (10 hours)

Theory

Fittings and Joints: GI, PVC, Method of Cutting and Joining Pipes, Soil Pipe and Waste Pipe Fitting, Different Types of Water Closets.

Practice

- Experiment 2.1: Fitting of the washbasin. Fitting a urinal pot with an auto cistern.
- Experiment 2.2: Simulating Water Flow and Pressure in Plumbing Systems.

Module 3: Electrical Tools and Wiring (10 hours)

Theory

Wireman's Tools Kit, Wiring Materials, Electrical Fittings, Systems of Wiring, Wiring Installation for Domestic Lighting.

Practice

- Experiment 3.1: Prepare terminations of cable ends. Practice skinning, twisting, and crimping.
- Experiment 3.2: Make simple twist, married, Tee, and western union joints.
- Experiment 3.3: Install earthing in different positions. Install and connect electrical appliances and take a reading with a voltmeter.
- Experiment 3.4: Prepare a list of materials and the cost of wiring using BIM software for Electrical Appliance Integration.

Module 4: Electrical Appliance Installation & 3D Experience for Electrical Systems (20 hours)

Theory

Estimation and Costing of Wiring, Different Electrical Wiring, accessories, ISI Rules of Wiring, Types of Earthing, Building Information Modeling (BIM) for Electrical Systems of a residential building.

Practice

- Experiment 4.1: Creating Electrical Layouts in BIM Software.

- Experiment 4.2: Integrating Electrical Components and Systems in BIM Models.
- Experiment 4.3: Simulating Electrical Loads and Analyzing Performance in BIM.

Module 5: HVAC Tools and Materials, HVAC Pipe Fitting (10 hours)

Theory

Materials Used in Plumbing, Different Types of Pipes, Fittings, and Joints: GI, PVC, Method of Cutting and Joining Pipes, Soil Pipe and Waste Pipe Fitting, Different Types of Water Closets, Urinals, Port Kitchen Sinks, Bathtubs, Washbasins.

Practice

- Experiment 5.1: Fitting of the washbasin. Fitting a urinal pot with an auto cistern.
- Experiment 5.2: BIM software for sanitary layout planning.

Module 6: HVAC Systems in BIM (10 hours)

Theory

Integration of Plumbing Components in BIM Models, Analyzing Plumbing System Performance using BIM Tools.

Practice

- Experiment 6.1: Creating detailed plumbing layouts in BIM software
- Experiment 6.2: Simulating Water Flow and Pressure in Plumbing Systems
- Experiment 6.3: Use BIM software for Complete Water Supply System Integration to prepare a water supply pipeline system in residential buildings using valves, fittings, and appliances.

Module 7: 4D Simulation (20 hours)

Theory

Define construction tasks, create a timeline using scheduling software, link BIM model elements to tasks (using tools like DELMIA/Navisworks), integrate time data to form a 4D sequence, and visualize the construction process to ensure better planning and coordination.

Practice

- Experiment 7.1: Identify construction tasks and phases and establish a timeline using scheduling software.
- Experiment 7.2: Associate BIM models with tasks using tools like DELMIA/Navisworks.
- Experiment 7.3: Run simulations to visualize the construction process.

Project:

1. Residential Electrical Layout Design using AutoCAD
2. Plumbing System Design using Revit
3. Design and install a complete plumbing system for a residential building.
4. Design and implement a water supply and purification system
5. Integrate electrical and plumbing systems in a BIM model and analyze their performance.

6. Design and implement a smart home electrical system using IoT devices.
7. Implement advanced plumbing techniques focusing on water conservation.
8. Integrate electrical, plumbing, and HVAC systems in a comprehensive BIM model.
9. Water Supply Network Simulation using EPANET
10. Energy-Efficient Building Design using Design Builder

Reference Books

- ASCENT, "Autodesk Revit 2022 MEP Fundamentals", SDC Publications, 2021.
- Hardin, B. and McCool, D., "BIM and Construction Management: Proven Tools, Methods, and Workflows", Wiley, 2015.
- Epstein, E., "Implementing Successful Building Information Modelling", Artech House, 2012.
- Holzer, D., "The BIM Manager's Handbook: Guidance for Professionals in Architecture, Engineering, and Construction", Wiley-Blackwell, 2016.

Design of RCC Structures (90 Hours)

Code	Course Title	Credit	T-P-PJ
CUCV1004	Design of RCC Structures	4	2+2+0

Course objectives:

- To make students understand the principles and theories related to structural design, including load considerations, structural behaviour, material properties, and design codes and standards.
- To educate the students about the selection of appropriate structural systems based on the project requirements, constraints, and considerations such as function, aesthetics, constructability, and sustainability.
- Students will learn about structural stability and how to ensure the designed structures are stable and resistant to failure under various loading conditions.

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

- **CO1:** Gain knowledge of engineering principles, theories, and design codes to design safe and efficient structures.
- **CO2:** Develop skills to convert requirements to structural drawing by using recently used modern tools and software to solve complex problems.
- **CO3:** Analyze Pre-Engineered calculations with relevant Indian Standards for complex structures by conducting experiments, and interpreting data.
- **CO4:** Design the structural stability against various failure modes using contextual knowledge to assess health and safety.
- **CO5:** Do independent research to enhance the material efficiency, life-cycle cost analysis, energy efficiency, and environmental impact.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3		2					1					2		
CO2				2	3				1					3	
CO3		3		1								2			
CO4			3			2					1			2	
CO5							2					3	3		

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

Course Syllabus:

Module 1: Concrete Structures and Design Philosophies (10 hours)

Theory

Introduction to Reinforced Concrete, Mechanical Properties of Concrete and Reinforcement, Flexural Analysis, Shear analysis. Limit State Method using Indian Standard Codes.

Practice :

- Experiment 1.1: Draw grids, Reference planes and joints, and create new project models and the layout in STAAD-PRO.
- Experiment 1.2: Prepare building structural frame with geometrical properties in STAAD - PRO.
- Experiment 1.3: Define Section Properties + Modifiers.

Module 2: Design of Beams, Columns and Slabs (20 hours)

Theory

Beams and slabs: direct design method, flexure, shear, bond and torsion. Columns: Short and slender Columns under biaxial bending and application of the limit state method.

Practice :

- Experiment 2.1: Design of doubly reinforced beams, design of T and L beams using ETABs.
- Experiment 2.2: Design of one-way and two-way slabs using ETABs.
- Experiment 2.3: Design short and long columns with axial and eccentric loadings using ETABs.

Module 3: Load Definition to Building Frame (10 hours)

Theory

Modeling of Building, Load Calculations, Seismic weight, Base shear, Storey shear, Mass source, diaphragm, Meshing of Slab.

Practice :

- Experiment 3.1: Define Mass Source, Load Pattern (Gravity Loads + Earthquake), Wind Loads, Dead loads, and live loads.
- Experiment 3.2: Define Load combination (Manual + Auto) and assign loads to structure as per IS Codes

Module 4: Reinforcement Detailing and Scheduling [codal provisions] (20 hours)

Theory

Nominal cover, Curtailment of Flexural Reinforcement, Shear reinforcement, reinforcement Splicing, and Ductile Detailing of RC structures.

Practice :

- Experiment 4.1: Detailing of Beams, Columns and slabs using Autocad/BIM/CATIA

Module 5: Design of Foundations using Safe Foundation (10 hours)

Theory

Introduction to SAFE foundation, Familiarizing tools used in SAFE foundation, Types of foundations, isolated footing design, combined footing design and mat foundation design.

Practice :

- Experiment 5.1: Importing ETABS model file into the SAFE foundation software
- Experiment 5.2: Design of isolated footing
- Experiment 5.3: Design of combined footing
- Experiment 5.4: Design of mat foundation

Module 6: Design of Retaining Walls and Water Tanks (10 hours)

Theory

Types of Retaining Walls and Their Applications, Design Principles of Gravity and Cantilever Retaining Walls, Design of RCC Water Tanks (Circular and Rectangular), Design Standards and Guidelines

Practice :

- Experiment 6.1: Design and Analysis of Gravity Retaining Walls
- Experiment 6.2: Design and Analysis of Cantilever Retaining Walls
- Experiment 6.3: Design and Detailing of RCC Water Tanks using Software

Module 7: Seismic Design and Retrofitting (10 hours)

Theory

Introduction to Seismic Design, Seismic Analysis Methods, Design of Seismic-Resistant Structures, and Retrofitting Techniques for Existing Structures.

Practice :

- Experiment 7.1: Seismic Analysis of a Multi-Storey Building using ETABS
- Experiment 7.2: Design of Seismic-Resistant Structural Elements
- Experiment 7.3: Retrofitting Techniques and Applications using FEA packages

Text Books:

- Reinforced Concrete design-S. N. Sinha. Tata McGraw-Hill, New Delhi
- S K Duggal," Design of steel structures",2012.
- S. Ramamurtham and R. Narayan," Design of steel structures" ,2014

References:

- [PEB design using ETABS](#)
- [2.Etabs Full - Video](#)

Analysis Of Structure (85 hrs)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUCV1005	Analysis Of Structure	4	2+2+0

Course Objective

- To equip students with a deep understanding of the fundamental principles of structural analysis, including the behaviour of different structural elements under various loads.
- To apply mathematical and computational techniques to evaluate structures' stability, strength, and performance.
- To emphasize the importance of accurate analysis in ensuring the safety and reliability of civil engineering projects

Course Outcome:

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

- **CO1:** Understand the fundamental concepts of structural analysis and their importance in civil engineering applications
- **CO2:** Apply analytical methods to determine forces and moments in statically determinate and indeterminate structures.
- **CO3:** Conduct stability analysis of structures, including buckling and stability assessment, using numerical methods.
- **CO4:** Perform dynamic and seismic analysis of structures, including multi-storey buildings, using modern engineering tools.
- **CO5:** Apply advanced techniques such as nonlinear analysis and finite element analysis (FEA) to evaluate complex structural behaviours.

Course Outcome to Program Outcome Mapping:

COs / Pos / PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	2												
CO2				3	3										
CO3		2	3			2									
CO4					3		2								
CO5			3						2					2	

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

Course Syllabus

Module 1: Introduction to Structural Analysis (12 hours)

Theory

Importance and applications of structural analysis, Types of structures and Various types of loads, Basics of Statics: Equilibrium of structures, Free-body diagrams, SDOF and MDOF

Practice:

- Experiment 1.1: Introduction to structural analysis software (e.g., SAP2000, STAAD.Pro)
- Experiment 1.2: Basic modelling and analysis of simple components of structures using STAAD-PRO

Module 2: Analysis of Statically Determinate Structures (12 hours)

Theory

Statically Determinate Structures: Different types of Beams, trusses, and frames. Methods of Analysis: Joint resolution method for trusses, Shear force and bending moment diagrams

Practice:

- Experiment 2.1: Analysis of trusses using STAAD-PRO
- Experiment 2.2: Calculation and plotting of shear force and bending moment diagrams using STAAD-PRO

Module 3: Analysis of Statically Indeterminate Structures (12hours)

Theory

Degrees of indeterminacy, Methods of Analysis: Force method[Column Analogy], Displacement method

Practice:

- Experiment 3.1: Analysis of various types of beams using STAAD-PRO
- Experiment 3.2: Hands-on practice with indeterminate structures using STAAD-PRO

Module 4: FEA and Stability Analysis (12 hours)

Theory

Stability Analysis: Buckling of columns, Stability of frames and other structures. Methods for Stability Analysis: Euler's critical load, Numerical methods for stability

Practice: (e.g., ANSYS, ABAQUS)

- Experiment 4.1: Finite element analysis of simple structures
- Experiment 4.2: Stability analysis of simple structures

Module 5: Analysis of Multi-Storey Building (12 hours)

Theory

Multi-Storey Buildings: Structural systems, load distribution and interaction in multi-storey structures, earthquake and wind load analysis, analysis methods: Approximate methods, and rigorous methods using FEA packages.

Practice:

- Experiment 5.1: Modelling and analysis of multi-storey buildings using ETABS.
- Experiment 5.2: Modelling and analysis of multi-storey buildings using OPENSEES.

Module 6: Dynamic Analysis of Structures (14 hours)

Theory

Natural frequencies and modes of vibration, Response to dynamic loading, Earthquake Analysis: Seismic design principles, Response spectrum analysis

Practice:

- Experiment 6.1: Dynamic analysis using SAP2000
- Experiment 6.2: Seismic analysis of a building structure using the response spectrum method

Module 7: Nonlinear analysis (14 hours)

Theory

Nonlinear analysis, Progressive collapse analysis

Practice:

- Experiment 7.1: Apply material nonlinearity and geometric non-linearity to a 2D frame structure.
- Experiment 7.2: Nonlinear analysis using Software.
- Experiment 7.3: Conduct a progressive collapse analysis of a structure, and the sequence of failures that can lead to total collapse.

Reference Books:

- "Theory of Structures" by S. Ramamrutham and R. Narayanan
- "Strength of Materials and Mechanics of Structures" by B.C. Punmia, Ashok Kumar Jain, and Arun Kumar Jain
- "Structural Analysis" by V.N. Vazirani and M.M. Ratwani
- "Analysis of Structures: Vol. I & II" by V.S. Reddy
- "Basic Structural Analysis" by C.S. Reddy

BIM using 3d Experience (90 Hours)

Code	Course Title	Credit	T-P-PJ
CUCV1006	BIM using 3d Experience	3	0+2+1

Course Objectives:

- To provide a comprehensive understanding of Building Information Modeling (BIM) concepts, tools, and techniques, enabling them to develop detailed architectural and structural models that meet industry standards.
- To equip students with the skills necessary to perform advanced analysis and integration of BIM models, including rebar detailing, geolocation, and the generation of accurate construction documentation for effective project management.
- To enhance the ability to apply BIM technology in real-world scenarios and use modern tools for sustainable design and construction.

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

- **CO1:** Understand and apply Building Information Modeling (BIM) and Level of Development (LOD) concepts to create detailed architectural models.
- **CO2:** Develop and integrate detailed structural BIM models, incorporating specific details such as load capacities and material properties.
- **CO3:** Analyze and accurately place rebar in concrete elements within BIM models, ensuring alignment with structural and architectural requirements.
- **CO4:** Apply geolocation techniques in BIM models to integrate site-specific data and analyze the building's context within its geographic location.
- **CO5:** Generate Material Take-Off (MTO) and Bill of Quantities (BOQ) from BIM models to support cost estimation and procurement.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	2			2										
CO2			3		3										
CO3				3	2									2	
CO4					3	2									2
CO5					3				2						

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

Course Syllabus:

Module 1: Concepts of BIM and LOD (10 hours)

Theory

BIM involves creating and managing digital representations of the physical and functional characteristics of a building. LOD defines the detail and accuracy of BIM models at various stages, from conceptual design (LOD 100) to fully detailed construction documents (LOD 500).

Detailed Architectural BIM Modeling: BIM models architecture creates detailed 3D representations of building structures, integrates design elements like walls and windows, and coordinates with the structure.

Practice

- Experiment 1.1: Develop accurate representations of building structures and layouts.
- Experiment 1.2: Include architectural details such as walls, doors, and windows.

Module 2: Detailed Structure BIM Modeling (20 hours)

Theory

Detailed structural BIM modelling involves creating precise 3D models of structural elements (beams, columns), incorporating specific details like load capacities and material properties, coordinating with architectural

Practice

- Experiment 2.1: Develop precise models of structural elements like beams, columns, and foundations.
- Experiment 2.2: Include specifics such as load-bearing capacities and material properties.
- Experiment 2.3: Integrate with architectural and MEP models for clash detection.

Module 3: Detailed Rebaring in BIM Models (20 hours)

Theory

Repairing in BIM models involves accurately placing rebar within concrete elements, and specifying types, sizes, and layouts. It includes integrating details on spacing, bending, and anchorage, coordinating with structural and architectural models, detecting clashes, and generating comprehensive drawings and schedules for construction.

Practice

- Experiment 3.1: Place the rebar in concrete elements accurately, specifying anchorage, es, and layouts.
- Experiment 3.2: Include detailed information on spacing, bending, and anchorage.
- Experiment 3.3: Ensure rebar placement aligns with structural and architectural models.

Module 4: Add Geolocation in BIM Models (10 hours)

Theory

Geolocation in BIM models involves setting project coordinates, integrating site-specific data, aligning with GIS for accuracy, and using the geolocation to visualize and analyze the building's context within its geographic location and environmental conditions.

Practice

- Experiment 4.1: Define the project's geographic location using latitude and longitude.
- Experiment 4.2: Import site-specific data like topography and environmental conditions.
- Experiment 4.3: Coordinate with Geographic Information Systems (GIS) for accuracy.

Module 5: Generating Good for Construction (GFC) Documentation (10 hours)

Theory

Create high-quality, photorealistic images of the BIM model using software to accurately visualize design details and materials.

Integrate Augmented Reality (AR) or Virtual Reality (VR) to offer immersive, interactive experiences, allowing stakeholders to explore and interact with the model in a realistic virtual environment.

Practice

- Experiment 5.1: Generate high-quality, photorealistic images of the BIM model using software like Revit or Lumion.
- Experiment 5.2: Use Augmented Reality (AR) or Virtual Reality (VR) to create immersive, interactive experiences of the model.
- Experiment 5.3: Showcase the model in realistic settings for stakeholder review and decision-making.

Module 6: Material Take-Off (MTO) (10 hours)

Theory

Creating a Material Takeoff schedule, selecting relevant categories (e.g., walls, floors), adding fields (material name, volume, area), applying filters and sorting, formatting the schedule for clarity, and exporting the data for cost estimation and procurement.

Practice

- Experiment 6.1: Select Schedules and choose Material Takeoff. in BIM Software.

- Experiment 6.2: Choose fields like material name, volume, and area, then apply filters and sorting for clarity. (3hrs)
- Experiment 6.3: Export the schedule to Excel or other formats for further analysis.

Module 7: Bill of Quantity (BOQ) Generation (10 hours)

Theory

Create schedules for relevant categories (walls, floors), add fields like quantity, material, and cost, format and filter for clarity, and then export the schedules to Excel for a comprehensive Bill of Quantity.

Practice

- Experiment 7.1: Select Schedules, choose Quantities, and Pick relevant categories.
- Experiment 7.2: Include necessary fields like quantity, material, and cost.
- Experiment 7.3: Export schedules to Excel for detailed BOQ.

Project :

1. Residential Electrical Layout Design using AutoCAD
2. Plumbing System Design using Revit
3. Design and install a complete plumbing system for a residential building.
4. Design and implement a water supply and purification system
5. Integrate electrical and plumbing systems in a BIM model and analyze their performance.
6. Design and implement a smart home electrical system using IoT devices.
7. Implement advanced plumbing techniques focusing on water conservation.
8. Integrate electrical, plumbing, and HVAC systems in a comprehensive BIM model.
9. Water Supply Network Simulation using EPANET
10. Energy-Efficient Building Design using Design Builder

Reference Books:

- ASCENT, "Autodesk Revit 2022 MEP Fundamentals", SDC Publications, 2021.
- Hardin, B. and McCool, D., "BIM and Construction Management: Proven Tools, Methods, and Workflows", Wiley, 2015.
- Epstein, E., "Implementing Successful Building Information Modelling", Artech House, 2012.
- Holzer, D., "The BIM Manager's Handbook: Guidance for Professionals in Architecture, Engineering, and Construction", Wiley-Blackwell, 2016.

Ground Improvement Techniques (45 Hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUCV1007	Ground Improvement Techniques	2	1+1+0

Course Objectives:

- To Develop a comprehensive understanding of in situ densification methods and soil stabilization techniques to enhance the structural integrity of various soil types.
- To gain expertise in foundation design and settlement analysis, using both theoretical approaches and advanced software tools for practical applications.
- To master the use of geosynthetics, dewatering, and grouting techniques to effectively manage soil reinforcement and groundwater control in construction projects.

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

- **CO1:** Identify and analyze problems in expansive soils.
- **CO2:** Hands-on practice for select and apply the best-suited stabilization methods based on soil properties.
- **CO3:** Develop skill to design and determine the most appropriate ground improvement technique based on specific ground conditions.
- **CO4:** Enhance project formulation skill for the design and plan various ground improvement techniques effectively
- **CO5:** Assess to choose suitable dewatering techniques based on the groundwater table and site conditions.

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												
CO3				3									1		
CO4					3									2	
CO5				2			3								

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

Course Syllabus:

Module 1: In Situ Densification Methods in Cohesion less and Cohesive Soils (8 hrs)

Theory

Vibration at the ground surface, Impact at the Ground Surface, Vibration at depth, Impact at depth. Stone and lime columns - thermal methods. Dynamic compaction, Vibroflot technique, Controlled blasting for compaction, Injection methods, Lime-columns, Compaction Quality Control, Selection of Field Compaction Procedure.

Practice:

- Experiment 1.1: Compaction methods
- Experiment 1.2 Lime-column implementation

Module 2: Foundations and Settlement Analysis (10hrs)

Theory

Foundations: Types, design, choice of foundation, Location of depth, Bearing Capacity, Terzaghi bearing capacity, IS Methods, bearing pressure based on N- value. Settlement analysis: Allowable bearing pressure; safe bearing capacity and settlement from plate load test – allowable settlements of structures.

Practice:

- Experiment 2.1: Settlement Analysis with PLAXIS
- Experiment 2.2: Settlement Analysis with GEO5 Settlement

Module 3: Stabization of soils (10hrs)

Theory

Mechanical Stabilization -Soil aggregate mixtures, properties and proportioning techniques, soft aggregate stabilization, compaction, field compaction control; Cement Stabilization-Mechanism, factors affecting and properties, use of additives, design of soil cement mixtures, construction techniques; Lime and Bituminous Stabilization-Type of admixtures, mechanism, factors affecting, design of mixtures, construction methods.

Practice

- Experiment 3.1: CBR Test
- Experiment 3.2: UCS test
- Experiment 3.3: Triaxial test

Module 4: Geosynthetics and Soil Reinforcement (7 hrs)

Theory

Geotextiles- Types, Functions and applications - geogrids and geomembranes - functions and applications.

Reinforced Earth: Principles - Components of reinforced earth - factors governing design of reinforced earth walls - design principles of reinforced earth walls. Properties of Geosynthetics, purpose of different components of reinforced earth.

