

COURSE STRUCTURE AND SYLLABI

B.Tech in Electrical and Electronics 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 Electrical and Electronics 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 Electrical and Electronics Engineering

CHOICE BASED CREDIT SYSTEM

COURSE STRUCTURE & SYLLABUS

BASKET – I, II, III, IV & V



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School of Engineering & Technology

2025-2026

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Programme Objectives; Job/Higher studies/Entrepreneurship

POs: Engineering Graduates will be able to;

PO	Outcomes
PO1	Engineering knowledge: Apply knowledge of mathematics, science, engineering fundamentals,
PO2	Problem analysis: Identify, formulate, review literature and analyze Electrical and Electronics
PO3	Design /development of solutions: Design solution for Electrical and Electronics Engineering
PO4	Conduct investigations of complex problems: Use research based knowledge and research
PO5	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern
PO6	The engineer and society: Apply reasoning informed by the contextual knowledge to assess
PO7	Environment and sustainability: Understand the impact of the Electrical and Electronics
PO8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and
PO9	Individual and team work: Function affectively as an individual, and as a member or leader in
PO10	Communication: Communicate effectively on complex engineering activities with the
PO11	Project Management and finance: Demonstrate knowledge & understanding of the Electrical
PO12	Life- long learning: Recognize the need for, and the preparation and ability to engage in

PEOs/PSOs

PSO1. Graduates can use their skills gained in the domain to work in Industrial Automation/Transformer Manufacturing/Distribution of Power/Renewable Energy.

PSO2. Demonstrate proficiency in use of software & hardware to be required to practice Electrical Engineering profession.

PSO3. Graduates will able to qualify GATE and other PSU examinations.

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

Course Structure

Course Structure

Basket - I

Course Code	Course Title	Credits	Course Type T+P+PJ	NcRF Level
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
CUTM1674	Environmental Science	4	3+0+1	4.5

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 having constant coefficient.

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

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

Reference Books:

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

Complex Analysis and Numerical Methods

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

Course Objectives:

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

Course Outcomes:

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

- CO1: Solve the problems related to analytic functions using the Cauchy-Riemann equations.
- CO2: Describe and discuss the importance of harmonic functions and analytical functions.
- CO3: Apply Cauchy integral theorem and Cauchy integral formula for evaluating complex contour integrals.
- CO4: Analyses and test the fundamental concepts numerical methods for finding out solutions of various mathematical problems arising in roots of linear and non-linear equations
- CO5: Formulate and competent in solving numerical problems by using Runge-Kutta 2nd & 4th order methods.

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 connectives 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
- **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:

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

Reference Books:

Engineering Mechanics by S. Timoshenko, D.H. Young and J.V. Rao, Tata McGraw Hill.

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/ Quinhydrone Electrode.

Module-VII (2Hrs)

Error in Chemical analysis

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

Text Books

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

Reference Books

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

Course Structure

Basket - II

Course Code	Course Title	Credits	Course Type T+P+PJ	NcRF Level
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	3-0-0	4.5
CUVA4056	Climate Change, Sustainability and Organisation	3	2-0-1	4.5
CUTM1016	Job Readiness	6	0-6-0	

Syllabus

Optimization Techniques (50 hours)

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

Course Objectives

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

Course Outcomes

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

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

Course Outcome to Program Outcome Mapping:

COs	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	PSO3
CO1	3		1									2	1		1
CO2	2	2	2		3								1	2	1
CO3	1	2	3										1	3	
CO4	2	3	3		3								3	3	
CO5	3	3	3		3								2		1

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

Course Syllabus:

Experiment 1: Practice of linear programming problems

Experiment 2: Practice of Graphical method

Experiment 3: Practice of Simplex method

Experiment 4: Practice of Penalty Method

Experiment 5: Transportation models

Experiment 6: Assignment Models

Experiment 7: Practice of Sequencing problems

Experiment 8: Scheduling Models by Johnson's Algorithm

Text Books

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

External Links:

1. <https://www.informs.org/Resource-Center/INFORMS-Student-Union/Consider-an-Analytics-OR-Career>
2. <https://www.informs.org/>
3. 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 banking system and Indian financial systems

Course Outcome to Program Outcome Mapping:

COPO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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+Pi)
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	-	-