Practice:

- Experiment 4.1: Tensile strength of geosynthetics
- Experiment 4.2: Stabilization geosynthetics

Module 5: Dewatering and Grouting (10 hrs)

Theory

Methods of de-watering - sumps and interceptor ditches- single, multi stage well points - vacuum well points- Horizontal wells-foundation drains-blanket drains- criteria for selection of fill material around drains - Electro-osmosis. Grouting: Objectives of grouting- grouts and their properties- grouting methods - ascending, descending and stage grouting- hydraulic fracturing in soils and rocks- post grout test. Permeation grouting, Compaction grouting, Jet grouting, Types of grout materials,

Practice:

- Experiment 5.1: Dewatering techniques (2hrs)
- Experiment 5.2: Effect of degree of consolidation (2hrs)
- Experiment 5.3: Fluidity test on grouting materials (2hrs)

Text Books:

- Hausmann, H.R. "Engineering Principles of Ground Modification", McGraw-Hill Book Company. 3rd Edition 2010.
- K.R.Arora, Soil Mechanics and Foundation Engineering, 7th Ed., Standard Publishers Distributors, Delhi, 2019
- Reinforced Soil and Its Engineering Applications” by Swami Saran (2017), I.K. International Pvt Ltd, New Delh.

Reference (s)

- P. Purushotamaraj “Ground Improvement Techniques”, Laxmi Publications (P) Ltd. 2016.
- Bowles, J.E., Foundation Analysis and Design, 5th Ed., McGraw-Hill Publishing Company, Newyork, 2017
- S. K.Gulhati & Manoj Datta, Geotechnical Engineering, 16th Ed., Tata Mc.Graw Hill Publishing Company, New Delhi. 2013

Pre-Engineered Structures (45 hours)

Course Code	Course Title	Credit	Type (T+P+Pj)
CUCV1008	Pre-Engineered Structures	2	1+1+0

Course Objectives:

- To demonstrate the principles and best practices of structural detailing, including the importance of accuracy, clarity, and adherence to industry standards.
- To Create detailed drawings that accurately and comprehensively represent the various structural components and connections, including beams, columns, braces, foundations, and connections.
- To Interpret and understand structural designs, including architectural and engineering drawings, specifications, and design calculations.

Course Outcome:

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

- **CO1:** Understand the components and design principles of Pre-Engineered Buildings (PEB), including primary, secondary, and bracing systems.
- **CO2:** Apply design methodologies for PEB frames considering various load conditions as per IS codes.
- **CO3:** Analyze and design bolted and welded connections in steel structures, including moment and shear connections.
- **CO4:** Design rigid frames (sway and no-sway) in steel structures with appropriate connection details, including trusses and space frames.
- **CO5:** Design prestressed concrete elements in PEB structures, including beams and columns, considering prestress losses

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		3			2									
CO2		3	3	2											
CO3			3	3	2									2	
CO4				3		2									
CO5		3	3												

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

Course Syllabus

Module 1: Mechanisms Of Steel Structures (10 Hrs)

Theory

PRE-ENGINEERED BUILDING COMPONENTS: Primary System: Mainframes, Gable End Frame. Secondary frame system: Sizes and Properties of Purlins & Girts – Bracing System: Rod, angle, Portal, Pipe bracing. Sheeting and Cladding: Roof Sheeting and Wall Sheeting.

Practice

- Experiment 1.1: LOADS ON PRE-ENGINEERED BUILDINGS.
- Experiment 1.2: Design of PEB frame under the influence of Dead, Live, Collateral, Wind, Seismic and Other applicable Loads.
- Experiment 1.3: Serviceability Limits as per code IS:800.

Module 2: Peb Design Methodology (10 Hrs)

Theory

Design Parameters of PEB Frames: Depth of the Section, Depth to Flange Width Ratios, Thickness of Flange to Thickness of Web Ratio, d/t_w , b_f/t_f Ratios of Sections as per IS Code

Practice : [Using 3D-Experience Software]

- Experiment 2.1: Design parameters of PEB Frames

Module 3: Connections In Steel Structures (5 Hrs)

Theory

Bolted and Welded Connections, Design of Moment and Shear Connections.

Practice:

- Experiment 3.1: Analyse the behaviour of bolted connection and Design using software
- Experiment 3.2: Design welded connections for both axial and eccentric forces

Module 4: Design of Rigid Frames [Sway And No-Sway Frames] (10 Hrs)

Theory

Rigid Frame Moment Connection, Shear Connection, Anchor Bolt and Base Plate Design (Pinned and Fixed)

Practice:

- Experiment 4.1: Design of Steel Trusses in PEB Structures using Software
- Experiment 4.2: Design of Steel Space Frames [Sway and No-Sway Frames] in PEB Structures using Software.

MODULE 5: Prestressed Concrete in PEB (10 Hrs)

Theory

Introduction to Prestressed Concrete: Basics and Principles of Prestressed Concrete, Advantages and Applications in PEB Structures. **Design of Prestressed Concrete Elements:** Design of Prestressed Concrete Beams using IS:1343, Losses in Prestress.

Practice:

- Experiment 5.1: Design of Prestressed Concrete Beams in PEB Structures using Software
- Experiment 5.2: Design of Prestressed Concrete Columns in PEB Structures using Software

Text Books:

- Bhatt N.D. and Panchal V.M., “Engineering Drawing”, Charotar Publishing House, 50th Edition, 2010.
- Luzzader, Warren.J. and Duff, John M., “Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
- Basant Agarwal and Agarwal C.M., “Engineering Drawing”, Tata McGraw Hill Publishing Company Limited, New Delhi, 2008

References:

- Gopalakrishna K.R., “Engineering Drawing” (Vol. I&II combined), Subhas Stores, Bangalore, 2007.
- Shah M.B., and Rana B.C., “Engineering Drawing”, Pearson, 2nd Edition, 2009.
- Venugopal K. and Prabhu Raja V., “Engineering Graphics”, New Age International (P) Limited, 2008.

Publication of Bureau of Indian Standards:

- IS 10711 – 2001: Technical products Documentation – Size and layout of drawing sheets.
- IS 9609 (Parts 0 & 1) – 2001: Technical products Documentation – Lettering.
- IS 10714 (Part 20) – 2001 & SP 46 – 2003: Lines for technical drawings.
- IS 11669 – 1986 & SP 46 – 2003: Dimensioning of Technical Drawings.
- IS 15021 (Parts 1 to 4) – 2001: Technical drawings – Projection Methods.

Theories of Failure Using Finite Element Analysis (85 hours)

Course Code	Course Title	Credits	Type (T+P+Pi)
CUTM1062	Theories of Failure Using Finite Element Analysis	4	2-2-0

Course Objectives

- To educate the students on fundamental theories behind the mechanics of solids.
- To educate the students on the Finite Element Analysis concept applicable to Practical conditions.
- To educate the students on using 3D Experience Tools to analyze 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 transmission of elements.
- **CO2:** Apply the basic principles of failure criteria to practical problem
- **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 / Pos / PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	1	3	2												
CO2		3	3	2											
CO3			2		3				2						
CO4		3		3			2								
CO5			2	2	3										

***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 1.1: 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 1.2: Performing a Tensile Test Simulation for the 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 2.1: Stress-strain curve of a Ductile Material (ASTM Standard Mild Steel Specimen) using a Universal Testing Machine
- Experiment 2.2: 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 3.1: Performing Shear force bending moment diagram considering Point loads and UDL for 3D simulation of a cantilever beam.

Link: https://youtu.be/yG_0c-fz5Xs

- Experiment 3.2: 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 Beams (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 4.1: 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, and Prevention of Failure in the Design Stage.

Fatigue Failure: Failure under Cyclic Loading, Endurance Limit, S-N Curve, Stress Concentration.

Practice

- Experiment 5.1: 3D Simulation of Bicycle Frame Structural Analysis
- Experiment 5.2: 3D simulation of Fatigue Analysis of Crankshaft of Two-Wheeler

Module VI: Torsion and Thin Shell Theory (12 Hours)

Theory

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 6.1: 3D simulation of Torsion Analysis of Shaft
- Experiment 6.2: Failure Analysis of Thin-walled Pressure Vessels.

Module VII: Column Analysis (12 Hours)

Theory

Columns and Struts: Failure of Column, End Conditions and Equivalent Length, Euler's Column Theory, Rankine's Formula, Slenderness Ratio.

Practice

- Experiment 7.1: Simulation of Buckling/Column Analysis of Structural Components

Text Books:

- Strength of Materials, R.K. Bansal, Laxmi Publications.
- Finite Element Analysis, S.S. Bhavikatti, New Age International Publishers

Reference Books:

- Fundamentals of Finite Element Analysis, David V. Hutton, McGraw Hill Higher Education
- Engineering Mechanics of Solids, Egor P. Popov, Pearson publication

Quantity Estimation & Costing (60 Hours)

Code	Course Title	Credit	T-P-PJ
CUTM1063	Quantity Estimation & Costing	3	2+1+0

Course Objectives:

- To develop proficiency in reading and interpreting construction drawings, preparing detailed estimates, and conducting quantity surveys.
- To acquire skills in rate analysis, cost estimation, and adhering to industry standards and guidelines.
- To strengthen the ability to apply software tools for estimating and utilize appropriate methodologies for various construction projects.

Course Outcome:

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

- CO1:** Gain knowledge in reading and interpreting construction drawings, plans, and detailed drawings related to structures.
- CO2:** Develop hands-on practice and the ability to prepare accurate and detailed estimates for various construction projects using manual methods and relevant software.
- CO3:** Acquire practice skills to understand rate analysis, specifications, and cost estimation standards as per industry analysis data and interpret guidelines.
- CO4:** Enhance research-based knowledge skills in conducting quantity surveys and determining the quantities of materials and labour required for different construction tasks.
- CO5:** Demonstrate the ability to apply acquired knowledge and skills to effectively analyze rates, prepare cost estimates, and produce comprehensive project reports with safety and legal by individuals.

Course Outcome to Program Outcome Mapping:

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

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

Course Syllabus:

Module 1: Building (10 hours)

Theory

Reading of Plans, Sections and detailed Drawings Related to buildings; preparation of Quantities and Units. Introduction of estimating & different types of estimates - Cost estimate of different construction materials and buildings.

Practice:

- Experiment 1.1: Study of construction drawings and preparation of WBS
- Experiment 1.2: Detailed estimates for a hostel Building using Estimator-2.0 software
- Experiment 1.3: Detailed estimates for a hospital using Estimator-2.0 software

Module 2: Culvert (10 hours)

Theory

Estimations and Quantity Surveying: Reading of Plans, Sections and detailed Drawings Related to irrigation structures; preparation of quantities and units.

Practice:

- Experiment 2.1: Detailed estimates for a Slab culvert with right-angled/ Splayed wing wall
- Experiment 2.2: Detailed estimates (Manual) for a box culvert
- Experiment 2.3: Detailed estimates (Manual) for a Hume pipe Culvert

Module 3: Road (10 hours)

Theory

Estimations and Quantity Surveying: Reading of Plans, Sections and detailed drawings related to road structures; preparation of Quantities and Units.

Practice:

- Experiment 3.1: Detailed estimates (Manual) for a road

Module 4: Sloped Roof (10 hours)

Theory

Estimations and Quantity Surveying: Reading of Plans, Sections and detailed Drawings Related to Sloping roof/Roof truss structures; preparation of Quantities and Units.

Practice:

- Experiment 4.1: Detailed estimate (Manual) for a timber roof truss and roof cover of GI sheets

Module 5: Quantity Survey (5 hours)

Theory

Estimations and Quantity Surveying; Preparation of Quantity of materials per unit rate of work; Estimating labour.

Practice:

- Experiment 5.1: Quantity of materials required for different items of works in buildings (Manual)

- Experiment 5.2: Quantity of different types of labor required for different items of works (Manual)

Module 6: Rate Analysis of Building (10 hours)

Theory

Specifications; Rate Analysis as per State Govt. and CPWD Standards.

Practice:

- Experiment 6.1: Development of Excel Sheet for Rates, Specifications and Cost Estimates
- Experiment 6.2: Rate Analysis and Cost Estimates for a hostel Building and a hospital

Module 7: Rate Analysis of Culvert & Road (5 hours)

Theory

Specifications: Rate Analysis as per State Govt. and CPWD Standards

Practice:

- Experiment 7.1: Rate Analysis and Cost Estimates for a Slab culvert with right-angled wing wall using Estimator-2.0 software
- Experiment 7.2: Rate Analysis and Cost Estimates for an arch culvert
- Experiment 7.3: Rate Analysis and Cost Estimates for a road

Text Books

- B.N Dutta 'Estimating and Costing in Civil Engineering', UBS Publishers & Distributors (P) Ltd, 2010.
- B.S.Patil, 'Civil Engineering Contracts and Estimates', University Press, 2006.
- D.N. Banerjee, 'Principles and Practices of Valuation', V Edition, Eastern Law House, 1998.

References

- Arbitration and Conciliation Act, 1996
- Standard Bid Evaluation Form, Procurement of Good or Works, The World Bank, April 1996
- Standard Data Book for Analysis and Rates, IRC, New Delhi, 2003.

Concrete Technology (70 Hours)

Code	Course Title	Credit	T-P-PJ
CUTM1066	Concrete Technology	3	1+1+1

Course Objectives:

- To determine the correct proportion of cement, sand and aggregate ratio for the concrete.
- To perform tests for cement, sand and aggregate and concrete.
- To supervise and monitor concrete casing and casting for building construction.

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

- **CO1:** Understand the basic properties of concrete materials.
- **CO2:** Identify different cement types and applications and analyze the properties and behavior of fresh and hardened concrete.
- **CO3:** Apply the principles of concrete technology to solve practical problems.
- **CO4:** Developing various mix design methods for concrete using different modern techniques.
- **CO5:** Evaluate and implement concrete testing, quality control methods, and construction techniques for concrete structures.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2	PS O1	PS O2	PS O3
CO1	3						2					2	3		
CO2		3	2											1	
CO3	2			2				1				2	3		
CO4			2		3						1				2
CO5							3			1		2		2	

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

Course Syllabus:

Module 1: Aggregate & Sand (10 hours)

Theory

Aggregate, classification (IS: 383), Grading, Characteristics, Bulking of fine aggregate, factors affecting the strength of concrete. water quality, hydration & workability, Admixture, waterproofing and permeability reducing admixture. Construction Chemicals.

Practice:

- Experiment 1.1: Perform sieve analysis on aggregate and determine the grade.
- Experiment 1.2: Determine bulking of sand.
- Experiment 1.3: Specific Gravity, Water Absorption for Coarse and Fine Aggregates.
- Experiment 1.4: Aggregate Impact Test, Aggregate Crushing Test

Module 2: Preparation of Cement Concrete (10 hours)

Theory

Preparation of concrete methods used, merits and demerits of methods, tools and equipment used. Scaffolding & formwork: Types & applications of different materials used in formwork. Precautions to be taken for the following processes, placing, compaction, curing, finishing, strength & durability requirements (IS: 456-2000), stripping of formwork, application of modern power tools, classification & specifications of concrete.

Practice:

- Experiment 2.1: Making of shuttering & supports with uprights and wedges for Arches, Lintels and Lintels with Chajjahs.

Module 3: Workability of Concrete (10 hours)

Theory

Factors affecting workability. Measurement of workability–slump, Compaction factor and Vee-Bee Consistometer tests, flow tests. Segregation and bleeding. Process of manufacturing of concrete- Batching, Mixing, Transporting, Placing and Compaction.

Practice:

- Experiment 3.1: Workability of Fresh Concrete by
 - (a) Slump cone method
 - (b) Compaction factor
 - (c) Flow table methods.

Module 4: Strength of Concrete (10 hours)

Theory

Nominal mix concrete, Plain cement concrete (PCC). Properties of PCC & RCC in the green state and hardened state. Reinforced cement concrete (R.C.C.) members for foundation, beams, columns, slabs, retaining wall etc.

Practice:

- Experiment 4.1: Compressive strength of concrete
- Experiment 4.2: Splitting tensile strength of cylinder.

Module 5: Design-Mix Concrete (10 hours)

Theory

Principles of mix proportioning, probabilistic parameters, factors governing selection of mix design. IS method of concrete mix design, Variability of test results, acceptance criteria, various IS code provisions.

Practice:

- Experiment 5.1: Preparation of design-mix concrete
- Experiment 5.2: Concrete shotcreting
- Experiment 5.3: Pressure grouting of concrete

Module 6: Reinforcement in Concrete (10 hours)

Theory

Structural elements & characteristics (simply supported, continuous, fixed, cantilever, overhang), the importance of the use of reinforcement in concrete, tools used in bar bending correct use of tools, different operation in bar bending (straightening of bars, cutting of bars, bending of bars, placing of bars, binding of bars, fixing of cover blocks).

Practice:

- Experiment 6.1: Cutting, bending & placing of reinforcement.

Module 7: Special Concreting Techniques (10 hours)

Theory

Characteristics of high-strength concrete, high-performance concrete, fibre-reinforced concrete, mass concrete, lightweight and heavyweight concrete, and Precast concrete. Geopolymer Concrete design, underwater concrete, pre-placed concrete, vacuum dewatered concrete, hot and cold weather concreting, and Ready-mixed concrete.

Practice:

- Experiment 7.1: Preparation of Lightweight concrete mix.
- Experiment 7.2: Preparation of concrete with solid wastes.
- Experiment 7.3: Geopolymer Concrete design.

Projects:

1. Assessment of Aggregate Quality and Its Impact on Concrete Strength
2. Investigation of Bulking Effect in Fine Aggregates and Its Influence on Concrete Mix
3. Design and Construction of Formwork for Different Structural Elements
4. Comparative Analysis of Concrete Preparation Methods: Hand Mixing vs. Machine Mixing
5. Evaluation of Workability Parameters in Concrete: Slump, Compaction Factor, and Flow Table Tests
6. Effect of Admixtures on the Workability and Strength of Concrete
7. Compressive and Splitting Tensile Strength of Concrete: A Comparative Study
8. Comparative Study of Plain Cement Concrete (PCC) and Reinforced Cement Concrete (RCC)
9. Design-Mix Concrete Preparation and Its Performance Evaluation

10. Implementation and Effectiveness of Concreting Techniques in Concrete Construction
11. Pressure Grouting Techniques for Concrete: Application and Performance Analysis
12. Detailed Reinforcement Design for Concrete Beams and Columns
13. Simulation of Bar Bending Operations for Reinforcement in Concrete Construction
14. Development and Testing of Lightweight Concrete Mix for Structural Applications
15. Design and Performance Analysis of Geopolymer Concrete: An Alternative to Traditional Concrete

Text Books:

- M.S. Shetty, “Concrete Technology” S. Chand & Co., Ltd., Revised Edition - New Delhi, 2018
- A.M. Neville, Properties of Concrete, 5th Ed., Low Priced Edition, Prentice Hall Publishers, 2012

Reference Books:

- R.K. Rajput “Engineering Materials (Including construction materials)”, 4th Ed., S. Chand Publications. 2014
- Rofat Siddique “Special structural Concrete” Galgotia Publishing Pvt. Ltd., New Delhi, 2000
- Code book: IS 10262-2019 “Concrete Mix Proportioning-Guidelines”, Second Revision

Fluid Mechanics with FVM (60 hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUTM1089	Fluid Mechanics with FVM	3	2+1+0

Course Objective

- 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 develop proficiency in applying the finite volume method to solve practical engineering problems in fluid mechanics

Course Outcomes: After the completion of the course, 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 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 / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3								2		1
CO2	3	3	2	3	2								2	2	1
CO3	2	3	2	2	2								3	3	
CO4	3	3	2	1	1								3	3	
CO5	3	2	3	1	2								2		1

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

Course Syllabus:

Module I: Introduction to FVM (10 hrs)

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 1.1: Introduction to SIMULIA- 3D Experience Platforming FVM Simulation Setup- Assigning Materials to fluid extraction models, Generating Output parameters for fluid flow calculations.
- Experiment 1.2: 3D Unstructured Mesh of Circular pipe.
- Experiment 1.3: 3D structure mesh of Circular Cylinder

Module II: Governing Equations of Flow Field (8 hrs.)

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 2.1: 3D unstructured mesh of Circular sphere

Module III: Incompressible Inviscid Flow and Flow Kinematics (8 hrs)

Theory

Bernoulli equations, static, stagnation, dynamic Pressure, streamlines, streaklines, pathlines, timelines, vorticity and rotationality in fluid flow kinematics

Practice

- Experiment 3.1: Reynolds's Experiment in pipe
- Experiment 3.2: Fluid Analysis of Bernoulli's equation: Flow in a contracting pipe through CFD simulation

Module IV: Internal Incompressible viscous Flow (10 hrs)

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 4.1: Simulation of Fluid Analysis of Laminar flow in 3D Circular Pipe.
- Experiment 4.2: Determining the frictional losses in the pipe.

Module V: External Incompressible viscous flow (8 hrs)

Theory

Drag and lift, Friction and Pressure drag, Flow over Cylinder and spheres, Flow separation, Effect of surface roughness.

Practice

- Experiment 5.1: Simulation of External Fluid Analysis over 3D Sphere

Module VI: Compressible Flow (8 hrs)

Theory

Propagation of Sound Waves, the Mach Cone, stagnation Properties, Isentropic Flow through Nozzles.

Practice

- Experiment 6.1: CFD Simulation of the Water Flow Passing Through a Converging Pipe.

Module VII: Flow Measurements (8 hrs)

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 7.1: CFD Analysis of Fluid flow through Orifice meter
- Experiment 7.2: CFD Analysis of Fluid flow through adjustable channel
- Experiment 7.3: Analysis of Fluid flow simulation through Venturi Meter

Text Books:

- R.K. Bansal, Fluid Mechanics and Hydraulic Machines, Laxmi Publications, ninth edition
- P.N. Modi & S.N. Seth, Hydraulics & Fluid Mechanics, Rajsons Publications Pvt. Ltd, Twentieth Edition

Source of reference;

- <https://nptel.ac.in/course.html>
- <https://nptel.ac.in/courses/112/105/112105218/>
- <https://nptel.ac.in/courses/112/105/112105183/>
- <https://nptel.ac.in/courses/112/105/112105182/>

Hydraulic Machinery (45 hours)

Code	Course Title	Credit	T-P-PJ
CUTM1090	Hydraulic Machinery	2	1+1+0

Course Objective

- To learn the principle of operation of hydraulic machines and their system design.
- To familiarize their vast applications in different industries.
- To learn the performance study of various hydraulic pumps and turbine

Course Outcomes:

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

- **CO1:** Understand the basic knowledge on engineering design of the machines for required applications
- **CO2:** Apply knowledge to determine performance characteristics of radial and axial flow pumps
- **CO3:** Develop and evaluate the performance of the Reciprocating pump.
- **CO4:** Analyze the performance of various hydraulic turbines.
- **CO5:** Create and conduct simulation study of various flow analyses of hydraulic machine

Course Outcome to Program Outcome Mapping:

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

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

Course Syllabus:

Module I: Principle of Operation of Hydraulic Machinery (3hrs)

Theory

Introduction to hydraulic machines: Classification and operation principle, Euler equation for turbo machines, Heads and efficiencies of Hydraulic Machinery

Module II: Hydraulic Turbine: Impulse Turbine (10 hrs.)

Theory

Classification of turbines, Pelton Wheel - Construction and working principle, Net head, Work done, and hydraulic efficiency.

Practice

- Experiment 2.1: Determine the force produced by the impact of the jet.
- Experiment 2.2: Flow analysis of Pelton turbine using Simulia Software
- Experiment 2.3: Performance Characteristics of Pelton Turbine.

Module III: Hydraulic Turbine: Reaction Turbine (10 hrs)

Theory

Reaction turbine (Francis, Kaplan) -Components, working principle, Work done and efficiency, draft tube, specific speed, cavitations

Practice

- Experiment 3.1: Performance Characteristics of Francis Turbine.
- Experiment 3.2: Flow analysis of Francis turbine using Simulia Software.
- Experiment 3.3: Performance Characteristics of Kaplan turbine.

Module IV: Radial and Axial flow pumps (12hrs)

Theory

Velocity triangle of pumps, Effect of inlet swirl on velocity triangles, Constructional features of Centrifugal Pump, design aspect, working principle and efficiencies, work done by the impeller, priming, specific speed, NPSH, effect of swirl on the cavitations, working principle of gear oil pump.

Practice

- Experiment 4.1: Flow analysis of fluid of Centrifugal pump through Simulia software

- Experiment 4.2: Performance Characteristics of gear oil pump.
- Experiment 4.3: Performance Characteristics of Centrifugal Pump.

Module V: Positive displacement Pumps (10 hrs)

Theory

Working principle of Reciprocating Pump, Discharge, works done and power requirement, slip

Practice

- Experiment 5.1: Performance Characteristics of Double Acting Reciprocating Pump.

Text Books:

- R.K. Bansal, Fluid Mechanics and Hydraulic Machines, Laxmi Publications, ninth edition

Reference Books:

- P.N. Modi & S.N. Seth, Hydraulics & Fluid Mechanics, Rajsons Publications Pvt. Ltd, Twentieth Edition

Source of reference;

1. <https://nptel.ac.in/course.html>
2. www.vlabs.ac.in

Disaster Preparedness & Planning Management (30 hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUTM1907	Disaster Preparedness & Planning Management	2	2+0+0

Course Objective

- To develop a comprehensive understanding of the concepts, classifications, and impacts of natural and man-made disasters.
- To acquire knowledge of disaster risk reduction strategies, including prevention, mitigation, preparedness, and recovery measures.
- To recognize the interconnections between disasters, environment, and development, and explore sustainable approaches for reconstruction and development in disaster-prone areas.

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

- **CO1:** Understand key concepts related to disasters, hazards, vulnerabilities, risks, and disaster management.
- **CO2:** Identify and classify various types of natural and man-made disasters by understanding their characteristics using available analyze and interpret data with appropriate consideration for the public health and safety.
- **CO3:** Evaluate the environmental, social, economic, and political impacts of disasters, recognizing the implications on health, demographics, and global/national trends.
- **CO4:** Understand the impact of disaster risk reduction strategies, including prevention, mitigation, preparedness, and recovery measures for societal and environmental contexts
- **CO5:** Recognize the interconnectedness of disasters for preparation and ability to engage in independent research and lifelong learning in disaster-prone areas.

Course Outcome to Program Outcome Mapping:

COs / Pos / PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3														
CO2		2	1												
CO3						2									
CO4							3								
CO5												3			

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

Course Syllabus:

Module 1: Introduction (6 hours)

Theory

Concepts and definitions: disaster, hazard, vulnerability, risks severity, frequency and details, capacity, impact, prevention, mitigation.

Module 2: Disasters (6 hours)

Theory

Disasters classification; natural disasters (floods, draught, cyclones, volcanoes, earthquakes, tsunamis, landslides, coastal erosion, soil erosion, forest fires etc.); manmade disasters (industrial pollution, artificial flooding in urban areas, nuclear radiation, chemical spills, transportation accidents, terrorist strikes, etc.); hazard and vulnerability profile of India, mountain and coastal areas, ecological fragility.

Module 3: Disaster Impacts (6 hours)

Theory

Disaster impacts (environmental, physical, social, ecological, economic, political, etc.); health, psycho-social issues; demographic aspects (gender, age, special needs); hazard locations; global and national disaster trends; climate change and urban disasters.

Module 4: Disaster Risk Reduction (Drr) (6 Hours)

Theory

Disaster management cycle – its phases; prevention, mitigation, preparedness, relief and recovery; structural and non-structural measures; risk analysis, vulnerability and capacity assessment; early warning systems, Postdisaster environmental response (water, sanitation, food safety, waste management, disease control, security, communications); Roles and responsibilities of government, community, local institutions, NGOs and other stakeholders; Policies and legislation for disaster risk reduction, DRR programmes in India and the activities of National Disaster Management Authority.

Module 5: Disasters, Environment And Development (6 Hours)

Theory

Factors affecting vulnerability such as the impact of developmental projects and environmental modifications (including dams, land use changes, urbanization, etc.), sustainable and environmentally friendly recovery; reconstruction, and development methods.

Text/Reference Books:

1. <http://ndma.gov.in/> (Home page of National Disaster Management Authority)
2. <http://www.ndmindia.nic.in/> (National Disaster Management in India, Ministry of Home Affairs).
3. Pradeep Sahni, 2004, Disaster Risk Reduction in South Asia, Prentice Hall.
4. Singh B.K., 2008, Handbook of Disaster Management: Techniques & Guidelines, Rajat Publication.
5. Ghosh G.K., 2006, Disaster Management, APH Publishing Corporation
6. Disaster Medical Systems Guidelines. Emergency Medical Services Authority, State of California, EMSA no.214, June 2003
7. Inter-Agency Standing Committee (IASC) (Feb. 2007). IASC Guidelines on Mental Health and Psychosocial Support in Emergency Settings. Geneva: IASC

Surveying Techniques (70 hrs)

Code	Course Title	Credit	T-P-PJ
CUTM2369	Surveying Techniques	3	1+2+0

Course Objective

- Apply the knowledge, techniques, skills and modern tools of mathematics, science, engineering, and technology to solve well-defined surveying problems appropriate to the discipline. To study the temporary adjustment of survey instruments by standard methods.
- Technical Adeptness - Graduates will be technically adept in Surveying Technology as well as supporting math and science disciplines, allowing these graduates to assist professional land surveyors in various surveying and mapping projects.
- To do various field works with the help of Modern Instruments e.g. GNSS, Total station and GPR.

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

- **CO1:** Understand the basic principles of surveying for vertical, horizontal, linear and angular measurements to arrive at solutions to basic surveying problems.
- **CO2:** Analyze type of survey operation required for problem solving in field to perform
- **CO3:** Design and implement different types of curves for deviating type of alignments, and applying surveying techniques to align highway and railway curves.
- **CO4:** Capture geodetic data to process and perform analysis for survey problems with the use of electronic instruments.
- **CO5:** Conduct land surveys and create accurate survey drawings and maps for engineering projects, including boundary surveys and topographic surveys.

Course Outcome to Program Outcome Mapping:

COs / Pos / PSOs	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														
CO2		2	3												
CO3				2		2									
CO4				2	3										
CO5				3											

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

Course Syllabus:

Module-1: Introduction to Surveying (10 Hours)

Theory

Classification and Principles of Surveying, Geodetic and Plane (Topographic) Surveying, Surveying Instruments, Geometry of Ellipsoid: Everest and WGS 84, Latitude and Longitude, Co-ordinate System and Map Projection: Polyconic Projection, Lambert Conformal Conic Projection, Universal Transverse Mercator Projection, Map scale: Fractional or ratio scale, Linear Scale, Graphical Scale.

Module-2: Basic Survey Operations (10 Hours)

Theory

Leveling: Concept and principles of levelling, Mean Sea Level, different types of levelling, their application, Source of error in Levelling (instrumental, natural, and personal) and elimination of errors.

Traversing: Traverse angle, Observation of Traverse Length, Selection of Traverse Station, Traverse Field Notes, Angle misclosure, Sources of error in traverse. Balancing angles, Computation of Azimuth or Bearing, Departure and Latitudes, Traverse adjustment, rectangular co-ordinates.

Practice:

- Experiment 2.1: Calculation of RL using HI and Rise and fall method.
- Experiment 2.2: Traverse by Total Station.

Module-3: Total Station (10 Hours)

Theory

Characteristics of Total Station /Electronics Total Station instrument, Function performed by Total Station, Parts of Total Station instrument, Handling and Setting up a Total station, Horizontal angle measurement, Vertical angle measurement, distance and angle measurement, Remote Elevation Measurement (REM), coordinate measurement, to view the data/ points collected, area calculation, data download. Source of error in total station.

Applications of total station: Detail survey i.e., data collection., Height measurement (Remote elevation measurement-REM, fixing of missing pillars (or) Setting out (or) Stake out, Resection. etc. Remote distance measurement (RDM) or Missing line measurement (MLM).

Practice:

- Experiment 3.1: Distance, angle and slope Measurements
- Experiment 3.2: Traverse adjustment (With help of software)
- Experiment 3.3: Area calculation using Total station
- Experiment 3.4: Height measurement (Remote elevation measurement- REM).
- Experiment 3.5: Fixing of missing pillars (or) Setting out (or) Stake out.
- Experiment 3.6: Preparation of contour maps using total station and surfer software.

MODULE 4: GLOBAL POSITIONING SYSTEM (10 Hours)

Theory

Introduction of Global Navigation Satellite System (GNSS): GNSS Satellites: Galileo, NAVSTAR Global Positioning System (GPS), GLONASS and BeiDou Navigation Satellite System. Indian Regional Navigation System, Navigation with Indian Constellation (NivIK), Segments of GNSS/GPS: Control Segment, Space Segments, User Segment-operations of GPS; GPS signals and data; Geo-Positioning-Basic Concepts., accuracy, error sources and analysis, methodology for collection of data, adjustment computations and analysis.

MODULE 5: DIFFERENTIAL GLOBAL POSITIONING SYSTEM (10 Hours)

Theory

Differential Global Positioning System: Method DGPS/DGNSS, Static and Rapid Static, Kinematic-Real time kinematic Survey, DGPS-GPS data processing and Accuracy, Real Time Kinematic Survey; data down loading and processing. Application of GPS in Surveying and Mapping, Navigation, Military, Location Based Services, Vehicle tracking, etc. Limitation of GPS & DGPS.

MODULE 6: GROUND PENETRATING RADAR (10 Hours)

Theory

GPR Explain working principle of ground penetrating radar (GPR), Describe the type of antennas used with GPR for different type of underground material detection, Use ground penetrating radar until a predefined depth from sub-surface based on the conductivity of material. Explain use of sketch/single line diagram (SLD). Describe the use of GPS/DGP in sync with GPR to get all data populated on map. Describe the use of other Utility locator like electromagnetic locator and other utility locators.

MODULE 7: CADASTRAL SURVEY(10 Hours)

Theory

Cadastral map preparation methodology, unique identification number of parcel, position of existing control points and its types, Adjacent boundaries and features, Topology Creation and verification. Scale of Cadastral map, Cadastral Survey by Total Station.

- **Text Books:**

Surveying Vol I & II, III B C Purnima, Laxmi Publication.

Surveying, volume 1&2 BY S.K.Duggal, TMH publisher.

Reference Books:

Surveying & Levelling by T.P Kanitkar & V S Kulkarni.

Elementary Surveying, by Charles D. Ghilani and Paul R. Wolf Pearson Publication

E Books:

1. Source of reference; NSQF

Online Source: NPTEL Videos (www.nptel.ac.in)

Transportation Engineering (60 hours)

Course Code	Course Title	Credits	Type (T+P+Pi)
CUTM2371	Transportation Engineering	3	2+1+0

Course Objective

- To develop an understanding of the fundamental concepts and principles of highway planning, geometric design, materials, construction, pavement design, traffic characteristics, railway engineering, airport planning, and harbor and dock design.
- To gain knowledge and skills in using relevant software tools such as Civil 3D, GIS, and AutoCAD to apply the principles of highway and transportation engineering in practical design and analysis tasks.
- To apply the learned concepts and techniques to analyze and design various components of transportation infrastructure, including roads, highways, pavements, railways, airports, and harbors, considering factors such as safety, efficiency, sustainability, and environmental impact.

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

- **CO1:** Understand the principles and practices of transport planning and geometric design.
- **CO2:** Identify and develop analytical hands on practice to characterize different types of pavement construction materials for sustainable development.
- **CO3:** Gain knowledge and skill for pavement design principles of flexible and rigid pavements with problem solving capacity behaviour.
- **CO4:** Acquire the industry-oriented skill for designing and preparing layout for different transport mode utilities using modern tools.
- **CO5:** Develop domain skill in transportation infrastructure systems for airports, railways, and harbors, considering factors such as safety and efficiency.

Course Outcome to Program Outcome Mapping:

COs / Pos / PSO s	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													
CO2			1				3								
CO3				3											
CO4					3										2
CO5						2							3		

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

Course Syllabus:

Module 1: Introduction and Basic in Geometric Design (8 Hours)

Theory

Highway planning in India, development, rural and urban roads, road departments in India, road classification, road authorities i.e., IRC, NHAI, CRRI, NHDP etc. Introduction to geometry design: Objective of geometric design, Design speed, cross-section elements, sight distance, horizontal alignment, vertical alignment, Superelevation, camber, cross-section, lane width.

Practice:

- Experiment 1.1: Design of Horizontal Alignment using Civil 3D.
- Experiment 1.2: Design of Vertical Alignment using Civil 3D.
- Experiment 1.3: Create a profile using Civil 3D.

Module 2: Road Materials Characteristics And Construction (12 hours)

Theory

Introduction, Aggregate Characterization: Types of aggregates; Mechanical and shape properties of aggregates, aggregate texture and skid resistance, proportioning and blending of aggregates; Bitumen Characterization; Subgrade Soil Characterization: Properties of subgrade layers; different types of soils, Mechanical response of soil; SPT, DCPT, CPT, CBR. Construction: Plain cement concrete (PCC), Hot Mix Asphalt (HMA), Base/Sub-base layers.

Practice :

Test on aggregate

- Experiment 2.1: Los Angeles abrasion test.
- Experiment 2.2: Aggregate crushing test
- Experiment 2.3: Aggregate Impact value test
- Experiment 2.4: Specific gravity and water absorption
- Experiment 2.5: Flakiness index and elongation index test of Aggregate

Test on bitumen

- Experiment 2.6: Penetration test of bitumen
- Experiment 2.7: Ductility value test of bitumen
- Experiment 2.8: Softening point test of bitumen
- Experiment 2.9: Flash and Fire point test of bitumen
- Experiment 2.10: Specific gravity of bitumen

Test on subgrade

- Experiment 2.11: California bearing ratio test

Module 3: Pavement Design (8 hours)

Theory

Basis design of Flexible pavements and rigid pavements according to standards.

Practical:

- Experiment 3.1: Marshall Mix design

- Experiment 3.2: Plain Concrete Mix design

Module 4: Traffic Characteristics (10 hours)

Theory

Basic traffic characteristics-Speed, volume and concentration, Relationship between Flow, Speed and Concentration
Volume Studies- Objectives, Methods; Speed studies- Objectives: Definition of Spot Speed, time mean speed and space mean speed, speed studies, parking study.

Practice :

- Experiment 4.1: Parking study (field study)
- Experiment 4.2: Vehicle volume counts (field study)

Module 5: Railway Engineering And Geometry (8 hours)

Theory

Introduction on component parts of railway track, problems of multi gauge system, coning of wheels, alignments and survey, permanent way track components, Type of rail sections, creep of rails, wear and failure in rails, ballast requirements, sleeper requirements, types of sleepers. Geometric design: Gradients and grade compensation, various speeds on a railway track, superelevation, horizontal and vertical curves, Points and crossings, signaling and interlocking.

Practice:

- Experiment 5.1: Draw a neat sketch of typical cross section of a permanent way
- Experiment 5.2: Environmental resistance test for ballast.
- Experiment 5.3: Impurities test on ballast

Module 6: Airport Planning And Visual Aids (8 hours)

Theory

Airport Master plan, Airport site selection, Air craft characteristics, Zoning laws, Airport classification, Runway orientation, Wind rose diagram, Runway length design, Terminal area and Airport layout, Visual aids and Air traffic control. Airport markings and lighting.

Practice:

- Experiment 6.1: Draw a topographical map for Airport Layout by GIS
- Experiment 6.2: Draw the typical layout of an airport using AutoCAD.

Module 7: Harbour & Dock (6 hours)

Theory

Classification of Harbour basin, general layout of harbours, Docks, Different components of docks, Jetties and Dolphins.

Practice:

- Experiment 7.1: Draw layout of harbour using AutoCAD.

Text Books:

- K.Khanna and C.E.G Justo, Highway engineering.
- Principles of Transportation Engineering by Partha Chakraborty and Animesh Das
- R Kadiyali, Traffic engineering and N B Lal, Principles and practice of highway engineering, Khanna Publications, 2005.
- A text book of railway engineering, By S.C.Saxena and M.G.Arora
- Air-port Engineering by S.K.Khanna and M.G.Arora

Reference Books:

- Railway Engineering by Satish Chandra & MM Agrawal, Oxford University Press.
- Transportation Engineering, Volume-II- Railways, Airports, Docks and Harbours, Bridges and Tunnels by C. venkatramaih, Universities Press.

Hydrology and Irrigation (60 Hours)

Code	Course Title	Credit	T-P-PJ
CUTM2372	Hydrology and Irrigation	3	2+1+0

Course Objectives:

- To study the basic principles and movement of groundwater and properties of groundwater flow
- To study the watershed characters and applications
- To study the hydrological disaster and role of earth observation technology

Course Outcome:

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

- **CO1:** Describe the hydrological cycle, types of rainfall, and computation of the direct runoff hydrograph for different storms using unit hydrograph theory.
- **CO2:** Explain the importance of flood forecasting, flood routing, and flood protections in mitigating the impacts of floods.
- **CO3:** Understand the concepts of dams, including their causes of failure and economical height, and to determine the reservoir capacity.
- **CO4:** Understand the water requirements of crops and consumptive use, as well as the quality of water needed for irrigation.
- **CO5:** Estimate the canal capacity, design the canal, and proficiently perform the functions and components of a diversion headworks by using latest tools, including waterlogging control.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2	PS O1	PS O2	PS O3
CO1	3			2									1		
CO2		3					2			1		2			3
CO3	2	3	3						1		1				
CO4	2			1		2	2						3		
CO5				3	2				2			2			

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

Course Syllabus:

Module 1: Introduction (5 hours)

Theory

Hydrological cycle, Types of Rainfall, Precipitation - measurement - average precipitation over a basin, evaporation, transpiration, infiltration - Infiltration indices. Runoff -Overland flow, Types of aquifers.

Practice:

- Experiment 1.1: Determination of infiltration capacity using double ring infiltrometer.

Module 2: Hydrograph (10 hours)

Theory

Direct runoff, Base flow, separation of base flow- Hydrograph, Unit hydrograph - Assumptions of Unit hydrograph, derivation of unit hydrograph from direct runoff hydrograph, Computation of direct runoff hydrograph for different storms using unit hydrograph theory.

Practice:

- Experiment 2.1: Construction of a double mass curve using Python.
- Experiment 2.2: Hydrograph analysis using Python.

Module 3: Flood Management (10 hours)

Theory

Floods- type and causes of occurrence, flood classification- probable maximum flood, standard project flood, design flood, Flood forecasting, Flood routing-channel routing, and flood protections.

Practice:

- Experiment 3.1: Determination of the flood stage-discharge relationship in a watershed using Python
- Experiment 3.2: Determination of flood peak-area relationships using Python

Module 4: Hydropower Engineering (10 hours)

Theory

Dams and their causes of failure, economical height of dams, planning of water resources projects, Reservoir Planning: Storage capacity of reservoirs, Yield from reservoir, Reservoir losses, reservoir sedimentation.

Practice:

- Experiment 4.1: Design of Stability analysis of gravity dam.
- Experiment 4.2: Various cases of Failure of concrete gravity dam.

Module 5: Irrigation Engineering (10 hours)

Theory

Water requirements of crops, consumptive use, quality of water for irrigation, irrigation methods and their efficiencies.

Practice:

- Experiment 5.1: Numerical analysis of Irrigation Parameters (Duty, Base Period, Delta and Efficiencies).

Module 6: Canal Irrigation (5 hours)

Theory

Classification of canals, Canal losses, Alignment of main and distributary canals, most efficient section, Cross section of irrigation canals, water logging - causes and control.

Practice:

- Experiment 6.1: Design of irrigation canal using Kennedy's and Lacey's theory.
- Experiment 6.2: Design of lined canal.

Module 7: Diversion Head Works (5 hours)

Theory

Functions and components of a diversion head work - Function - selection of site - type of weirs on pervious foundations - cause of failure - Bligh's creep theory and Khosla's theory - complete design of a vertical drop weir.

Practice:

- Experiment 7.1: Design of head regulators and cross regulators.
- Experiment 7.2: Field visits for various irrigation structures.

Text Books:

- Todd D.K., (2000) Ground Water Hydrology, John Wiley and Sons,
- K., subramanya (2008) Engineering Hydrology, Tata McGraw-Hill Publishing Company Limited.
- Ahmadi, A., Akhbari., M., and Karamouz, M (2011) Groundwater Hydrology: Engineering, Planning and Management, CRC Press.