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-Luod9tl>
- 14) Bitrix: ([https://www.bitrix24.in/tasks/free_online_project_management.php?utm_source=google&utm_medium=cpc&utm_campaign=19998176636-149585073993&gclid=EAJaIQo_ChMI5vCVoKGe_wIVnpJmAh3OYAraE-AAAYASAAEgIYrfd_BwE\)](https://www.bitrix24.in/tasks/free_online_project_management.php?utm_source=google&utm_medium=cpc&utm_campaign=19998176636-149585073993&gclid=EAJaIQo_ChMI5vCVoKGe_wIVnpJmAh3OYAraE-<u>AAAYASAAEgIYrfd_BwE</u>))
- 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.

Course Structure

Basket - III

Course Code	Course Title	Credits	Course Type T+P+PJ	NcRF Level
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
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

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, cloud

Computing, fog or edge computing,

Connecting an Arduino /raspberry pi to the Web: Introduction, setting up the Arduino/raspberry pi development Environment, Options for Internet connectivity with Arduino, configuring your Arduino/raspberry pi board for the IoT.

Practice:

7. Visualization of diverse sensor data using dashboard (part of IoT's 'control panel')

8. Sending alert message to the user.

MODULE 5:

Theory

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

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

Practice

9. Device control using mobile Apps or through Web pages.

10. Machine to Machine communication

MODULE 6: Control & Supervisory Level of Automation

Theory

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

HMI in an automation process, ERP &MES

Practice

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

Module 7: Application of IIOT

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

Text Books:

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

Reference Books:

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

Data Analysis and Visualization Using Python (70 Hours)

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

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

Course Objectives:

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

Course Outcomes (COs):

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

CO-PO-PSO Mapping:

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

Course Syllabus:

Module 1: STORY BOARD DEVELOPMENT (20 hours)

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

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

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

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

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

Projects List:

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

References:

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

Machine Learning using Python (98 Hours)

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

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

Course Objectives:

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

Course Outcomes (COs):

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

CO-PO-PSO Mapping:

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

Course Syllabus:

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

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

Module 2: Regression (24 hrs)

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

Module 3: Classification (26 hrs)

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

Module 4 - Unsupervised Learning (24 hrs)

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

Projects

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

References:**Text Book:**

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

Web Resource:

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

Robotic automation with ROS and C++

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

Course Content:

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

Course Objectives

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

Course Outcomes

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

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

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

*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. 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

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

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

1

2

3

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-crJOG00&t=26s>

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

Session 14

Project 14

Simulating a model – Magnetic Ball System using Magnetic Library

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

Workbench Use: Behaviour Modelling.

Session 15

Project

15

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

Description: Create a package under Fluid_Package called Water_To_Stream using temperature sensors.

Workbench Use: Behaviour Modelling.

Session 16

Project

16

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

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

Workbench Use: Behaviour Modelling.

https://www.youtube.com/watch?v=P_YI3RiT114

SMART ENGINEERING PROJECT (G2M)

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

COURSE OBJECTIVES

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

COURSE OUTCOMES

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

COURSE OUTCOME TO PROGRAM OUTCOME MAPPING:

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

- 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.

1. Proteus Professional
2. MATLAB/Simulink
3. LabVIEW
4. Xilinx ISE
5. Ansys
6. Fusion 360
7. Autodesk
8. Dymola
9. Simulia
10. Maplesoft
11. Modelica
12. Python

Projects In Track:

- Analysis Design of G+10 Building using STAAD Pro
- Automated water irrigation controller for rice field
- Automatic Microgrid System
- Automation in Light and Fan in Classroom
- Speed Control Of Dc Motor using Arduino

- Bench Tapping Machine
- Modular E-Rickshaw Design using Catia
- Renewable Energy using Compressor
- Wireless Control Robotic car through MATLAB GUI
- Water Level and Temperature Indicator
- Speech Recognition using Python
- IOT Based Air Pollution Quality Monitoring with ESP8266
- Plant Disease Detection using Image Processing
- IOT Based Air Quality and Monitoring By Using Arduino
- Automatic agriculture field monitoring device
- IOT Based Weather Station Using GY-BME280 Sensor Module and ESP8266-12E Node MCU LUA Wi-Fi Module
- Bluetooth Controlled Car Using ARDUINO
- Crimes Against Women in India
- A Presentation on Analysis of QUAD COPTER
- Collecting Data and Visualizing of a Mobile Sensors of Android Device
- Manufacturing of Knuller Tool
- Smart Product Sanitization and Packaging System

Product In Track

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

Session Plan

Session 1

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

Session 2

- Review of gate zero process

Course Structure
Basket - IV
Electrical and Electronics Engineering

Course Code	Course Title	Credits	Type T+P+PJ
CUCS1001	Programming in C	6	2+4+0
CUCS1002	Data Structures with Competitive Coding	6	2+4+0
CUCS1004	Java Programming	6	2+2+2
CUTM1039	Embedded System Design Using ARM Cortex	6	3-2-1
CUTM1040	VLSI Design	6	3-2-1
CUTM1042	Electromagnetic Field Theory and Transmission Line	3	2-1-0
CUTM1043	Network Analysis	3	2-1-0
CUTM1051	Energy Production & Transmission	3	2-1-0
CUTM1052	Substation Switch gear & Protection	4	2-1-1
CUTM1053	System Modeling and Control	4	3-1-0
CUTM1054	Electrical Machines Operation and Control	4	2-2-0
CUEE1011	Industrial Power Electronics	3	2-1-0
CUTM1056	Digital Measurement and Instrumentation	3	2-1-0
CUEE1010	Basic Electrical Engineering	3	2-1-0
	Total Credits	60	

Programming in C (140 hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUCS1001	Programming in C	6	2+4+0

Course Description:

This course provides an introduction to programming using the C language, a foundational language that has influenced many other programming languages and is widely used in software development. Students will learn the core concepts of programming including syntax, data types, control structures, functions, arrays, pointers, and dynamic memory management.

Course Objectives:

- To gain a foundational understanding of the syntax and data types in C programming, and achieve proficiency in handling input/output using standard functions.
- Learn to use operators and expressions effectively and implement control structures in C programs.
- To enhance problem-solving abilities by working with functions, recursion, arrays, strings, pointers, structures, and files.

Course Outcomes:

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

- **CO1:** Define and record the fundamental syntax and data types used in the C programming language. (Remembering)
- **CO2:** Describe and illustrate the usage of input/output functions and operators in C programming. (Understanding)
- **CO3:** Demonstrate various operators and control structures to construct functional C programs. (Applying)
- **CO4:** Examine and break down problems appropriate functions and recursion techniques for solution development. (Analysing)
- **CO5:** Design and evaluate sophisticated algorithms and advanced C programs incorporating arrays, strings, pointers, structures, and unions. (Creating)

Course Outcome to Program Outcome Mapping:

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

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

Course Syllabus:

Module 1: Basic Syntax and Control Structures (20 hours)

Theory

- Data Types and Variables
- Basic Data Types: int, char, float, double
- Variable Declaration and Initialization
- Constants and Literals
- Input/Output: printf(), scanf(), gets(), puts()
- Operators and Expressions: Arithmetic, Relational, Logical, Bitwise, Assignment, Conditional (Ternary)

Practice

- Experiment 1.1: Write a C program to demonstrate the use of variables and constants.
- Experiment 1.2: Implement basic arithmetic operations using C.
- Experiment 1.3: Develop a program to showcase the use of relational and logical operators.
- Experiment 1.4: Write a program to perform input and output operations.
- Experiment 1.5: Demonstrate the use of conditional operator in a C program.
- Experiment 1.6: Implement a program using bitwise operators.
- Experiment 1.7: Write a C program to convert temperature from Celsius to Fahrenheit.
- Experiment 1.8: Develop a program to swap two numbers without using a temporary variable.
- Experiment 1.9: Write a program to find the maximum and minimum of three numbers.
- Experiment 1.10: Implement a program to calculate the area of a circle.

Module 2: Control Statements (20 hours)

Theory

- if, if-else, nested if-else
- switch-case
- for loop, while loop, do-while loop
- break, continue, goto, return

Practice

- Experiment 2.1: Write a program using if-else statement to find the largest of three numbers.
- Experiment 2.2: Implement a C program using switch-case to perform arithmetic operations.
- Experiment 2.3: Develop a program to print the first 10 natural numbers using for loop.
- Experiment 2.4: Write a C program to calculate the factorial of a number using while loop.
- Experiment 2.5: Implement a program to reverse a given number using do-while loop.
- Experiment 2.6: Develop a program to check whether a number is prime or not.
- Experiment 2.7: Write a C program to print Fibonacci series up to n terms.
- Experiment 2.8: Implement a program to check whether a number is palindrome or not.