Reference Books:

- Saeid Eslamian (2014) Handbook of Engineering Hydrology: Environmental hydrology and water management, CRC Press.
- Malcolm. G. Anderson and Jeffrey J Mc Donnell (2005) Encyclopedia of hydrological Science, J Wiley.

• **Water supply and Sanitary Engineering (45 Hours)**

Code	Course Title	Credit	T-P-PJ
CUTM2373	Water supply and Sanitary Engineering	2	1+1+0

Course Objectives:

- To inculcate the basics of water supply, purification, and treatment of water and wastewater.
- To inculcate the basic concepts of wastewater treatment, its design, and management.
- To understand the water distribution networks and plumbing system

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

- **CO1:** Understand the importance of water supply engineering, including selecting suitable water sources and assessing water quality through physical, chemical, and biological tests.
- **CO2:** Develop to design and decision-making capability to operate water treatment plants effectively, considering health and safety issues.
- **CO3:** Design and investigate proficiency in selecting pumps, pipes, valves, and fittings for water conveyance systems, while implementing measures for water conservation and leak prevention for environmental contexts.
- **CO4:** Evaluate various methods of sewage collection and disposal, including sewer systems and waste management techniques, to maintain public health and environmental sustainability.
- **CO5:** Analyze and apply appropriate techniques for sewage treatment processes and ensure compliance with environmental regulations.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	2										2	2		
CO2			3	2		3		1						3	
CO3			2	3			2		1						
CO4			3			2	2				1		2		
CO5		2			3		2			1					2

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

Course Syllabus:

Module 1: Sources, Quality and Demand of Water (5 hours)

Theory

Importance and necessity of water supply Engineering; Sources of water; Suitability of water; Choice of source; Types of demand Population forecast; Computation of quantity of water; Fluctuation in demand; Factors affecting demand. Impurities in water; Collection of water sample; Physical Chemical and Biological tests; Standards of quality of water.

Module 2: Treatment of Water (10 hours)

Theory

Objectives of water treatment; Location of water treatment plant; Layout of water treatment plant; Basic principles of working of treatment plant; Various stages of treatment of influent water; Functioning of Coagulation treatment plant; Sedimentation; Filtration; Disinfection

Practice

- Experiment 2.1: Predict Population from given field data by various methods
- Experiment 2.2: Calculation of hardness of water from the observed field data

Module: 3 Conveyance of Water (10 hours)

Theory

Pumps and selection (outline only); Types of pipes used for conveyance; Pipe joints; Laying of Pipes; Distribution system; Types of valves; Types of Meters; Pipe fittings and fixtures of different materials their advantages and disadvantages; Necessity; Methods to prevent leaks; Measures for conservation of water.

Practice

- Experiment 3.1: Design lay out of pipe system from the overhead tank to different supply terminals.
- Experiment 3.2: Determination of pH value, Turbidity and hardness of water sample

Module 4: Sanitation System (10 hours)

Theory

Objective of sewage disposal; Methods of sewage collection; Conservancy system; Waste carriage system; Classification of Drains; Sewer System (Manhole; Flushing tank; Catch basin etc.)

Practice

- Experiment 4.1: Preparation of AUTOCAD layout plans/ sketches of different Water treatment plant, Sewage treatment plant, sedimentation tank, filters, Manholes, Flushing tanks etc. 2hr
- Experiment 4.2: Design of Septic tank using HEC software 1hr
- Experiment 4.3: Design of Manhole from given field data 1hr

Field Visit:

Water treatment plant and a sewage treatment plant must be followed by a field Visit report

Module 5: Waste Management (10 hours)

Theory

Sewage Treatment plant; Treatment of sewage; Types of waste, sewage and sludge disposal (Solid, liquid, Radio Active), Utilization and management of solid waste.

Practice

- Experiment 5.1: Determination of B.O.D. and C.O.D. of waste water sample 2hr

Text Books:

- Text Book of water supply and sanitary Engineering; S K Hussain: Oxford and IBH
- Water supply & Sanitary Engineering; Vazirani & Chandola; Khanna Publishers

Reference Books:

- Municipal and Rural Sanitation: Ehlers & Steel; Mc Graw hill book
- Elements of Public Health Engineering: K.N.Duggal, S.Chand & Co.

Construction Materials (60 Hours)

Code	Course Title	Credit	T-P-PJ
CUTM2989	Construction Materials	2	0+2+0

Course Objectives:

- To introduce students to the fundamental properties, characteristics, and behavior of construction materials such as concrete, steel, timber, and masonry.
- To familiarize students with the manufacturing processes and techniques involved in producing construction materials.
- To educate students about sustainable construction materials and practices, promoting the use of environmentally friendly and energy-efficient materials.

Course Outcomes:

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

- CO1 Understand the properties, characteristics, and behaviour of various construction materials.
- CO2 Develop analytical skills to identify different types of construction materials and their applications considering social and environmental contexts.
- CO3 Analyze factors influencing material selection for various structures, ensuring they meet desired needs while considering public health & safety.
- CO4 Hands-on to evaluate construction materials' quality and durability, including design of experiments, analysis and interpretation of data.
- CO5 Solve complicated issues by conducting advanced research on construction materials.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3				2				1			1	2		
CO2		2		2			1							3	
CO3			2			3			1		1		2		
CO4	2			3								3	3		
CO5	2			2				1						2	

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

Course Syllabus:

Module 1: Structural and Nonstructural Materials (10 hours)

Overview of Materials and Building/Structural Types, Factors Affecting Choice of Materials and Structural Form, Mechanical Properties, Non-Mechanical Properties (physical properties, durability), Individual Building Materials Manufacturing, Properties, Comparative Behavior, Structural Steel, Composition, Material Properties, and Behaviour, Non-ferrous metals.

- Experiment 1.1: Measure and analyze the tensile and compressive strength of structural steel.
- Experiment 1.2 : Durability and Water Absorption Test on Building Materials

Module 2: Stones, Bricks, Concrete Blocks (10 hours)

Theory

Stone as a building material, Criteria for selection, Refractory bricks, Concrete blocks, Light-weight concrete blocks, Air Cleaning Bricks, Passive Cooling Ceramics or hydro ceramic bricks, Fly ash bricks, AAC, ECA, CLC blocks, EPS Building.

Practice

- Experiment 2.1: Evaluate the compressive strength of different types of bricks (e.g., clay, fly ash, AAC) and concrete blocks.
- Experiment 2.2: Study the physical properties and selection criteria for stones used in construction (e.g., hardness, density).
- Experiment 2.3: Compare the properties and performance of different lightweight concrete blocks (e.g., AAC, ECA, CLC).

Module 3: Timber, Roof & Flooring Materials (5 hours)

Theory

Timber, Market forms, Industrial Timber, Plywood, Mass timber, laminated timber and glue, laminated timber, Veneer, thermocol, Panels of laminates, Steel, Aluminum and Other Metallic Materials, Composition, Aluminium composite panel, Market forms, Mechanical treatment, Granite, Tile flooring, Cladding of tiles, materials according to types of roof, Elements of a pitched roof, Trussed roof, Steel Truss, Different roofing materials, R.C.C. Roof.

Practice

- Experiment 3.1: Evaluation of Mechanical Properties of Industrial Timber and Laminated Timber for Structural Applications.
- Experiment 3.2: Determination of structural integrity of Granite and Tile Flooring.

Module 4: Nonstructural Materials, Accessories, and Finishes (10 hours)

Theory

Materials for doors and windows, Paneled door, Flush door, Collapsible door, Rolling shutter, PVC Door, Review of Nonstructural Materials and Criteria for Selection, Polymer Floor Finishes, Paints, varnishes, enamel, distemper, Tiles, Acoustic Treatment, Drywalls, Anchors, plumbing and sanitary fittings.

Practice

- Experiment 4.1: Hands-on experience with different Door and Window materials
- Experiment 4.2: Nonstructural Materials and Interior Finishes.

Module 5: Exterior Wall Materials (5 hours)

Theory

Gypsum Area Separation Walls, Insulated Vinyl Siding, House Wrap Installation Tips, Common Cladding Alternatives, Insulated Wall Panels, WPC sheets, and GFRG panels.

Practice

- Experiment 5.1: Assess the structural strength and durability of GFRG (Glass Fiber Reinforced Gypsum) panels.
- Experiment 5.2: Analyze different cladding materials and learn proper house wrap installation techniques.

Module 6: New Generation Construction Materials (10 hours)

Theory

Glass, Ceramics, Clay products, Refractories, Composite materials, Fibre textiles, Geomembranes and Geotextiles for earth reinforcement, Illuminating Cement, Prefabricated panels, Epoxy resin, and grouting.

Practice

- Experiment 6.1: Sealants for joints
- Experiment 6.2: Applications of laminar composites

Module 7: Green and Sustainable Construction Materials (10 hours)

Bamboo, Reclaimed wood, cork, mycelium, recycled steel, straw bales, rammed earth, hempcrete, grasscrete, GGBFS, CSF, geopolymer, Silica fume, Fly ash, Red Mud, copper slag, construction demolition waste, waste plastic.

Practice

- Experiment 7.1: Exploring Sustainable and Alternative Construction Materials
- Experiment 7.2: Characterization of Industrial By-products and Recycled Materials in Construction

Text Books:

- S. K. Duggal, Building Material, 5th Ed, New Age International Publishers, 2019
- Rangwala “Engineering Materials (Material science)” Charotar Publishing House Pvt. Ltd., Edition-2017

Reference Books:

- P.C. Varghese, Building materials, 2nd Ed., Prentice-Hall of India private Ltd, New Delhi. 2015
- R.K. Rajput “Engineering Materials (Including construction materials)”, 4th Ed., S. Chand Publications. 2014
- Rofat Siddique “Special structural Concrete” Galgotia Publishing Pvt. Ltd., New Delhi, 2000
 - Code book: IS 10262-2019 “Concrete Mix Proportioning-Guidelines”, Second Revision

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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/> Soft-ware/Tool(s): Java 8, Eclipse IDE

Online Compiler: <https://ide-one.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 avg² 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: $X_1 X_2 * X_3$

2.0 4.0

3.0 9.0

1.0 1.0

2.0 4.0

sum 8.0 18.0

Now:

$$\text{avg} = 8.0/4 =$$

$$2.0 \text{ avg}^2 = 4.0$$

$$\text{avgSquare} = 18.0/4 = 4.5$$

$$SD = \text{Math.sqrt}(4.5 - 4.0) = \text{Math.sqrt}(.5) = 0.7071067812$$

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 calcula-

tor” 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 have 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 / PS Os	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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,amoun
```

t). 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

BASKET – V

(Domain)

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+PR+TU T	Credits	Hrs.
1.	CUCP3001	Site Study & Structural Drawings	0+2+2	4	60
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	50
6.	CUCP3006	Sustainability in Construction & Green Structures	0+0+6	6	60
Total				20	

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.

Site Study & Structural Drawings

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					

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

Module – 1 (Preparation of Site Map)

6 Hrs.

Practice – 1: Conduct a site survey to gather information about the topography, soil conditions, vegetation, and existing structures on the site.

Practice – 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.

Practice – 3: Develop a conceptual site plan that includes the proposed layout of the development, including the location of buildings, roads, sidewalks, and other infrastructure.

Practice – 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)

8Hrs

Practice – 1: Preparation of plans, elevations and section drawings of the structure.

Practice – 2: Identifying the columns position as per the plan and preparation of column layout of the structure.

Practice – 3: Preparation of 3D exterior design of the structure with rendering effect.

Practice – 4: Preparation of 3D interior design with all necessary appliances of the structure with rendering effect.

Module – 3 (Preparation of Electrical and Plumbing drawing)

7Hrs

Practice – 1: Review the architectural plans and specifications to understand the electrical and plumbing requirements of the project.

Practice – 2: Develop a rough electrical layout, which includes the location of electrical panels, switches, outlets, and lighting fixtures.

Practice – 3: Develop a rough plumbing layout, which includes the location of plumbing fixtures, water supply, and drainage lines.

Practice – 4: Prepare single line diagrams, load schedules, and other technical documents as needed.

Practice – 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)

8Hrs

Practice – 1: Structural design of indeterminate RCC beams, columns, walls and slabs as per IS code using STAAD Pro and E-Tabs.

Practice – 2: Structural design of foundations as per IS code using STAAD foundations.

Practice – 3: Design of steel girders, columns and truss members as per IS code using STAAD Pro and E-Tabs.

Practice – 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)

6Hrs

Practice – 1: Preparation of different bar bending schedules as per the structural design.

Practice – 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

Practice – 3: Preparation of layout of the structure on the field showing the column layout.

Practice – 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

Computational Techniques in Construction

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

Module- 1: Project Management and Scheduling

6 Hrs.

Introduction, Project planning, scheduling, controlling, Role of decision in project management, Project management Process and role of Project Manager.

Lab/Practical:

- Project scheduling and management using software tools.
- Case studies: Real-world construction project planning and scheduling.

Module-2: Project Planning Tools

6 Hrs.

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.

Lab/Practical:

- Creating Gantt Charts and Milestones in project management software
- Developing CPM and PERT networks and performing network analysis

Module -3: Cost Analysis & Updating

6 Hrs.

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.

Lab/Practical:

- Cost estimation and optimization in project management software
- Project updating exercises using real-world data

Module -4: Simulation Techniques

6 Hrs.

Monte Carlo Simulation: Principles and applications in construction.

Monte Carlo simulation exercises in MATLAB/Python.

Basic discrete event simulation using appropriate software.

Lab/Practical:

- Monte Carlo simulation exercises in MATLAB/Python
- Discrete event simulation exercises

Module -5: Building Information Modeling (BIM)

6 Hrs.

Introduction to BIM

Applications of BIM in construction supervision

Benefits of BIM in modern construction projects

Lab/Practical:

- BIM software exercises (e.g., Autodesk Revit)
- 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.

Contract Laws & Equipment Management

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

Module – 1 (Contracts and forms)

6 Hrs

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)

3+4 Hrs

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: Preparation of sample contract documents for different construction projects as per CPWD guidelines.

Module – 3 (Stages in Contracting)

3+4 Hrs

Theory: Preparation of tender documents estimating, pre-qualification, bid evaluation, award of contract, project financing and contract payments, contracts close out and completion.

Practice: Preparation of sample tender documents for different construction projects as per CPWD guidelines.

Module – 4 (Contract Conditions)

3+4 Hrs

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: Preparation of sample documents with respect to the above conditions of contract for various project works as per CPWD guidelines.

Module – 5 (Equipment Management)

8 Hrs

Equipment Management & Procurement: Equipment Management Check List - Equipment Order and Invoice - Equipment Maintenance sheets and Log Book.

Practice based 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

Practice through demo:

Proper record keeping in contract administering, establishment of standard procedures, coordination between various agencies involved, providing data for interpretation of contract clauses Special aspects of contract management.

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

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**

Module 1 : Introduction-**6 Hrs.**

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 :

1. Use a case study or a real construction project scenario to develop a Quality Management System (QMS) framework.
2. Create documents such as Quality Policy, Quality Manual, and Standard Operating Procedures (SOPs) for quality control processes.

Module 2: Quality Assurance**6 Hrs.**

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:

1. Evaluate sample construction projects using CONQUAS to assess quality levels and identify areas for improvement.
2. Develop inspection checklists for critical construction activities such as concrete pouring, steel reinforcement installation, and formwork erection.

Module 3: Quality Control**6 Hrs.*****Practice:***

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.
2. Generation of sample Quality Control Inspection schedule Check list for form work for a Building / Irrigation Structure.
3. Generation of sample Quality Control Inspection Schedule Check list for concreting in a Residential building / Irrigation Structure.
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

6 Hrs.

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:

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).
2. Emphasize proper test preparation, execution, and interpretation of results.
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

6 Hrs

- 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:

1. Develop a safety management plan for a construction site, considering hazards identification, risk assessment, and control measures.
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.

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

Module 1: Introduction to Modern Construction and Advanced Materials

Introduction to Modern Construction

- 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

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

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

Concrete Technology

- Advanced concrete types and their applications
- Mix design and testing of concrete
- Quality control in concrete construction

Steel Structures and Supervision

- Modern techniques in steel construction
- Supervision of steel erection and assembly
- 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

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

Sustainability in Construction & Green Structures (0+0+6)

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

Module 1:

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:

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:

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 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

- 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

List of 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.

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
Total				20	

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.

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		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
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	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3					2									
CO2		2			2										
CO3			2										3		
CO4				3											
CO5										3					

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	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3					2									
CO2		2			2										
CO3				2											
CO4			3										2		
CO5						3									

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.

COs / Pos / PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3			2											
CO2		2	2												
CO3				2											
CO4						3									
CO5											3				

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		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1		3			2											
CO2			2			2										
CO3					2											
CO4				3												
CO5							3									

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.
4. Mangrove change detection study using Multi-Temporal satellite data.
5. Solid waste management and shortest path identification using GIS Technology.
6. Watershed management using GIS Technology.
7. Identification of Mineral mapping using GIS and RS.
8. Crop Health Monitoring using Geospatial Technology.
9. Identification of Hydrocarbon Locales using space inputs and Geospatial Technology.
10. Groundwater exploration using GIS and RS Techniques.
11. Interlinking of River using GIS Technology.
12. Biomass estimation using Space Technology.
13. Land surface Temperature mapping using RS Technology.
14. Climate Change study using Earth Observation Technology.
15. 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.

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.
- To become an expert in Entrepreneurship.

Domain Track Course Outcomes

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Able To gain the knowledge on different types of materials used in Renewable Energy.	PO1 (3)
CO2	To know the applications of solar thermal technology, off-grid , on-grid and hybrid renewable energy systems.	PO2(3), PO5(1)
CO3	To become an expert in Entrepreneurship.	PO8(3),PO7(2)

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, TIO₂)
- 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, TiO₂-SiO₂ composite for solar cell)
- 1.14 Perovskite based solar cell (transition metal doped PbTiO₂)
- 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, Jawaaid, 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=4SlfaocMfdA>

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 TiO₂/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, TiO₂)

<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, TiO₂-SiO₂ composite for solar cell)

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

<https://www.youtube.com/watch?v=qDviZVbf7AA>

<https://www.youtube.com/watch?v=qvxH0RuaTpY&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 PbTiO₂)

<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

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

Session 19. Practice: Site visit for acquire knowledge on different renewable energy technologies and its 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

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

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=rrldwVGmmy4&t=161s>

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/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

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

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/9qu5ryJBIIIE>

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 its components

<https://youtu.be/XboxQHJPD4>

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

Session 82. Practice: Analysis and assessment of project cost

Session 83. Economic profile and power consumption trends

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/hilb4v_dnck

Session 90. Entrepreneurship skill

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 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 Distribution System & Transformers

Domain Name	Code	Type of course	T-P-P	Pre-requisite
Operation and Maintenance of Electrical Distribution System & Transformers	CUED 2100	Theory + Practice + Project	7-11-6	Nil

TRACK TOTAL CREDITS:

Theory + Practice + Project: [7+11+6 =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, validate them and innovate for design efficiency

DOMAIN OUTCOMES:

- **CO1:** Gain knowledge of the processes involved in making commercially viable distribution transformers, along with an understanding of the distribution system, preliminary power generation concepts, power system planning, modeling, power quality, and electricity market fundamentals.
- **CO2:** Identify and resolve problems related to transformer manufacturing and operational challenges in distribution systems.
- **CO3:** Develop design skills for distribution transformers, generate technical reports, troubleshoot distribution system issues, and conduct analysis related to power markets and system modeling.
- **CO4:** Acquire hands-on experience in transformer maintenance and testing procedures.
- **CO5:** Apply different software tools (such as ETAP, MATLAB, PSCAD, DigSILENT, Proteus, etc.) to validate theoretical concepts and practical studies related to transformers and distribution systems.

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 the following components, which will be reflected in the grade sheet.

- CUED 2100 Power Scenario, Power Quality & Generation System [2-2-0]
- CUEG 2091: Switchyard & Substation Types upto 33kV, [2-1-0]
- CUEG XXXX: Cable, Switchgear, Protection system [2-2-0]
- CUEG 2096: Transformer Manufacturing, and Testing [1-6-0]
- CUEG 2097: Project, [0-0-6]

The Domain will be delivered through case studies, assignments and product development Product Development Stack:

1. Distribution Transformer (Full product)
2. Smart Transformer (Modular Platform design)
3. Prototype distribution system

Session Plan for the Entire Domain:

Course 1: CUED 2100: Power Scenario, Power Quality & Generation System [Interactive + Modeling], [2-2-0]

Module 1: Power Generation Landscape

- **Overview of Energy Sources**
 - Classification: Conventional vs. Non-Conventional
 - Current power scenario in India and globally
 - Energy demand and supply trends
- **Conventional Generation Technologies**
 - **Thermal Power Plant:** Working principle, key components, efficiency, environmental impact
 - **Hydro Power Plant:** Types (run-of-river, storage), site selection, advantages and limitations
 - **Gas Power Plant:** Simple cycle, combined cycle operations
 - **Nuclear Power Plant:** Basic operation, safety measures, environmental aspects

Module 2: Non-Conventional & Renewable Energy Systems

- **Sources and Technology Overview**
 - Solar, wind, biomass, tidal, geothermal
 - Characteristics, feasibility, and challenges
 - Stand-alone vs. grid-connected systems
- **Hybrid and Distributed Energy Systems**
 - Need for hybridization
 - Case studies of micro grids and smart energy systems
 - Energy storage and management systems
- **Renewable Energy Integration**
 - Technical challenges (intermittency, variability)
 - Voltage regulation, frequency stability, power quality issues
 - Policy, regulation, and grid code compliance

Lab Practice /Activity:

- Field Visit to RE Installations in Campus

Module 3: Distribution System Planning & Modeling

- **Role of Computers in Distribution Planning**
 - Use of simulation and modeling tools

- Load flow and fault analysis in distribution networks
- **Load Modeling and Forecasting**
 - Load types: Residential, commercial, industrial
 - Load curves, demand-side management, and energy conservation
 - Loss factor, demand factor, and load factor definitions and implications
- **Feeder and Substation Design**
 - Feeder configurations: Radial, loop, and networked systems
 - Voltage level selection and feeder loading criteria

Module 4: Application, Case Studies

Lab Practice /Activity:

- Case studies on renewable integration and power quality improvements
- Substation layout, equipment, and automation
- Modeling exercises and hands-on simulations using tools like MATLAB/ETAP
- Interactive group discussions and project work
- Review, assessment, and feedback

Module 5: Power Quality and Power Market

- **Introduction to Power Quality**
 - Importance in modern power systems
 - Definitions: Sag, swell, transients, interruptions, harmonics
- **Quantification and Monitoring**
 - Power quality indices
 - Measurement tools and techniques
 - Standards and limits (IEEE, IEC)
- **Mitigation Techniques**
 - Filters, compensators, voltage regulators
- **Electricity Market**
 - Electricity market types
 - Indian market structure
 - Open Access and Trading Licensees

Lab Practice /Activity:

- Mock bidding exercise
- Case study: Daily market clearing price from IEX
- Role play as GENCO/DISCOM/TRADER
- Visit to State Load Despatch Centre(Odisha)

Module 6: Energy Audit & Efficiency

- Types of audits: Preliminary, Detailed, Walk-through
- Electrical load survey techniques
- Tariff structure and cost analysis
- Power factor improvement, load optimization, lighting audit
- Standards: BEE, ISO 50001, EC Act
- National Electricity Policy, Tariff Policy
- Renewable Energy Certificates (RECs), RPOs, Green Open Access
- Feed-in tariffs, Net metering, Virtual net metering
- ESG & SDGs related to energy

Lab Practice/Field Work:

- Electrical audit of a lab/building/machine
- Load inventory and phase balance check
- Power factor correction analysis

Video Links

- https://www.youtube.com/watch?v=lh5_7sHyLU4
- [Hydro Power](#)
- [Gas Power Plant](#)
- [Nuclear Power Plant](#)
- [Co-Generation](#)
- [Power Market Fundamental](#)
- [Power Exchange](#)
- [Energy Conservation](#)
- [General Grid Safety](#)
- [Industrial Safety](#)
- [Electrical Shock First Aid](#)
- [Fire Extinguisher](#)

Course 2: CUED 2101: Switchyard & Substation Types up to 33kV

[Lab Practice in Own Distribution Network, Modeling], [2-1-0]

Module 1. Introduction to 33 kV Substations

- **Purpose and Classification:**
 - Step-down substations (e.g., 33/11 kV, 33/0.433 kV)
 - Distribution switching and control points
- **Indoor vs. Outdoor Substations:**
 - Applicability and constraints in urban/rural environments

Module 2. Equipment Used in 33 kV Systems

- **Transformers:**
 - Power and distribution types (typically 33/11 kV)
 - Oil-filled vs. dry type; OLTC, cooling methods
- **Switchgear and Protection Devices:**
 - Circuit Breakers (VCB, 33 kV GIS)
 - Isolators, Earth switches
 - Fuses and Lightning Arrestors
- **Measurement and Instrumentation:**
 - Current Transformers (CTs), Potential Transformers (PTs)
 - Energy meters, Multifunction meters, Indicating Meters(Ammeter, Voltmeter, Frequency-meter etc)

Lab Practice/Field Work:

- Visit to 33/0.44KV Distribution Substation of Campus

Module 3. Single Line Diagrams (SLDs) and Wiring Diagrams

Lab Practice/Field Work:

- **Representation of Equipment Connections:**
 - SLD for typical 33/11 kV and 33/0.433 kV substations
- **Control and Protection Wiring Diagrams:**
 - Interlocking, relay wiring basics
 - Control Circuits(Close and Trip)

Module 4. Protection Systems and Relays in 33 kV Substations

- **Types of Relays Used(Electro-Mechanical vs Numerical Relays)**
 - Overcurrent, Earth fault, Under/Over voltage
- **Relaying Schemes:**
 - Feeder protection, transformer protection
 - Backup and main protection logic
- **Auxiliary Systems:**
 - DC supply systems, battery banks
 - Alarm systems and annunciators

Lab Practice/Field Work:

- Hands-on in main distribution system of Campus

Module 5. Layout and Design of 33 kV Substations

- **Component Placement and Physical Layout:**
 - Transformer bays, switchgear rooms, control panels
 - Cable trenches and earthing grids
- **Clearances and Safety Standards:**
 - Phase-to-phase, phase-to-earth minimum distances
 - IS/IEC recommendations

Lab Practice/Field Work:

Hands-on in main distribution system control and operation of Campus

Module 6. Busbars and Mounting Structures

- **Busbar Arrangements:**
 - Single, double, ring-type for 33 kV
- **Busbar Mountings:**
 - Insulator types, support structures
 - Indoor (panel type) vs. Outdoor (gantry mounted) systems

Lab Practice

1. Design 33/11 KV substation
2. Single Line layout of substation

Module 7. Transmission Support up to 33 kV

- **Tower and Pole Design for 33 kV Lines:**
 - Types: Suspension, Tension, Dead-end
 - Use of PSC poles, lattice towers, H-Pole, NBLS(Narrow based Lattice Structure)
- **Design Parameters:**
 - Ground clearance, span length, wind load
- **Earthing and Grounding of Towers:**
 - Tower footing resistance
 - Earthing methods for lightning protection
 - Grid Earthing System

Lab Practice/Field Work:

1. Earth Resistance Testing of 33/0.44KV distribution substation of campus.
2. Earth resistance measurement of grid earth mat.

Video Links

- [Substation layout](#)
- [Distribution Tower Design](#)
- [\(6\) TOWER - YouTube](#)

Course 3: CUED 2102: Cable, Switchgear, Protection system [2-2-0]

[Lab Practice in Own Distribution Network, Tutorial & Demonstration]

Module 1: Instrument Transformers, Basics of Protections

- CTs and PTs: Types, Ratings, Accuracy Classes, Application on measurement and protection.
- Primary vs. Secondary Protection Schemes and circuitry relating to CT and PT.

Lab Practice/Field Work:

- **CT/PT Testing and Ratio Verification**
- Layout of Switchyard, Protection Zones, Relay Panels

Module 2: Protection Schemes, Relays & Coordination

- Overcurrent, Earth Fault, Differential
- Relay Types: Electromechanical, Static, Digital/Numerical
- Relay Coordination and Selectivity
- Case Study: IDMT Relay for Feeder Protection

Lab Practice/Field Work:

- **Relay Testing and Setting Configuration:** Digital relay interface with laptop/software

Module 3: Isolator, Circuit Breakers and Maintenance

- Isolator: Types and Applications Isolators: Manual & Motorized – Selection, Operation
- Breaker Types: Air, Oil, Vacuum (Indoor & Outdoor up to 33 kV), GIS Breaker
- Breaker Control & Trip Circuits
- Breaker Testing and Preventive Maintenance

Lab Practice/Field Work:

- **Breaker Control and Trip Circuit Simulation**
 - Breaker trip/close wiring, Interlock circuit
- **Auxiliary Panel Wiring Practice**
 - Battery charger circuit, DC interlocking logic

Module 4: Cable Basics, Cable System Components & Classification

- Underground Cabling: Evolution, Trends, Applications
- Comparison: Overhead vs. Underground Systems
- Cable Types: LV, MV, HV (up to 33 kV) – Power vs. Control
- Components: Conductors, Insulation (XLPE, PVC), Sheathing, Screening
- Ratings, De-rating Factors, Bending Radius
- Indoor/Outdoor Cables – IS & IEC Standards

Lab Practice/Field Work:

- Cable Identification and Termination Practice
- Glanding, lugging, ferruling
- **Heat Shrink Jointing and Termination Kits – Hands-on Exercise**

Module 5: Cable Installation, Grounding & Auxiliaries

- Laying Methods: Trenching, Ducts, Trays, Conduits
- Jointing & Termination: Heat Shrink, Cold Shrink, Resin Kits
- Grounding System Design: Mat, Pipe, Rod Earthing
- DC Supply Systems, Battery Chargers, Battery Banks, Fire Protection

Lab Practice/Field Work:

- **Insulation Resistance and Continuity Testing:** Using megger and multimeter
- **Cable Tray Layout and Earthing Practice**
 - Routing plan with mechanical support and safety norms
- **Cable Fault Detection**

Module 6: Surge Protection & Cable Testing

- Surge Arresters: Types, Operation, Location
- Cable Testing: IR, Continuity, Hi-Pot, VLF
- Fault Location Techniques: TDR, Thumper, Bridge Method

Lab Practice/Field Work:

1. **Lightning Arrestor Inspection and IR Value Check**
2. Surge Protection and Isolator Demonstration

Field Visit & Demonstration

1. **Visit to a standard Cable Testing Laboratory**
 - Observe physical, thermal, electrical, mechanical tests (e.g., tensile strength, HV, breakdown voltage, aging tests)
 - Material inspection and cable manufacturing insights (optional, if possible)
2. **Industrial/Utility Cable Laying Site Visit**

- Observe trenching, installation, jointing, and safety protocols
- 3. **Inspection of the Installed Cable System in Campus/Utility Yard**
 - Feeder cable routes, terminations, earth continuity

Video Links

- [Under Ground Cable](#)
- [Cable Laying](#)

Course 4: CUED 2103: Transformer Manufacturing and Testing

[Workshop Practice], [1-6-0]

Module 1. Transformer Construction and Components

- **Inner Parts:** Core, windings, insulation, tap changers, oil ducts
- **Outer Parts:** Tank, conservator, bushings, radiators, explosion vent, breather, terminal box
- Materials used and insulation standards

Module 2. Transformer Manufacturing Process

- Design of Transformer
- Mechanical design of the Core dimensions, insulation type, width and material
- Design of winding: material, shape, diameter.
- Step-by-step overview of manufacturing stages
- Core stacking, coil winding, insulation, tank fabrication
- Drying and vacuum treatment
- Assembly and quality checks

Lab Practice/Field Work at Transformer Workshop:

- Visit to manufacturing unit or simulated assembly in lab
- Core and winding demonstration, assembly sequence

Module 3. Transformer Testing

Lab Practice/Field Work at Transformer Workshop:

- Routine tests: IR value, winding resistance, ratio test, polarity test, vector group, Magnetic Balance, open circuit test, Back to Back Test, Estimation of Eddy current loss and Hysteresis loss separately
- Type tests: Temperature rise, impulse test, short circuit test
- Special tests and modern testing tools
- Introduction to online monitoring and diagnostic tools (SFRA, DGA, etc.)
- Understanding test reports and parameters

Module 4. Transformer Fault Conditions

Lab Practice/Field Work at Transformer Workshop:

- Causes of internal and external faults: short circuits, insulation failure, oil leakage
- Symptoms and early warning signs (noise, heating, oil discoloration)
- On-load vs. no-load fault conditions

- Analysis of field failure case studies
- **Fault Finding & Corrective Action**

Module 5. Transformer Health Index (THI) & Life Assessment

- Concept of THI and its components (moisture, DGA, furan, etc.)
- Condition monitoring techniques: Thermal imaging, Partial Discharge, DGA
- Predictive vs. preventive maintenance
- Life expectancy estimation models and factors affecting ageing

Lab Practice/Field Work at Transformer Workshop:

- Simulated fault diagnosis: overheat, leakage, winding short
- Interpreting real DGA results, THI evaluation
- Re-commissioning procedures after fault clearance

Module 6. Maintenance of Transformers

Lab Practice/Field Work at Transformer Workshop:

- Preventive and condition-based maintenance schedules
- Oil filtration and testing
- Bushing inspection, tap changer maintenance
- Earthing system and surge arrester checks
- Record keeping, logbooks, and tagging systems

Course 5: CUED 2104: Project, [0-0-6]

List of Projects/products to be done in domain:

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 University norms

Industrial Automation

Code	Course Title	(Credit)	T-P-PJ
IACU2100	Industrial Automation	24	5-13-6

Course Code	Course Title	Credits	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
CUIA2109	SCADA & PLC based sequential control	4	0-4-0
CUIA2110	HMI AND VFD	4	1-3-0
CUIA2106	OPC server base data fetching & control	2	1-1-0
CUIA2107	Project	6	0-0-6
	Total Credits	24	

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

- 1.1 Control wiring of PLC.
- 1.2 PLC, Sensor and field instruments signal flow wiring.
- 1.3 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

- 1.1 Alarms
- 1.2 Trends, Data base connectivity & Report generation
- 1.3 Recipe management
- 1.4 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

- 1.1 Script
- 1.2 Networking
- 1.3 Device connectivity.

Practice:

P5.1 Script

P5.2 Networking

P5.3 Device connectivity

P5.4 Pneumatic controls

P5.4.1 2-Way Valves control

P5.4.2 3-Way Valves control

P5.4.1 Pressure Relief Valves

P5.4.2 Pressure Reducing Valves

Course – 6: HMI AND VFD

- 1.1 What is HMI. Different features and connectivity of PLC
- 1.2 What is VFD and concept of different operational features
- 1.3 Connectivity of HMI, PLC and VFD.

Practice:

P6.1 Alarms, Security and connectivity.

P6.2 VFD operation with BOP.

P6.3 VFD operation with IO terminals

P6.4 HMI, PLC and VFD based control system of motors.

Course – 7: OPC SERVER BASE DATA FETCHING & CONTROL

- 1.1 Study of Open Platform Communications
- 1.2 OPC to control PLC, SCADA.
- 1.3 OPC based different protocol concept.
- 1.4 Data handling using OPC.

Practice:

- P7.1 Installation of OPC
- P7.2 OPC protocols
- P7.3 Connectivity of PLC, SCADA to OPC.

Embedded System Design

Course Code	Course Title	Credits	T-P-PJ
ESCU2050	Embedded System Design	20	4-10-6

Course Objectives

• 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 Outcomes

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Gain and apply knowledge about the architectural features and instructions of 32-bit ARM microcontrollers to develop the embedded system.	PO1(3)
CO2	Identify, analyze, formulate, develop and design various product-based applications based on Embedded Systems.	PO(2), PO3(3)
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.	PO9(3), PO12(3)
CO4	And apply the techniques and knowledge gained in Embedded Systems to become an entrepreneur for sustainable development.	PO5 (2), PO7(3)

Domain Syllabus:

1. **Microcontroller-Based Embedded System Design (57.5 Hrs)**
 2. Introduction to Embedded System
 3. Embedded System Development Life Cycle
 4. Introduction to ARM
 5. AMBA & AHB
 6. Features of ARM7, ARM9, ARM 11, ARM Cortex
 7. Datasheet analysis
 8. GPIO programming – LED, Seven Segment Display, LCD, Matrix keypad, Actuators(Relay, Motors and valves)
 9. System control block-
 10. ADC & DAC -- Sensors(Analog and Digital),
 11. Timer/Counter
 12. Pulse Width Modulation(PWM)
 13. Vectored Interrupt Controller(VIC)
 14. Real Time Clock (RTC)
 15. Watch Dog timer (WDT)

16. Debugging with JTAG
17. Inter System Protocols – UART, USART, USB, Bluetooth, BLE, GPS, GSM
18. Intra System Protocols – I2C, SPI, CAN
19. 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 μ 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
4. Raspberry Pi
5. STM32
6. 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 Meter

Course Developed and Prepared by: Prof. Swarna Prabha Jena

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 Objectives

- 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 network

Course Outcomes

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Gain Knowledge on microwave communication, fibre optics communication and wireless sensor network	PO1(3), PO2(3), PO4(2)
CO2	Analyze the concept of antenna design for various applications	PO2(3), PO3(3)
CO3	Examine the communication systems parameters performance mathematically	PO4(3)
CO4	Design and Simulation of microwave components and BTS installation	PO5 (3)
CO5	Estimate the performance analysis and optimization of various communication systems parameters	PO8(2), PO12(2)

Evaluation Systems

As per University Norms

COURSE CONTENT

1. Microwave & RADAR Communications (2-1-0) (33 Hours)

1. Introduction to Microwaves: Microwave frequencies
2. Scattering matrix formulation
3. Passive microwave devices

4. Active Microwave Devices
5. Study of field pattern of various modes inside a rectangular waveguide
6. Microwave Measurements
7. Transit time limitations in Microwave Bipolar Transistors
8. Power frequency limitations Microwave Field Effect Transistors
9. Gunn Effect
10. IMPATT diodes
11. TRAPATT diodes
12. Microwave vacuum tube based devices
13. Limitations of conventional tubes at UHF
14. Microwave Klystron
15. Reflex klystron,
16. Traveling wave tube
17. Magnetron
18. Introduction to Smith chart and its application for the unknown impedance measurement
19. Scattering Matrix Parameters
20. Introduction to radar and RADAR Parameters
21. MTI RADAR
22. FMCW RADAR
23. Tracking RADAR
24. Monopulse RADAR
25. RADAR Receiver
26. Synthetic Aperture RADAR

Text Books:

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)

1. Configuration of a satellite communications system
2. Types of orbit
3. Radio regulations
4. Keplerian orbits
5. Useful orbits for satellite communication
6. Perturbations of orbits
7. Digital video broadcasting via satellite (DVB-S)
8. Second generation DVB-S
9. Digital transmission of telephony
10. Digital broadcasting of television
11. Configuration of a link
12. Uplink received power
13. Downlink received power
14. Additional losses
15. Noise power spectral density at the receiver input
16. Individual link performance
17. Influence of the atmosphere
18. Mitigation of atmospheric impairments
19. Overall link performance with transparent satellite
20. Overall link performance with regenerative satellite
21. 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

3. Cell Site and BTS Operation, Maintenance and Troubleshooting: RF Planning and Drive Test (36 Hours) (0-3-0)

1. Antennas for mobile Tower
2. Power supply at BTS
3. Equipment used in the Shelter
4. Power Interface Unit (PIU)
5. Line Conditioning Unit (LCU)
6. Free Cooling Unit (FCU)
7. Preventive Maintenance (PM) & site management
8. Basic functioning of alarm box and the interface
9. Concept on TRX & Baseband receiver unit.
10. RF Propagation path loss 3.11 Frequency hopping and Planning
11. RF Optimization
12. GSM RF Drive Test

13. 3G Optimization
14. EMF Radiation Calculation and testing
15. 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, Toma’s 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.

4. Optical and Wireless Sensor Networks (1-2-0) (33 Hours)

1. Propagation of signals in optical fiber:
2. Transmission characteristics of optical fiber
3. Optical fiber Transmitters.
4. Optical Components.
5. 4.5 Optical fiber loss measurement using power meter, LASER and OTDR.
6. Layered Protocol Model in the Transport Network.
7. SONET and SDH, Architecture of Optical Transport Networks (OTNs)
8. Implementation and performance analysis of TCP/IP protocols. Tools to be used: NS2 Simulator and Socket Programming
9. Challenges for Wireless Sensor Networks.
10. Single-Node Architecture - Hardware Components.
11. Network Architecture - Sensor Network Scenarios
12. Physical Layer and Transceiver Design Considerations.
13. Routing Protocols.
14. Topology Control, Clustering.
15. Arduino and Wireless Communications
16. Sensor Tasking and Control.
17. WSN using Arduino with Wireless modules
18. MATLAB Experiments Related to Compressed Sensing for Energy Efficient WSN
19. Sensor Node Hardware – Berkeley Motes, Programming Challenges.
20. Node-level Software platforms, Node-level Simulators.

TEXT Books

1. John M. Senior, "Optical fiber communication", Pearson edition, 2000
2. Uyless Black "Optical Networks ", Pearson Education , 2011.
3. Holger Karl and Andreas Willig, “Protocols and Architectures for Wireless Sensor Networks”, John Wiley, 2005
4. Kazem Sohraby, Daniel Minoli, & Taieb Znati, “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 Kaufmann 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

Code	Course Title	T-P-Pj (Credit)	Prerequisite
VLCU2070	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 Objectives

- This course would enable students to design analog / digital IC components, design of application-specific integrated circuits (ASICs) for digital systems and theory and practice of VLSI test and verification.
- To study the issues relating to the design of application-specific integrated circuits (ASICs) for digital systems.
- To involve the students in the theory and practice of VLSI test and verifications.

Course Outcomes

Cos	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	To acquire knowledge and become familiar with modern VLSI circuits	PO1(3), PO5 (3), PO3(3)
CO2	To develop critical thinking to solve issues involved in ASIC design, including technology choice, Timing analysis, tool-flow, testability.	PO1(3), PO5 (3)
CO3	To acquire problem solving skill to design CMOS amplifiers in deep submicron technology.	PO1(3), PO2(3)
CO4	Students will acquire the technical skill to become Industry-ready RTL Design/Physical design/Testing/Verification Engineer.	PO4(3), PO5(3), PO8(1), PO12 (3)

Evaluation Systems

As per University Norms

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 &
- 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

- Questa Sim

Tool::

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 Books

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](#)

Course Structure & Syllabus

GTM – 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
	<i>TOTAL CREDITS</i>	<i>T-P-PJ (4-10-8)</i>	22

Domain Track Title: Go To Market-Product Development

Track Total Credits (4-10-8)

Courses Division (list all divisions):

- Design Thinking and Managing Innovation Through GATE Process (1-2-0)
- PLM Tools on Dassault Platform (Design and Validation using Dymola, Catia, Simulia) (2-6-0)
- Process management (Using Enovia) (1-2-0)
- Product Development (0-0-8)

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 Learning Outcomes:

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	A Digitally Validated Innovatively and efficiently designed product.	PO1(3), PO2(3)
CO2	Experience with 3 D experience platform Catia-Simulia- Dymola and Enovia tools.	PO1(3), PO2(3)
CO3	PLM cycle management.	PO1(3), PO5(3)

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 patented.
- 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	P2.1 System Engineering Dymola
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 https://www.youtube.com/watch?v=ISdup32L6Mw
Practice(3 h)	10	P2.10 CATIA part design of different components https://www.youtube.com/watch?v=CQWjb91_vKg
Practice(3 h)	11	P2.11 Surface designing for creating high end complex design https://www.youtube.com/watch?v=RT24Yj5thd8
Practice(3 h)	12	P2.12 Assembly Designing of the complete product https://www.youtube.com/watch?v=B7_irVMmOzw
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 https://www.youtube.com/watch?v=B-XoaRfeD9w
Practice(3 h)	15	P2.15 CATIA live rendering https://www.youtube.com/watch?v=HsK3RVTOX1Q
Practice(3 h)	16	P2.16 Behaviour experience of the complete product https://www.youtube.com/watch?v=9RgdZUvEjPw
Practice(3 h)	17	P2.17 Design validation/Simulation using Simulia https://www.youtube.com/watch?v=cDDeWRB7PCs
Practice(3 h)	18	P2.18 Simulation using Simulia https://www.youtube.com/watch?v=cDDeWRB7PCs

Practice(3 h)	19	P2.19 Classification of simulation https://www.youtube.com/watch?v=gVlvp1RDj2s
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 (2 h)	4	P3.4 Practicing for the given project
Practice (2 h)	5	P3.5 Learning Task allocation for an existing project using Enovia
Practice (2 h)	6	P3.6 Practicing for the given project
Practice (2 h)	7	P3.7 Resource allocation for different tasks in an existing project using Enovia
Practice (2 h)	8	P3.8 Practicing for the given project
Practice (2 h)	9	P3.9 Review and monitoring of an existing project through Enovia
Practice (2 h)	10	P3.10 Practicing for the given project
Practice (2 h)	11	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-Pr	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
Total					24

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:

Cos	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Students will gain knowledge about the construction and working of different systems and subsystems of automobile.	PO1(3)
CO2	They will be able to disassemble and assemble major aggregates of the automobile	PO3(1)
CO3	Students will be able to do vehicle trouble shooting	PO5(3)

Introduction to Automobile Engineering

Course Title	Course Code	Type of Course	T-P-Pr	Pre-Requi-site
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 Turbo-charging.

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-Pr	Pre-Requi-site
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 Converter, 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-Pr	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-Hydrate (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-Pr	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-Pr	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
Total					26

Domain Track Objectives:

- To provide in-depth technical training & knowledge of machining technologies and machinery which would strengthen product development and industrial-institutional partnership.

Domain Track Course Outcomes:

Cos	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Knowledge to do machining effectively & Efficiently.	PO1 (3)
CO2	Able to identify and solve problems in product machining.	PO2(3)
CO3	Use of advanced CAD & CAM software	PO4(3), PO5 (3)
CO4	Research in advancement in machining	PO2 (3), PO3 (2)

Manufacturing Requirements and Planning (Jigs & Fixtures; Process Planning & Cost Estimation) 20 Hrs

Course Code	Course Title	Type of Course	T-P-Pr	Pre-Requisite
CUCM2150	Manufacturing Requirements and Planning (Jigs & Fixtures; Process Planning & Cost Estimation)	Theory	2-0-0	Nil

COURSE CONTENT (20 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, 3rd 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 Planing 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, 1st Edition, Laxmi Publications.
2. Rao, P N, Manufacturing Technology, Volume 2, 2009, 2nd 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, 17th Edition, Khanna Publishers.
2. Agarwal, P M, CNC Fundamentals & Programming, 2014, 2nd 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 Fundaments, 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)

Fundaments 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, 2nd 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:

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Students are able to recognize with certification of Welding from various national and international levels industry.	PO4(3)
CO2	Students able to be self-employable skills to become an entrepreneur with small scale to a medium scale welding units.	PO11(3)
CO3	Ability to suggest and handle various weld joints based on Strength, Failure and Reliability	PO1(3)

Joining Processes & Technology

Course Title	Course Code	Type of Course	T-P-Pr	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 Private Limited
2. Welding Technology by R. S. Parmar, 3rd 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.

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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. Ultrasonic 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. 3rd 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-Pr	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
Total					20

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:

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Students able to write computer programs for solving elementary fluid dynamics/ heat transfer problems.	PO1(3)
CO2	Execute industry projects to produce Quality products for Clients	PO3(3)
CO3	General competency in Numerical solution of problems in fluid dynamics	PO4(3),PO6 (2)

Introduction to CFD

Course Title	Course Code	Type of Course	T-P-Pr	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 prims 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 $Re=107$.

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-Pr	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 Learning Outcomes:

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Get familiarized with the concept, classification and application of Composite	PO1(2)
CO2	Know how to test a composite and check the product quality	PO3(2), PO5(2)
CO3	Able to design a composite using Materials Studio	PO3(3)

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: Kevlar, 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, 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

Project

Code	Course Title	T-P-Pj (Credit)	Prerequisite
CUCD2136	Project	0-0-6	Nil

Domain

Architectural and Structural Design

Course Title	Type of course	T+P+PJ	Prerequisite
Architectural and Structural Design	Practice + Project	0+15+5	Nil

Courses Divisions:

DOMAIN: Architectural and Structural Design (0+15+5)					
Sl. No.	Code	Subject Name	T+P+P	Credits	Hrs.
1.	CUSD 2120	Critical thinking and presenting it with digital platform (AutoCAD leads to 3D base)	0+3+0	3	48
2.	CUSD 2121	Scope to enrich by exposing them to BIM modelling.	0+5+0	5	72
3.	CUSD 2122	Design and failure analysis of structure.	0+5+0	5	72
4.	CUSD 2123	Amalgamation of architecture and civil requirements using Generative Apps.	0+2+0	2	26
5.	CUSD 2124	Project	0+0+5	5	72
Total				20	

Course Objectives:

- To teach the Principles of architectural building design.
- To familiarize the student with practicing life in construction industry and orient their learnings towards practical application in the field.

- Make a difference with cutting edge technology.

Course Outcomes:

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Strong understanding of architectural design and scope for innovative ideas.	PO1 (3), PO3 (2),
CO2	Case study based practical solution with actual site visits/live buildings.	PO4[3]
CO3	Modelling of structural elements and failure analysis.	PO5 (3)
CO4	Time saving estimations/structural calculations using digital tool in sustainable manner.	PO7 [2]

Domain Syllabus

Critical thinking and presenting it with digital platform

Subject Name	Code	Type of course	Credit	T+P+P	Prerequisite
Critical thinking and presenting it with digital platform.	CUSD 2120	Practice	3	0+3+0	NIL

- 1.1 Introduction to Architectural Design
- 1.2 The need and scope of with basics of Design Principles
- 1.3 Ergonomic data and its application
- 1.4 Hands-on experience with designing their own house or hostel
- 1.5 The need of digital drive for 2D design expressions
- 1.6 Basics of AutoCAD, Conceptualization of Design: Own House drafting/Hostel
- 1.7 Addition of Creativity and modifying the design
- 1.8 Study the impact of Geological data, climatological data on design
- 1.9 Modification of design based on hydrology, soil, site conditions
- 1.10 Carving out a meaningful design in terms of architecture and structure.
- 1.11 Application of 2D design/ welcoming them in the world of 3D design
- 1.12 Basics of 3D concepts and commands

- 1.13 Practical techniques for saving area/cost
- 1.14 Presenting a wholesome idea before moving to BIM

Scope to enrich by exposing them to BIM Modelling

Subject Name	Code	Type of course	Credit	T+P+P	Prerequisite
Scope to enrich by exposing them to BIM modelling	CUSD 2121	Practice	5	0+5+0	NIL

- 2.1 Introduction to BIM modelling
- 2.2 The need and scope of with live examples
- 2.3 Ergonomic data and its application
- 2.4 Applying learnings to a bigger scale hotel/flat scheme/hostels
- 2.5 Incorporation of site factors
- 2.6 Realistic approach road and building bye-laws
- 2.7 The magic of Importing previous plans & reorient them to achieve larger scale in no time
- 2.8 Prepare specifications in BIM
- 2.9 Estimating all the quantities in a very short time
- 2.10 Concepts of CATIA
- 2.11 Layer wise calculation for pipelines, electrical ducts, AC units etc.
- 2.12 Introducing structural layers for design
- 2.13 Cross check with grid formation, foundation calculation & column orientation
- 2.14 Data and record for 3D design of individual aspects for the next level

Design and Failure Analysis of Structure

Subject Name	Code	Type of course	Credit	T+P+P	Prerequisite
Design and Failure Analysis of Structure	CUSD 2122	Practice	5	0+5+0	NIL

- Introduction to steel structures. Modeling, Analysis and design of steel truss in as per AISC 360.
- 3.2 Linear buckling analysis of structures.
 - 3.3 Introduction to PEB, Modelling PEB and assigning properties, load cases, design parameters, Analysis and extracting results.
 - 3.4 Introduction to lattice steel structures. Modelling, Analysis and design of lattice steel structures.
 - 3.5 Reading design results and optimizing the steel structure.

- 3.6 Modelling, Analysis and design of portal frame as per AISC 360 and ASCE 07-16
- 3.7 Introduction to nonlinear static analysis. Perform pushover analysis.
- 3.8 Introduction and modelling of composite deck platform
- 3.9 Modelling of deck slab and assigning section properties with releases
- 3.10 Assigning specifications and diaphragm to the structures
- 3.11 Define and calculate seismic and wind loads as per ASCE 07 and ATC hazards
- 3.12 Define load cases and load combinations, Deflection check concept, floor vibration analysis.
- 3.13 Analyse composite structure and extract results.
- 3.14 How to import CAD MODEL, Design and analysis of multi storey residential building based on different loading criteria (based Code on IS456:2000), Creating plate elements and shear walls.
- 3.15 Design and analysis of frame structures based on different loading criteria (based Code on IS456:2000)
- 3.16 Design, analysis of Foundations (Isolated footing and Combined footing based on code IS456:2000)
- 3.17 Design, analysis of structural elements e.g. Beam, column, Slab (one way and Two way) (based Code on IS456:2000 and BS8007)
- 3.18 Error and warning analysis, Report generation

Amalgamation of Architecture and Civil Requirements using Generative Apps

Subject Name	Code	Type of course	Credit	T+P+P	Prerequisite
Amalgamation of Architecture and Civil Requirements using Generative Apps	CUSD 2123	Practice	2	0+2+0	NIL

- 4.1 Optimisation of steel cost- using permutation & combination of steel/foundation type or small changes in architectural design
- 4.2 Segregated services
- 4.3 Revising PERT/CPM paths
- 4.4 Addition of storage spaces
- 4.5 Façade treatment/modification
- 4.6 Inclusion of basement/parking areas/bunkers
- 4.7 Reduction of construction cost
- 4.8 Site development and slope calculation (in brief)
- 4.9 Mitigating hydrological impacts on difficult sites

PROJECT

Subject Name	Code	Type of course	Credit	T+P+P	Prerequisite
Project	CUSD 2124	Project	5	0+0+5	NIL

List of 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. Highway geometry design
4. Design and analysis industrial ware house
5. Design and analysis of auditorium with proper load calculation, load cases, load combination based on code (IS 456:2000 and BS 8007).
6. Design of bridge deck slab

Gate Process for Project

1. Gate 0: Project Identification
2. Gate 1: Planning
3. Gate 2: Modelling
4. Gate 3: Design and simulation
5. Gate 4: Documentation

Computer Science and Engineering

DOMAIN				
CUTM	MLCU2000	Data Science and Machine Learning	26	2-9-15
BTech	CUML2010	ML for Predictive Analysis	4	1-2-1
BTech	CUML2011	ML for Image Analytics	4	0-2-2
BTech	CUML2007	Digital video Processing	3	0-2-1
BTech	CUML2008	IoT Analysis	4	0-2-2
BTech	CUML2009	Mathematics for ML	3	2-1-0
BTech	CUML2004	ML for Hyperspectral imaging	6	0-4-2
BTech	CUML2005	Internship	4	0-0-4
BTech	CUML2006	Project	4	0-0-4
CUTM	STCU2010	Software Technology	20	0-9-11
BTech	CUST2010	Web Services Using JAVA	5	0-4-1
BTech	CUST2011	Advanced JAVA Programming	4	0-3-1
BTech	CUST2012	Web Programming Using React	3	0-2-1
BTech	CUST2013	Product Development	8	0-0-8
CUTM	CTCU2030	Cloud Technology	18	4-8-6
BTech	CUCT2030	AWS Solution Architect (SAA-CO2)	6	2-4-0
BTech	CUCT2031	AWS Developer (DVA-CO1)	6	2-4-0
BTech	CUCT2032	Project	6	0-0-6
CUTM	CUCS2045	Cyber Security	20	6-10-4
BTech	CUCS2045	Linux Server Management and Security	4	2-2-0
BTech	CUCS2046	Advanced Hacking Techniques	4	2-2-0
BTech	CUCS2047	IT Networking and Network Security	4	2-2-0
BTech	CUCS2048	Vulnerability Assessment & Penetration Testing	4	0-0-4
	CUCS2049	Project	4	0-0-4
CUTM	ARCU2060	Gaming and Immersive Learning (AR & VR)	20	5-5-10
BTech	CUAR2060	Introduction to Gaming & Simulation	2	1-1-0
BTech	CUAR2061	Game Assets & Game Objects	3	1-1-1
BTech	CUAR2062	Building Game Environment	3	1-1-1
BTech	CUAR2063	Game Animation, Scripting & UI	3	1-1-1
BTech	CUAR2064	Binary Deployment and Cross-Platform Controls	3	1-1-1
BTech	CUAR2065	Project	6	0-0-6
Internship & minor project				
BTech	CUTM1905	Internship	2	0-0-2
BTech	CUTM1906	Minor Project-I	2	0-0-2
BTech	CUTM1577	Minor Project II	2	0-0-2
BTech	CUTM2598	Minor Project-III	2	0-0-2
BTech	CUTM1578	Summer Internship I	2	0-0-2

BTech	CUTM1579	Summer Internship II	2	0-0-2

Elective Courses				
	Subject Code	Subject Name	Credit	Type
BTech	CUTM2583	Software Testing and Test Automation	4	2-2-0

		DOMAIN		
CUTM	MLCU2000	Data Science and Machine Learning	26	2+9+15
	CUML2010	ML for Predictive Analysis	4	1+2+1
	CUML2011	ML for Image Analytics	4	0+2+2
	CUML 2009	Mathematics for ML	3	2+1+0
	CUML 2008	IoT Analytics	4	0+2+2
	CUML 2012	Digital video Processing	3	0+2+1
	CUML2004	ML for Hyperspectral imaging	6	0+4+2
	CUML2005	Internship	4	0+0+4
	CUML2006	Project	4	0+0+4

Data Science and Machine Learning

Code	Course Title	T-P-Pj (Credit)	Prerequisite
MLCU2000	Data Science and Machine Learning	2-9-15	NIL

Course Objectives

- Understand the scope, stages, applications, effects and challenges of ML.
- Understand the mathematical relationships within and across ML algorithms and the paradigms of supervised and unsupervised learning.
- Able to get jobs in AI/ML field

Course Outcomes

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Able to gain knowledge on design and implementation of various machine learning algorithms in a range of real-world applications.	PO1 (3)
CO2	Able to analyze prediction and classification using different ML and deep learning methods	PO2(3)
CO3	Ability to solve the real world problems using ML solutions in their respective fields of study.	PO2(3)
CO4	Ability to design product	PO3 (2), PO5(2)
CO5	Able to do research for publishing articles/ file patents.	PO4 (3)

ML for Predictive Analysis (0+2+2)

<https://careerfoundry.com/en/blog/data-analytics/regression-vs-classification/>

Project/Task: (Choose two projects, Prediction and Classification)

Time Series Analysis

Health Care System

Concept Required:

3.1 Data pre-processing: -

- Accessing / collecting the datasets from different online repository.
- Missing values handling, noise reduction, finding Correlation between features, outlier elimination.
- Label Encoding / Encoding the categorical data
- Splitting the dataset
- Data Normalization

3.2 Learning Algorithms: -

- Supervised Learning Algorithms
- Unsupervised Learning Algorithms

3.3 Feature extraction and selection: -

- Principal Component Analysis (PCA)
- Linear Discriminant Analysis (LDA)
- Different Feature Selection Techniques / Algorithms

3.4 Model building: -

- Regression (Linear, Polynomial, multiple, logistic), Decision Tree, Random Forest.
- Artificial Neural Network (Feed Forward Neural Network, Gradient Descent, Back Propagation Neural Network).
- Convolutional Neural Network
- Other Pre-Trained Models

3.5 Performance measures: -

- Perdition: Root Mean Square Error (RMSE), Average Percentage Error (APE), Mean Average Percentage Error (MAPE).
- Classification: Confusion Matrix (TN, TP, FP, FN), Sensitivity, Specificity, Gmean, F-score, Overall Accuracy, (Receiver Operating Characteristic) ROC Curve. Area under Curve (AUC)

3.6 Reading and Writing Research Articles

ML for Image Analytics (0-2-2)

Project/Task: (Choose one among six Tasks)

Detection of optometry diseases using retinal fundus imaging.

1. Diabetic Retinopathy
2. Glaucoma
3. Cataract

Detection of various diseases using X-ray imaging.

1. Covid19

Leaf disease classification using RGB images.

1. Tomato leaf
2. Potato leaf

Concept Required:

Image Pre-processing:-

- Accessing individual pixels using matrix concept
- Image resize, grey scale conversion, Colour channel splitting
- Histogram equalisation (CLAHE).

Image Feature Extraction: -

- Edge detection (Sobel, Canny), Morphological operations
- Image segmentation, Image Thresholding, Binary conversion
- Cluster based segmentation
- Feature extraction based on size, shape and colour
- Feature extraction using predefined functions: SIFT, SURF, STAR, ORB.
- Feature Extraction using convolutional neural network (CNN).

Creation of Feature Matrix by combining Extracted Features: -

- Matrix flattening, Horizontal stacking, Vertical stacking, padding.
- Splitting the feature matrix (training/testing) and labelling.

Classification algorithms: -

- Support vector machine (SVM)
- Different kernels of SVM (linear, polynomial, radial basis function).
- Gradient Boosting (GB)
- Multi-layer Perceptron (MLP), deep learning.

Mathematics for ML (2+1+0)

When Models Meet Data:-

- Data, Models, and Learning
- Empirical Risk Minimization
- Parameter Estimation
- Probabilistic Modelling and Inference
- Directed Graphical Models
- Model Selection

Linear Regression:-

- Problem Formulation
- Parameter Estimation
- Bayesian Linear Regression
- Maximum Likelihood as Orthogonal Projection

Dimensionality Reduction with Principal Component Analysis:-

- Problem Setting
- Maximum Variance Perspective
- Projection Perspective
- Eigenvector Computation and Low-Rank Approximations
- PCA in High Dimensions

- Key Steps of PCA in Practice
- Latent Variable Perspective

Density Estimation with Gaussian Mixture Models:-

- Gaussian Mixture Model
- Parameter Learning via Maximum Likelihood
- EM Algorithm
- Latent-Variable Perspective

Classification with Support Vector Machines:-

- Separating Hyperplanes
- Primal Support Vector Machine
- Dual Support Vector Machine
- Kernels
- Numerical Solution

Practice:

- Curve Fitting in Python.
- Exploratory Data Analysis in Python.
- Kernel Density Estimation in Python.
- Probability Distribution Function Plotting in Python.
- Cumulative Distribution Function Plotting in Python.
- Dimensionality Reduction and Feature Extraction in Python.

References:

1. Mathematics for Machine Learning by Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong.
2. https://youtube.com/playlist?list=PLLy_2iUCG87D1CXFxE-SxCFZUiJzQ3IvE

IoT Analytics (0+2+2)

Defining IoT Analytics and Challenges

IoT

Benefits of Deploying IoT

End to End IoT architecture

IoT challenges

IoT Protocols

1 Wireless Protocol

Connectivity Protocols (when Power is Limited)

Bluetooth Low Energy (BLE)

Zigbee

LoRaWAN

NFC

2 Connectivity Protocols (when Power is Not a problem)

Wifi

3 Data Communication Protocol

MQTT

Web-Socket

HTTP

2 Sensors

Types of Sensors based on communication-I2C, SPI
Types of Sensors based on Application

3 Overview of 32-bit Controller

ESP8266
ESP32
Raspberry Pi

4 AWS IoT for Cloud

AWS IoT Core services
AWS IoT Analytics services
AWS DynamoDB Services

5 Thingspeak for IoT

Getting and posting Data to IoT Cloud using ESP devices
Posting Data to IoT Cloud using Raspberry Pi

6 ThingWorx for Industrial IoT

Building Dashboard on Thingworx platform
Binding the sensor value to the dashboard

Text Book:

1. Minter, Andrew. *Analytics for the Internet of Things (IoT)*. Packt Publishing Ltd, 2017.

Reference Books:

1. Geng, Hwaiyu, ed. *Internet of things and data analytics handbook*. John Wiley & Sons, 2017.

Digital video Processing (0+2+1)

UNIT 1:

Fundamentals of Video Processing: Digital Video Acquisition, Principles of Color Video, Video Camera, Video Display, **Analog Vs Digital Video:** Progressive Vs Interlaced scans, Signal, Bandwidth Characterization of a Digital Video Signal.

Practice:

- Read and play video files
- Extract frames from video files
- Combine frames to create a video file

UNIT 2:

Fourier Analysis of Digital Video Signals: Spatial and Temporal resolution, Fourier Analysis of Digital Video Signals, **Spatial-Temporal Sampling:** Temporal Frequency Response and Flicker Perception. Spatial Frequency Response, Spatiotemporal Frequency Response, Smooth Pursuit Eye Movement

Practice:

- Applying fourier transformation on video
- Time domain analysis

- Frequency domain Analysis

UNIT 3:

Digital Video Formats: Significance of Video Formatting, Data rate and bandwidth trade-off,

File Formats: MP4, MOV, WMV, AVCHD, FLV, AVI, WebM, MKV

Digital Video Compression Standards: Digital Video Compression Metrics, Digital Video Storage Precisions, Significance of Video compression, **Video Compression Codec's:** Motion JPEG, JPEG 2000, H.264/MPEG-4 AVC, VP8, HEVC, H.265 High Efficiency Video Codec.

Practice:

- Conversion of video files from one format to another.
- Using Motion JPEG Codec
- Using MPEG-4 Codec
- Using H.265 Codec

UNIT 4:

Digital Video Editing Basics: Video Editing Types- Online, Offline, Linear, Non-linear, Assemble, Insert, Rough-cut, Video Shot Transition Effects: Cut, Fade, Wipe, Dissolve, B-roll, Video Shot Boundary Detection Methods: pixel differences, statistical differences, histogram comparisons, edge differences and motion vectors. Video Shot Detection Performance Metrics: ROC Curves, Recall, Precision, F-Measure

Practice:

- Video Shot Detection using pixel Difference
- Video Shot Detection using Histogram based methods
- Video Shot Detection using Edge based methods
- Video Shot Detection using Motion Vectors

Project List

1. Creating a VIDEO object detection system
2. Vehicle detection in Videos using OpenCV and Python
3. Detecting faces in live camera feed with identification of the person.

TEXT BOOK:

1. Rafael C Gonzalez and Richard E Woods, "Digital Image Processing", Pearson Education, 3rd Edition, 2009.
2. Handbook of Image and Video processing - Al Bovik (Alan C Bovik), Academic Press,

REFERENCE BOOK:

1. Fundamentals of Digital Image Processing", Anil K. Jain, PHI, 1995.
2. "Digital Image Processing", William. K.Pratt, Wiley Interscience, 2nd Ed, 1991.

ML for Hyperspectral imaging (0-4-2)

Project/Task: (Choose one among four Tasks)

Agriculture

1. Crop yield prediction.
2. Crop quality prediction
3. Soil health monitoring

Mining

1. Iron ore quality prediction

Concept Required:

Introduction to Remote Sensing: -

- Multi-Spectral Imagery (MSI)
- Hyperspectral Imagery (HSI)

Scientific Principles:

- Physics of imaging spectroscopy
- Electromagnetic propagation
- Sensor physics
- Atmospheric Corrections.

Hyperspectral Concepts and System Trade-offs:-

- Signal-to-Noise ratio (SNR)
- Spectral resolution, sampling.

HSI Data Processing Techniques:-

- Spectral angle mapping
- Principal Component Analysis (PCA)
- Minimum Noise Fraction (MNF)
- Spectral feature fitting.

Classification Techniques:-

- Support Vector Machine (SVM)
- Partial Least Squares Regression (PLSR)
- Neural Network
- Deep learning and CNN

Clustering Techniques:-

- K-mean clustering

Project (0-0-4)

Internship (0-0-4)

Software Technology

Code	Course Title	T-P-Pj (Credit)	Prerequisite
CUST2010	Software Technology	0-9-11	- Java Technologies - Advanced Web Programming - DBMS

		DOMAIN		
CUTM	STCU2010	Software Technology	20	0+9+11
	CUST2010	Web Services Using JAVA	5	0+4+1
	CUST2011	Advanced JAVA Programming	4	0+3+1
	CUST2012	Web Programming Using React	3	0+2+1
	CUST2013	Product Development	8	0+0+8

Course Objectives

- Develop knowledge-based force to serve the IT industry with the latest technologies. - To explore methods of capturing, specifying, visualizing and analyzing software requirements. - To learn and explore Spring Framework, Android, React, GIT. - Able to get jobs in software industry

Course Outcomes

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Able to gain knowledge on design and implementation of various software applications	PO1 (3), PO12(3)
CO2	Develop skills to analyze, design, and prepare SRS	PO2(3)
CO3	Ability to solve the real world problems	PO2(3)
CO4	To design and develop web applications using Spring, React and android applications	PO3 (2), PO5(2)
CO5	Able to do research for publishing articles.	PO4 (1)

1. CUST2011: Advanced JAVA Programming (0-3-1) (75 hrs)

- 1.1 Understanding Web Architecture
- 1.2 Installation and configure java environment.
- 1.3 Understanding MVC Architecture
- 1.4 Create GIT repository for version control and teamwork
- 1.5 Create a web project and define a landing page.
- 1.6 Create controller using servlet in web project
- 1.7 Retrieve value from page in controller through the request parameter.
- 1.8 Establish Connection with database
- 1.9 Perform CRUD operation
- 1.10 Present data in JSP page using scriptlet, expression and action tag.

- 1.11 Declare method and variable in JSP page.
- 1.12 Transferring control from one resource to another using RequestDispatcher and ResponseRedirect
- 1.13 Set and get values in ServletContext and ServletConfig parameter.
- 1.14 Set and get values in application, session and request attribute.
- 1.15 Perform session tracking.
- 1.16 Upload file to the server.
- 1.17 Working with JSTL

2. CUST2010: Web Services Using JAVA (0-4-1) (60 hrs)

- 2.1 Setting Spring environment
- 2.2 Understanding Maven and define POM
- 2.3 Create project using Spring and Understanding Spring Architecture
- 2.4 Setting bean in IOC container and understand Dependency Injection
- 2.5 Working with Spring AOP
- 2.6 Access data using JdbcTemplate; CRUD operation
- 2.7 Create Spring Boot projects using Spring Initializr
- 2.8 Implement DevTools for rapid application development
- 2.9 Implement application logs using application.properties
- 2.10 Implement Global Exception handling mechanism
- 2.11 Implement Security using Spring Boot
- 2.12 Configure Email in application.properties
- 2.13 Implement Testing using Spring Boot Test
- 2.14 Implement application monitoring using Actuator
- 2.15 Create Spring MVC project and define controller
- 2.16 Implement form handling using SpringMVC
- 2.17 Implement RESTful Web Service using GET Method
- 2.18 Implement RESTful Web Service using POST, PUT, DELETE and validations
- 2.19 Implement End to End testing using Spring Boot Testing - @AutoConfigureMockMvc
- 2.20 Handle cyclic dependency during JSON creation in Web Service
- 2.21 Understanding ORM and Hibernate
- 2.22 Hibernate Configuration using XML and annotation
- 2.23 Implement DML using Spring Data JPA on a single database table
- 2.24 Implement Query Methods feature of Spring Data JPA
- 2.24 Implement O/R Mapping using Spring Data JPA
- 2.25 Implement Hibernate Query Language (HQL) and Native Query
- 2.26 Explain the need and benefit of Criteria Query

CUST2012: Web Programming Using React (0-2-1) (45 hrs)

- 3.1 Configure the environment (install node and react), what is React? React version history, Create React app and debug

Templating using JSX

- 3.2 Working with React. createElement, Expressions, using logical operators, specifying attributes, Specifying children,

It's all about components

3.3 Significance of component architecture, Types of components - Functional, Class based, Pure, Component Composition

Working with state and props

3.4 What is state and its significance, read state and set state, passing data to component using props

3.5 Validating props using propTypes, supplying default values to props using defaultProps

Rendering lists

3.6 Using React key prop, using map function to iterate on arrays to generate elements, Event handling in React

3.7 Understanding React event system, Understanding Synthetic event, Passing arguments to event handlers

Understanding Component Lifecycle & Working with Forms

3.8 Controlled components, Uncontrolled components, Understand the significance to defaultValue prop, using react ref prop to get access to DOM element

Routing with React Router

3.9 Setting up react router, understand routing in single page applications, working with BrowserRouter and HashRouter components, configuring route with Route component, Using Switch component to define routing rules, making routes dynamic using route params

3.10 Working with nested routes, navigating to pages using Link and NavLink component, Redirect routes using RedirectComponent, Using Prompt component to get consent of user for navigation, Path less Route to handle failed matches

Just Redux

3.11 What is redux, why redux, Redux principles, Install and setup redux, Creating actions, reducer and store

Immutable.js for immutable data structures

3.12 What is Immutable.js? Immutable collections, Lists, Maps, Sets

React Redux

Redux saga(Redux middleware)

3.13 What is React Redux, Why React Redux, Install and setup, Presentational vs Container components

3.14 Understand high order component, Understanding mapStateToProps and mapDispatchToProps usage

3.15 Why redux middleware, Available redux middleware choices, What is redux saga, Install and setup redux saga

3.16 Working with Saga helpers, Sagas vs promises

4. CUST2013: Product Development (0-0-8) (45 hrs)

Text Books:

1. *Craig Walls, Spring in Action, Fifth Edition*
2. *Keogh Jim, J2EE: The Complete Reference*
3. *Maximilian Schwarzmuller, React Key Concepts, Packt Publishing*

Reference Books:

1. *Kogent Learning, Java Server Programming Java Ee7 (J2EE 1.7), Black Book*
2. *Alef Arendsen, Professional Java Development with the Spring Framework*
3. *Anthony Onyekachukwu Okonta , React.js Design Patterns, BPB PUBL*
http://courseware.cutm.ac.in/courses/software_technology/

Cloud Technology

		DOMAIN		
CUTM	CTCU2030	Cloud Technology	18	4--8--6
	CUCT2030	AWS Solution Architect (SAA-CO2)	6	2+4+0
	CUCT2031	AWS Developer (DVA-CO1)	6	2+4+0
	CUCT2032	Project	6	0+0+6

Course Objectives

- To learn architectural principles and services of AWS - Able to develop scalable and secure Cloud applications - Get skills to use resources in Cloud - Able to get jobs in various industries

Course Outcomes

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO 1	Able to gain knowledge on architectural principles and services of AWS	PO1 (3)
CO 2	Develop skills to analyze, design, and prepare resources in Cloud	PO2(3)
CO 3	Ability to solve the real world problems	PO2(3)
CO 4	Able to develop scalable and secure Cloud applications	PO3 (2), PO5(2)

AWS Solution Architect (SAA-CO2)

Module I : Overview of AWS

(10 Hrs)

On Premise Data Center , What is Cloud Computing, Cloud Computing Offerings - Public, Private and Hybrid Cloud, AWS as the Public Cloud IaaS Leader, AWS Global Infrastructure - Regions and Availability Zones, Elastic Compute Cloud (EC2) Foundation, Create your first EC2 instance, VPC Components - Implied Router and Route Tables, Configuring VPC, IP Addressing - Internet Gateway - Subnet Types, VPC - Network ACLs and Security Groups, Configuring Security groups and NACL, VPC Security Scenarios - Applying Security Group and NACLs, VPC - Network Address Translation – NAT

Practice:

- Launching an EC2 instance
- Configuring Security groups and NACL
- IP Addressing
- Subnetting

Module II: Virtual Private Cloud (VPC)

(14 Hrs)

VPC Peering, Transit Gateway, VPC Virtual Private Networks (VPN), VPC Direct, Implementing AWS Direct Connect, Connect Knowledge - Direct Connect Routing and Link Aggregation Groups (LAGs), Hybrid Connectivity, AWS Direct Connect Gateway, AWS Direct Connect Limits, AWS VPC, Creating a VPC, VPC Endpoints - Gateway Endpoint, AWS VPC - VPC Gateway Endpoint, Configuring VPC gateway, Troubleshooting VPC Endpoints and gateways, AWS VPC - VPC Interface Endpoint, Egress Only Internet Gateway (for IPv6), VPC Flow log and DHCP Option Sets

Practice:

- Configuring VPC
- Troubleshooting EC2 and VPC
- Creating a VPC
- Implementing AWS Direct Connect
- Configuring VPC gateway
- Troubleshooting VPC Endpoints and gateways

Module III: Elastic Block Store, Elastic Network Interfaces

(14 Hrs)

Elastic Block Store Types, EC2 Enhanced Networking and Placement Groups, EC2 Placement Groups, EC2 Status Checks and Monitoring, EC2 Instance States, EC2 Instance Termination and Termination Protection, EC2 Instance Metadata and User, EC2 Instance Launch Modes VPC and EC2, Instance Tenancy Attribute, Elastic Compute Cloud - Elastic Network Interfaces (ENIs, Elastic Network Interface (ENI) - IP Addressing, NAT instance Source/Destination Check, Public IPv4 address auto assignment, Configuring Elastic Block Store, Monitoring and checking health of EC2 instances, Elastic Network Interface, Troubleshooting ENI, Configuring and troubleshooting with EBS

Practice:

- Configuring Elastic Block Store
- Monitoring and checking health of EC2 instances
- Configuring and troubleshooting with EBS

Module IV: Elastic Load Balancer (10 Hrs)

Introduction, How ELB works , ELB health checks, ELB Cross Zone Load Balancing, ELB Positioning - Internet-facing vs Internal ELB, Refresher for TCP IP Packet flow, ELB - Security Group and ELB - Network ACLs, ELB - Layer 4 TCP/SSL Listeners, ELB - Layer 7 HTTP/HTTPS Listeners, Attaching Elastic load balancer to instances, ELB Health check and ELB Security groups, NACL configuration, troubleshooting ELB - Application and Network

Practice:

- Attaching Elastic load balancer to instances
- ELB Health check
- ELB Security groups
- NACL configuration
- Troubleshooting ELB - Application and Network

Module V: Auto Scaling, Simple Notification Service

(10 Hrs)

Auto Scaling Components, Auto Scaling Features, Auto Scaling Availability Zone Rebalance feature, Adding/Detaching EC2 instances to/from Auto Scaling Groups, Auto Scaling and Elastic Load Balancing Service, Auto Scaling Health Checks, Simple Notification Service, SNS

Notifications & Merging Auto Scaling groups, Implementing Auto Scaling, Troubleshooting Autoscaling with new EC2 instances

Practice:

- Implementing Auto Scaling
- Adding/Detaching EC2 instances to/from Auto Scaling Groups
- Auto Scaling health checks
- Simple Notification Service
- Troubleshooting Autoscaling with new EC2 instances

Module VI: AWS Elastic File System (EFS)

(16 Hrs)

Introduction to the Service and Mount Targets, AWS EFS - Use Cases, Use in On Premise Servers, Storage Classes, Pricing, AWS EFS - Data Encryption, EFS Data backup, EFS and AWS Datasync, Monitoring EFS, AWS FSx for Windows File Server - Introduction, Deployment options & Encryption, Amazon FSx - Data Protection, Backup/Restore, Access, Monitoring and Security, Amazon FSx for Lustre, Amazon EFS vs FSx for Windows vs FSx for Lustre, Creating Elastic File System, Monitoring EFS, Implementing Data Encryption, Setting up AWS FSx Windows File Server

Practice:

- Creating Elastic File System
- Monitoring EFS
- Implementing Data Encryption
- Setting up AWS FSx Windows File Server

Module VII: Elastic Map Reduce

(10 Hrs)

Amazon Elastic Map Reduce Introduction, AWS EMR - Clusters, Nodes, and deployment in an AZ, Amazon ElastiCache Introduction, Amazon ElastiCache - Caching Strategies, Amazon ElastiCache for Memcached, Amazon ElastiCache for Redis, Amazon CloudFormation, Implementing AWS EMR, Deployment in Availability Zone, Amazon ElastiCache, Amazon ElastiCache for Redis, Amazon CloudFormation

Practice:

- Implementing AWS EMR
- Deployment in Availability Zone
- Amazon ElastiCache
- Amazon ElastiCache for Redis
- Amazon CloudFormation

Online Resource: <http://aws.amazon.com/training/awsacademy>
<http://aws.amazon.com/awsseduate>

AWS Developer

Module I: IAM and EC2

(14 Hrs)

IAM Introduction, IAM Hands-On, EC2, Connect to SSH using Linux / Mac and Windows and Troubleshooting, Security Groups, Private vs Public vs Elastic IP, Configuring Webserver - Apache and Tomcat, Elastic Network Interfaces

ELB and ASG: High Availability and Scalability, Elastic Load Balancing (ELB), Classic Load Balancer (CLB), Application Load Balancer (ALB), Network Load Balancer (NLB), Elastic Load Balancer - Cross Zone Load Balancing, Elastic Load Balancer - SSL Certificates, Elastic Load Balancer - Connection Draining, Auto Scaling Groups - Scaling Policies

EBS and EFS: EBS Volume Types Deep Dive, EBS vs Instance Store

RDS ,Aurora and ElastiCache: AWS RDS Overview, RDS Read Replicas vs Multi AZ, RDS Encryption and Security, Aurora, ElastiCache and its Strategies

Practice:

- Launching EC2 instance and Connect to SSH using Linux / Mac and Windows
- Configuring Webserver - Apache and Tomcat
- Implementing Elastic Load Balancing
- Configuring EBS volume
- Create database using AWS Aurora

Module II: Route53

(10 Hrs)

Route 53: EC2 Setup, Route 53 - TTL, CNAME vs Alias, Routing Policy - Simple, Weighted, Latency Route 53 Health Checks, Routing Policy - Failover, Geolocation, Multi Value

VPC: VPC, Subnets, IGW and NAT, NACL, SG, VPC Flow Logs, VPC Peering, Endpoints, VPN, DX, VPC Cheat Sheet & Closing Comments, Three Tier Architecture.

AWS CLI, SDK, IAM Roles & Policies: AWS CLI Setup, Configuration on Windows and Linux, CLI Installation Troubleshooting, Using CLI - EC2, S3, IAM Roles and Policies, AWS Policy Simulator, AWS CLI Dry Run AWS CLI STS Decode, AWS EC2 Instance Metadata, AWS CLI Profiles, AWS CLI with MFA, AWS SDK, Exponential Backoff & Service Limit Increase, AWS Credentials Provider & Chain, AWS Signature v4 Signing

Practice:

- Route 53
- Create Amazon VPC
- AWS CLI Setup and Configuration on Windows and Linux
- CLI Installation Troubleshooting
- AWS CLI with MFA and AWS SDK

Module III: AWS S3

(10 Hrs)

Amazon S3: Amazon S3 - S3 Buckets and Objects, S3 Versioning and Encryption, S3 Security & Bucket Policies, S3 Consistency Model

S3 and Athena: S3 MFA Delete, S3 Default Encryption, S3 Access Logs, S3 Replication (Cross Region and Same Region), S3 Pre-signed URLs, S3 Storage Tiers + Glacier, S3 Lifecycle Policies, S3 Performance, S3 & Glacier Select, S3 Event Notifications, Athena, S3 Lock Policies & Glacier Vault Lock

CloudFront: CloudFront - CloudFront Caching & Caching, CloudFront Security, CloudFront Signed URL / Cookies

Practice:

- Creation of S3 bucket and uploading of objects to it
- S3 Versioning and Encryption
- S3 Replication and S3 glacier
- Application of CloudFront with S3

Module IV: AWS ECR

(14 Hrs)

ECS, ECR, Fargate - Docker in AWS: ECS, What is Docker, ECS Clusters, ECS Task Definition, ECS Service, ECS Service with Load Balancers, ECR, Fargate, ECS IAM Deep Dive & Hands On, ECS Task Placement and Constraints, ECS Auto Scaling

Elastic Beanstalk: AWS Elastic Beanstalk, Beanstalk First Environment, Second Environment, Beanstalk Deployment Modes, Beanstalk CLI and Deployment Process, Beanstalk Lifecycle Policy

Beanstalk Extensions, Beanstalk & CloudFormation, Beanstalk Cloning, Beanstalk Migrations, Beanstalk with Docker, Beanstalk Advanced Concepts, Code Commit, Code Pipeline, Code Build in VPC, Code Deploy for EC2 and ASG, AWS Code Star

CloudFormation: AWS CloudFormation - Create Stack, Update and Delete Stack, YAML, Resources, Parameters, Mappings, Outputs, Conditions, Conditions, Intrinsic Functions, RollBacks, ChangeSets, Nested Stacks & StackSet

Practice:

- ECS Service with Load Balancers
- ECS Auto Scaling
- Elastic Beanstalk CLI and Deployment Process
- Applying Code Commit and Code Pipeline
- Implementing AWS CloudFormation

Module V: Monitoring and Audit

(10 Hrs)

Monitoring and Audit: AWS Monitoring, AWS CloudWatch Metrics, Alarms and Logs, CloudWatch Agent, Logs Metric Filters, CloudWatch Events, EventBridge Overview, X-Ray, X-Ray: Instrumentation and Concepts, Sampling Rules, APIs, Beanstalk, AWS CloudTrail, CloudTrail vs CloudWatch vs X-Ray

Integration and Messaging - SQS, SNS and Kinesis: AWS Integration & Messaging, AWS SQS, Dead Letter Queue, SQS CLI, FIFO Queues, SQS Advanced, AWS SNS, AWS Kinesis, KCL, Kinesis Security, Firehose and Analytics, SQS vs SNS vs Kinesis, Data Ordering for Kinesis vs SQS FIFO

Practice:

- Monitoring and checking health of the resource
- Application of AWS X-Ray
- Messaging using SNS and SQS
- Streaming of Data using AWS Kinesis

Module VI: Serverless Using Lambda

(18 Hrs)

Serverless Using Lambda: AWS Lambda, Lambda Synchronous Invocations, Lambda & Application Load Balancer, AWS Lambda@Edge, Lambda Asynchronous Invocations & DLQ, Lambda & CloudWatch Events / Event Bridge, Lambda - S3 Event Notifications, Lambda Event Source Mapping, Lambda Destinations, Lambda Permissions - IAM Roles & Resource Policies, Lambda Monitoring & X-Ray Tracing, Lambda in VPC, Lambda Function Performance, Lambda Concurrency, Lambda External Dependencies, Lambda and CloudFormation, Lambda Layers, Versions and Aliases, CodeDeploy, Limits

Serverless using DynamoDB: DynamoDB - Throughput, Basic APIs, Indexes (GSI + LSI), Optimistic Concurrency, DAX, Streams, TTL, CLI, DynamoDB Transactions, Session State, Partitioning Strategies, Conditional Writes, Concurrent Writes & Atomic Writes, Patterns with S3, Operations and Security

Serverless using API Gateway: API Gateway - API Gateway Stages and Deployment, Canary Deployments, Integration Types & Mappings, Swagger & Open API, Caching, Usage Plans &

API Keys, Monitoring, Logging and Tracing, Authentication and Authorization, REST API vs HTTP API vs WebSocket API

Serverless Application Model: SAM, Installing the SAM CLI, Creating first SAM Project, Deploying SAM Project, API Gateway, DynamoDB, CloudFormation Designer and Application Repository, Policy Templates, CodeDeploy

Practice:

- Creating AWS lambda functions
- Lambda Permissions - IAM Roles & Resource Policies
- Creating and Maintaining database using DynamoDB
- API Gateway configuration
- Deploying Serverless Application

Module VII: AWS cognito

(08 Hrs)

Cognito: Cognito, User Pools, Identity Pools, Cognito User Pools vs Cognito Identity Pools, Sync
Security and Encryption: AWS Security, Encryption 101, KMS, KMS using CLI, KMS Encryption Patterns and Envelope Encryption, Limits, S3 Security Advanced, SSM Parameter Store Overview, Secrets Manager, SSM Parameter Store vs Secrets Manager, CloudWatch Logs Encryption, CodeBuild Security

Practice:

- Implementation of AWS Cognito
- AWS Key Management Service
- Key Management Service Encryption Patterns

Online Resource: <http://aws.amazon.com/training/awsacademy>
<http://aws.amazon.com/awseducate>

Project

- Locally Debug a Serverless App
- Build a Serverless Web Application
- Design a database for a mobile app with Amazon DynamoDB
- Create a Load Balanced WordPress website
- Building serverless applications
- Add Voice to Your WordPress Site
- Deploy a Python Web App
- Migrate a Git Repository to AWS
- Build a Drupal Website
- Build a Modern Application
- Build, Train, and Deploy a Machine Learning Model
- Handle Errors in Serverless Applications
- Create and Manage a Nonrelational Database
- Launch and Configure a LAMP Website
- Deploy and Host a ReactJS App
- Set Up a Compliant Archive
- Host a Static Website
- Launch a Linux Virtual Machine
- Launch a WordPress Website
- Remotely Run Commands on an EC2 Instance
- Launch a Windows Virtual Machine
- Create and Query a NoSQL Table

- Introduction to Deep Learning
- Train a Deep Learning model
- Create a machine learning model automatically with Amazon SageMaker Autopilot
- Setting up a Document Database With Amazon DocumentDB (with MongoDB compatibility) and AWS Cloud9
- Detect, Analyze, and Compare Faces
- Create an AWS DeepLens Project
- Provision Desktops in the Cloud
- Publish Amazon SNS Messages Privately
- Deploy WordPress with Amazon RDS
- Create and Manage a Nonrelational Database
- Create an Audio Transcript

Gate Process for Project

Gate 0: Planning

Gate 1: Analysis

Gate 2: Design

Gate 3: Implementation

Gate 4: Testing

Gate 5: Deployment

Course Outline Prepared by: Prof. K.V. Kalyan/ Prof. Raj Kumar Mohanta

Courseware link: <http://courseware.cutm.ac.in/courses/domain-cloud-domain/>

Cyber Security

		DOMAIN		
CUTM		Cyber Security	20	6+10+4
	CUCS2045	Linux Server Management and Security	4	2-2-0
	CUCS2046	Advanced Hacking Techniques	4	2-2-0
	CUCS2047	IT Networking and Network Security	4	2-2-0
	CUCS2048	Vulnerability Assessment & Penetration Testing	4	0-0-4
	CUCS2049	Project	4	0-0-4

Course Objectives

• Develop skills to manage a Linux server and provide basic security to the server • Master hacking methodology to be used in penetration testing • Good understanding on network infrastructure and identify points of vulnerability in networks • Hands on experience on various tools & techniques of vulnerability assessment & penetration testing used in Linux and shall pursue a career in penetration testing domain • Able to get job in the field of cyber security

Course Outcomes

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Able to gain knowledge on the various ways through which hackers' attempts to compromise an Application, Service, Desktop or a server and its countermeasures	PO1 (3)
CO2	Analyse and perform different type of attack and find the vulnerabilities	PO2(3)
CO3	Identify some of the problems driving the need for network security	PO2(3)
CO4	Able to design client and server side configuration of different services, build networks and subnets, configure network devices for switching and routing etc.	PO3 (3), PO5(1)

1. CUCS2045 - Linux Server Management and Security (50 HRs)

- 1.1 Access the command line, Recovery of the root user password
- 1.2 Managing files from the command line
- 1.3 Creating, Viewing, and Editing Text Files
- 1.4 Managing Local Linux Users and Groups
- 1.5 Linux File System Permissions
- 1.6 Monitoring and Managing Linux Processes
- 1.7 Archiving and Copying Files Between Systems
- 1.8 Installing and Updating Software Packages
- 1.9 Accessing Linux File Systems
- 1.10 Linux Networking

- 1.11 Analyzing and Storing Logs
- 1.12 Configuring and Securing OpenSSH Service
- 1.13 Using Regular Expressions with grep
- 1.14 Scheduling Future Linux Tasks
- 1.15 ACLs
- 1.16 SELinux Security
- 1.17 Adding Disks, Partitions, and File Systems to a Linux System
- 1.18 Managing Logical Volume Management (LVM) Storage
- 1.19 Boot Process
- 1.20 Managing different services using systemctl
- 1.21 Planning and Configuring Security Updates
- 1.22 Basics of System Auditing
- 1.23 Security guidelines during installation
- 1.24 Configuring firewalld
- 1.25 Compliance Policy and Vulnerability Scanning With OPENSCAP

2. CUCS2046 -Advanced Hacking Techniques (56 HRs)

- 2.1 What is zero day vulnerability and how it works.
- 2.2 Replay attack, pass the hash
- 2.3 Hijacking, Clickjacking, Session hijacking, URL hijacking
- 2.4 Typo squatting, Manipulating Driver, Shimming
- 2.5 Refactoring, Pivot, Initial exploitation, Persistence
- 2.6 Techniques of Penetration Testing, vulnerability scanning
- 2.7 Passively test Security Controls
- 2.8 Identifying vulnerability, lack of security control, common misconfigurations
- 2.9 Intrusive vs non intrusive, Credentialed vs non- credentialed, False positive
- 2.10 Security using Firewall, ACL, Application based vs network based
- 2.11 Stateful vs Stateless, Implicit deny
- 2.12 Remote access vs site-to-site
- 2.13 IPSec, Tunnel mode, Transport mode, AH, ESP
- 2.14 Split tunnel vs full tunnel, TLS, Always-on VPN
- 2.15 HIDS/HIPS, Antivirus
- 2.16 File integrity check, Host based firewall
- 2.17 Application whitelisting, Removable media control
- 2.18 Advanced malware tools, Patch management tools
- 2.19 Data execution prevention, web application firewall
- 2.20 Network Segmentation, Blackholes, Sinkholes, and Honeypots
- 2.21 System Hardening
- 2.22 Google Dork
- 2.23 Proxy
- 2.24, Password Guessing
- 2.25 Browser Password Hacking
- 2.26 Application Password Hacking
- 2.27 OS Password Hacking
- 2.28 Server Password Hacking

3. CUCS2047 - IT Networking and Network Security (54 Hrs)

- 3.1 Network Fundamentals
- 3.2 OSI model
- 3.3 TCP/IP protocol suite
- 3.4 IP addressing- IPv4
- 3.5 IP addressing- IPv6
- 3.6 Subnetting
- 3.7 Wireshark
- 3.8 Packet capturing
- 3.9 Analysis of packet
- 3.10 DHCP
- 3.11 DNS
- 3.12 IP configuration
- 3.13 WAN connectivity
- 3.14 Authentication
- 3.15 Basic switching
- 3.16 Static routing
- 3.17 Dynamic routing
- 3.18 VLAN
- 3.19 IPSec
- 3.20 ACL
- 3.21 Firewall
- 3.22 SSL
- 3.23 VPN
- 3.24 NAT
- 3.25, AAA

4. CUCS2048 - Vulnerability Assessment & Penetration Testing (44 HRs)

- 4.1 To gain knowledge about how VAPT works, as well as network security protocols, devices, and controls.
- 4.2 Initiate and manage incidents, as well as do penetration testing.
- 4.3 Comprehend packet sniffing techniques.
- 4.4 Learn about network penetration testing models and procedures, security analysis
- 4.5 scanning and its types(network, port and vulnerability scanning)
- 4.6 Nmap and live scanning on ports and networks
- 4.7 Netcat usage on TCP/UDP ports
- 4.8 Wireshark basics and capturing data
- 4.9 NFS ,SMB ,SMTP enumeration
- 4.10 Vulnerability scanning overview
- 4.11 Different types of vulnerability scanning
- 4.12 Nessus installation and configuration
- 4.13 Vulnerability scanning with Nessus
- 4.14 Web application assessment with nikto, burp suite and Vega
- 4.15 Vulnerability analysis with Metasploit framework
- 4.16 Application security testing using acunetix
- 4.17 OWASP mobile vulnearibility
- 4.18 Tools for Mobile application vulnearibility
- 4.19 Identify and mitigate security issues using Microsoft TMT
- 4.20 Automated software testing using VAF tool
- 4.21 password security auditing and password recovery using John the Ripper

4.22 Penetration testing using BeEF tool

Text Books:

1. Soyinka Wale, Linux Administration A Beginners Guide ,Mcgrawhill HED, Sixth Edition
2. Jon Erickson , Hacking: The Art of Exploitation, No Starch Press, US, Second Edition
3. CCNA - Routing And Switching Study Guide by Todd Lammle

Reference Books:

1. *Patrick Engebretson,, The Basics of Hacking and Penetration Testing: Ethical Hacking and Penetration, Syngress Media,U.S, Second Edition*
2. *Designing Storage Area Networks – Second Edition – Tom Clark*
3. <http://ptac.ed.gov/sites/default/files/issue-brief-threats-to-your-data.pdf>

Sample Project

1. Password Security
2. System Auditing
2. Website vulnerabilities and counter measures
3. Secure application development

Course outline Prepared by: Suvendu Kumar Nayak

Date:02-07-2022

Courseware Link: <http://courseware.cutm.ac.in/courses/domain-track-cyber-security/>

Gaming and Immersive Learning (AR & VR)

		DOMAIN		
CUTM	ARCU2060	Gaming and Immersive Learning (AR & VR)	20	5+5+14
	CUAR2060	Introduction to Gaming & Simulation	2	1+1+0
	CUAR2061	Game Assets & Game Objects	3	1+1+1
	CUAR2062	Building Game Environment	3	1+1+1
	CUAR2063	Game Animation, Scripting & UI	3	1+1+1
	CUAR2064	Binary Deployment and Cross-Platform Controls	3	1+1+1
	CUAR2065	Project	10	0+0+10

Course Objectives

- Students will know about the History of Computer Graphics
- Know about Gaming Industry and get a job in AR/VR field
- Understanding of Individual Roles in a Gaming Industry
- End to End Game Development skill

Course Outcomes

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Able to gain knowledge on game Assets Development, efficient Import/ Export of assets for Games.	PO1 (3)
CO2	Able to design Animation in Games, User Interface, Cross-Platform Support of a Game, Technical and Specification Document of a Game etc	PO3 (3), PO5(3)

1. Introduction to Gaming & Simulation

Module I: Welcome to Game Engine (2+2.5)

Importance of Storyboarding a Game Idea, The Economics of Game Development, Assessing Game Markets and Platforms, Marketing Methods for Games, Monetizing Games and Upgrades.

Module II: Introduction to Game Production (1)

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 Team.

Module III: The Game Engine User Interface

(2+2)

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.

Module IV: Using Game objects and assets

(1+2)

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.

Module V: Defining a Game Object

(2+2)

Creating Unity-native Game Objects, Manipulating Game Objects in the Unity Editor, Describing What is a Unity-native Game Object, 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.

Module VI: The Hierarchy of Scenes within a Game

(1+2)

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.

Module VII: Managing Projects and Assets

(1+2)

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.

2. Game Assets and Objects

Module I: Preparing Assets for implementation

(1+2.5)

Best Practices in 3D Content Creation, Modelling for Games, Animating for Games, UV Mapping and Texturing Techniques, and Exporting to Unity, Importing into Unity, Materials in Unity, The Interaction of Lighting and Materials.

Module II: Discovering the Standard Shader in Unity

(1+2)

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.

Module III: Assembling the Game Level (2+2)

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 Rigid body Component.

Module IV: Introduction to Colliders (1+2)

Creating the Colliders for Zombie Toys Props, Introduction to Game Level Design, 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.

Module V: Lighting in Games (1+2)

Introduction to Game Lighting, 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.

Module VI: Differentiating Shadow Types (1+2)

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.

Module VII: Baking Lighting in Game Production (1+2)

Light Baking in Video Games, Introduction to 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.

3. Building Game Environment

Module I: Building the Player and Allies (2+2)

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 Behaviour, 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.

Module II: Building the Enemies (2+2)

Creating an Enemy, Designing the Enemy Behaviours, 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.

Module III: Introduction to Unity's Particle System

(1+1)

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.

Module IV: Creating Particle Systems

(1+2)

Intro to the 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, And Production Best Practices for Particle Systems.

Module V: Case Study

(1+2)

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.

Module VI: Case Study

(1+2)

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.

Module VII: Adding Audio to Game Levels

(1+2.5)

Introduction to Audio in Game Development, Introduction to Audio in Game Development, Importing Audio into Unity, Introduction to Importing Audio in 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, Introduction to Audio Effects.

4. Game Animation, Scripting & UI

Module I: Animating Game Objects in the Unity Editor

(1+2)

Introduction to Animation in Game Development, Introduction to Animation in Game Development, Animating in the Unity Editor, Creating Animation in the Unity Editor, Refining Animation in the Unity Editor.

Module II: Bringing Animation into the Game

(1+2)

Importing Animated Characters, Introduction to Rigging and Imported Animation, Recognizing Asset Data when Importing, Differentiating Available Rig Animation Types.

Module III: Animation Creation and Controlling

(1+2)

Creating and Naming AnimationClips, Creating an Animator Controller, Introduction to the Animator Controller, Creating and Modifying Animation States, Creating Parameters to Control Transitions, Creating an Animator Override Controller.

Module IV: Scripting in Game Development

(2+2.5)

Intro to Scripting in Game Development, Intro to Scripting in Game Development, Creating Scripts in Unity, Creating and Saving a Script in Unity, Analysing the Default, Script Methods, Scripting Primer and Best Practices, Attaching a Script to a Game Object. Declaring Variables, List of Variable Types, Creating Conditions in Scripting, Introduction to Conditions, The “if” Condition, The “if else” Condition, Complex Conditions, Looping.

Module V: Designing User Interfaces for Games

(1+2)

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 a UI Button, Creating a UI Image, Creating UI Text, Creating Interaction in the UI with Events.

Module VI: Introduction to Looping

(1+2)

The “while” Loop, The “for” Loop, Creating Custom Methods, The Benefits of Using Custom Methods, Utilizing Arguments, Utilizing Method Return Types, Coroutines, Introduction to Coroutines, Accessing Components via Script, Utilizing the GetComponent() Function, Common Code Cases, Common Pieces of Zombie Toys Code..

Module VII: Implementing Navigation and Path Finding

(1+2)

Introduction to Navigation and Path Finding, Introduction to Navigation in Unity, Describing a NavMesh, Defining a NavMesh Agent, Describing a NavMesh Obstacle.

5. Binary Deployment and Cross-Platform Controls

Module I: Building the Camera and Player Selection System

(1+3)

Intro to the Camera and Player Selection Behaviours, Analyzing the Player Selection System.

Module II: Creating another Player Option

(2+2.5)

Making the Player Selectable, Adding Another Player, Finalizing the Camera.

Module III: Adding Camera Animations

(2+2)

Configuring the Camera Animator Controller, Applying Behaviour to the Camera, Adding Character Selection Spotlights.

Module IV: Building and Deploying the Game (1+1)

Building the Game, Introduction to the Build Process, Adjusting the Player Settings, Building the Game.

Module V: Protecting Your Creation (1)

Legal Considerations for Your Game, Unity Services, Unlocking the Unity Platform Potential, Surveying Unity Services

Module VI: Understanding of Cross-Platform Inputs (1+2)

Different Input types like, Mobile, WebGL, OpenVR & other unity supported platforms.

Module VII: Preparing for Mobile Deployment (2+2)

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.

Text Books:

- 1) Jared Halpern, Developing 2D Games with Unity: Independent Game Programming with C#, Apress, Final Edition
- 2) Jon Manning, Paris Buttfield-Addison, and Tim Nugent, Unity Game Development Cookbook: Essentials for Every Game, O'Reilly Media, Inc.
- 3) Reference Books:
- 4) Jason Gregory, Game Engine Architecture, CRC Press, Third Edition
- 5) Linowes Jonathan, Unity Virtual Reality Projects, Packt, Second Edition

Course outline Prepared by: Abhi Mitra

Date: July 6, 2020

Source of reference: UCA Courseware.

Note: 1 credit theory=10 hrs lecture, 1 credit practice/project=12.5 hrs lab/workshop/field work in a semester

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/Syn MOTORS.
- Motor Control Technology for Electric Vehicle applications.
- Lithium Batteries and Battery Pack Design for Electric Vehicle Applications.
- Lithium-Ion Battery Management Systems.
- Safety, Testing, Regulations, and Standards of Electric and Hybrid Vehicles.
- Powertrain Sizing Calculation Procedure and Practice Problems.
- Case Study on different electric vehicles.

Domain Track Course Outcomes:

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

COs	Course outcomes
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-I (1-1-0)-30 Hrs

Electric Vehicle Technology

This is an essential level course that 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/Syn MOTOR
- Motor Control Technology for Electric Vehicle applications

Domain Track Course Outcomes:

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

COs	Course outcomes
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

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
- To know the various transmission system used for efficient EV powertrain design

Domain Track Course Outcomes:

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

COs	Course outcomes
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 Converter

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

COs	Course outcomes
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

1. Lead-acid cell design.
2. 1c Li-ion cell design.
3. 3c Li-ion cell design.
4. Cells series connection.
5. Cells parallel connection.
6. Fixed shunt Passive cell balancing.
7. Switched Shunt Resistor Passive cell balancing
8. Battery pack design.
9. Battery thermal cooling.
10. BMS design
11. 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

COs	Course outcomes
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 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 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%20thanks%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
CO5	To develop AUTOSAR communication stack and how it is used.

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 Projects

Basket V(Elective)

Software Testing and Test Automation

Course Title	Code	Type of Course	T-P-PJ	Prerequisite
Testing and Test Automation		Theory+ Practice	2-2-0	Nil

Course Objectives:

- Develop methods and procedures for software development that can scale up for large systems and that can be used to consistently produce high-quality software at low cost and with a small cycle time
- Students will learn how to use available resources to develop software, reduce cost of software and how to maintain quality of software methods and tools of testing and maintenance of software's
- Students will get employability on software testing

Course Outcomes

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Able to gain knowledge on modern software testing processes in relation to software development and project management	PO1 (3), PO12(3)
CO2	Contribute to efficient delivery of software solutions and implement improvements of various problems in the software development processes. It stimulate analytical skill and critical thinking among students	PO2(3)
CO3	Ability to solve the real world problems	PO2(3)

CO4	To create and design test strategies and plans, design test cases, prioritize and execute them	PO3 (2), PO5(2)

Module I: Introduction to Software Engineering (8 Hours)

Evolving of software engineering, Software requirements, Requirement engineering process: feasibility studies, requirements elicitation and analysis, requirements validation, requirements management. Process models: waterfall model, incremental process models, evolutionary process models, the unified process. System models: context models, behavioral models, data models, object models, structured methods.

Module II: System Design (8 Hours)

Software architecture, Data design, Architectural styles and patterns, Architectural design, SDLC, Conceptual model of UML, Basic structural modeling, Class diagrams, Sequence diagrams, Collaboration diagrams, Use case diagrams, Component diagrams, Design scenario and case studies. Test case examples.

Module III: Testing (8 Hours)

A strategic approach to software testing, Software testing life-cycle (STLC), Test scenario, Test execution, Bug tracking. Quality management: Statistical software quality assurance, Software reliability. Basics of manual testing: Concepts, Types, Tools, Automation testing Vs Manual testing, Unit testing, Integration testing, System testing, Black-box and white-box testing, Validation testing, Sanity Vs Smoke Testing, Regression Testing and Functional and non-functional Testing.

Module IV: Selenium - Web Testing (10 Hours)

Web Application Testing, Cross-browser Testing, Test Case Management: Sample Test Case Template, Requirements Traceability Matrix (RTM) - Test Coverage, Test Data Management, Automation Testing using Selenium: Introduction to Selenium, Basics of Selenium Automation Testing, Selenium Web Driver and its contrast operation with RC, Web Driver Basics : First Selenium Web Driver Script: JAVA Code Example, Locators in Selenium IDE: CSS Selector, DOM, XPath, Link Text, ID, Find Element and Find Elements in Selenium Web Driver, Selenium Form Web Element: TextBox, Submit Button, sendkeys(), click()

Module V: Selenium - Web Driver Essentials (8 Hours)

How to Select Check Box and Radio Button in Selenium Web Driver, How to Click on Image in Selenium Webdriver, How to Select Value from Drop Down using Selenium Webdriver, Locate Elements by Link Text & Partial Link Text in Selenium Webdriver, Mouse Click & Keyboard Event: Action Class in Selenium Webdriver

Module VI: Selenium - File Handling Essentials (8 Hours)

How to Upload & Download a File using Selenium Webdriver, XPath in Selenium WebDriver: Alert & Popup Window Handling in Selenium WebDriver, How to Handle Web Table in Selenium WebDriver, Handling Dynamic Web Tables Using Selenium WebDriver, Desired Capabilities in Selenium WebDriver, How to Verify Tooltip using Selenium WebDriver, How to Find All/Broken links using Selenium Webdriver, Gecko (Marionette) Driver Selenium: Download, Install, Use with Firefox

Module VII: selenium - Testing (10 Hours)

TestNG: Annotations, Framework, Examples in Selenium, TestNG Groups: Include, Exclude with Example, TestNG @Test Priority in Selenium, Parallel Execution in Selenium: Session Handling & TestNG Dependency, TestNG: How to Run Multiple Test Suites in Selenium, TestNG Listeners in Selenium: ITestListener & ITestResult Example, How to Execute Failed Test Cases in TestNG: Selenium WebDriver, TestNG Report Generation in Selenium WebDriver, Customize, PDF & Email TestNG Reports in Selenium WebDriver

Online Source (active on 25th June 2019):

1. <https://s1.demo.opensourcecms.com/wordpress/>
2. <https://book.theautomatedtester.co.uk/>

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 re-

Course outcome

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

COs	Course outcomes
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 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 different 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- Ø transmission line when the voltage, power, current is given at the receiving end line. Using π 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

Objective

- The growing worldwide concern for the conservation of energy has reawakened interest in ecologically sustainability, processes, and sources of energy.

- The better ways to conserve energy from energy audit concepts, Representations and energy conservation schemes.
- Management skills and communication of energy manager
- Evaluation of the lifetime of the machine based on time value money and demand, economic analysis with respect to demand side management.

Course outcome

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

COs	Course outcomes
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 content

Module I: ENERGY AUDITING Theory	(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 Theory	(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: 2. Energy audit of workshops and proposed energy consumption reduction techniques.

Module III: POWER FACTOR IMPROVEMENT Theory	(8 Hours)

Power Factor — Methods of Improvement, Location of Capacitors, pf with Non-Linear Loads,
Practice: 3. Time-of-use load shifting and intelligent load management.

Module IV: LIGHTING AND ENERGY INSTRUMENTS Theory	(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 Theory	(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 Theory	(5 Hours)

Introduction to DSM, Function of load dispatch center (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.