Module 3: Functions and Recursion (30

hours) Theory

- Function Declaration, Definition, Call

- Parameter Passing: Pass by Value, Pass by Reference
- Scope and Lifetime of Variables
- Inline Functions, Function Pointers
- Recursion: Basics, Examples (Factorial, Fibonacci, Tower of Hanoi)

Practice

- Experiment 3.1: Write a program to demonstrate the use of functions.
- Experiment 3.2: Implement a program using recursion to find the factorial of a number.
- Experiment 3.3: Develop a program to calculate the GCD of two numbers using recursion.
- Experiment 3.4: Write a program to find the nth Fibonacci number using recursion.
- Experiment 3.5: Implement a program to demonstrate pass by value and pass by reference.
- Experiment 3.6: Develop a program using function pointers.
- Experiment 3.7: Write a C program to find the sum of an array using recursion.
- Experiment 3.8: Implement a program to solve the Tower of Hanoi problem

Module 4: Arrays and Strings (20 hours)

Theory

- One-Dimensional Arrays, Multidimensional Arrays
- Array as Function Arguments
- Strings: Declaration, Initialization
- String Manipulation Functions: strcpy(), strcat(), strcmp(), strlen(), etc.
- Array of Strings

Practice

- Experiment 4.1: Write a C program to implement linear search in an array.
- Experiment 4.2: Implement a program to sort an array using bubble sort.
- Experiment 4.3: Develop a program to perform matrix addition.
- Experiment 4.4: Write a program to perform matrix multiplication.
- Experiment 4.5: Implement a program to reverse a string.
- Experiment 4.6: Develop a program to check whether a string is palindrome.
- Experiment 4.7: Write a C program to concatenate two strings without using library functions.
- Experiment 4.8: Implement a program to find the length of a string using a user-defined function.

Module 5: Pointers (20 hours)

Theory

- Pointer Declaration, Initialization
- Pointer Arithmetic
- Pointers and Arrays, Strings
- Advanced Pointers: Pointers to Pointers, Function Pointers
- Dynamic Memory Allocation: malloc(), calloc(), realloc(), free()

Practice

- Experiment 5.1: Write a C program to demonstrate pointer arithmetic.
- Experiment 5.2: Implement a program to swap two numbers using pointers.
- Experiment 5.3: Develop a program to reverse an array using pointers.
- Experiment 5.4: Write a C program to find the length of a string using pointers.

- Experiment 5.5: Implement a program to copy one string to another using pointers.
- Experiment 5.6: Develop a program to dynamically allocate memory for an array.
- Experiment 5.7: Write a C program to demonstrate the use of function pointers.
- Experiment 5.8: Implement a program to demonstrate double pointer.

Module 6: Structures and Unions (10 hours)

Theory

- Defining and Declaring Structures, Accessing Members
- Array of Structures, Passing Structures to Functions, Pointers to Structures
- Defining and Declaring Unions, Difference between Structures and Unions

Practice

- Experiment 6.1: Write a C program to define and use a structure.
- Experiment 6.2: Implement a program to demonstrate array of structures.
- Experiment 6.3: Develop a program to pass structure to a function.
- Experiment 6.4: Write a C program to demonstrate the use of pointers to structures.
- Experiment 6.5: Implement a program to define and use a union.
- Experiment 6.6: Develop a program to demonstrate the difference between structures and unions.
- Experiment 6.7: Write a C program to implement a student record system using structures.
- Experiment 6.8: Implement a program to calculate the size of a structure using sizeof operator.

Module 7: Advanced Topics (20 hours)

Theory

- File I/O: fopen(), fclose(), fread(), fwrite(), fprintf(), fscanf()
- Error Handling in File Operations
- Bitwise Operations and Preprocessor Directives

Practice

- Experiment 7.1: Write a C program to perform file I/O operations.
- Experiment 7.2: Implement a program to demonstrate error handling in file operations.
- Experiment 7.3: Develop a program to perform bitwise operations.
- Experiment 7.4: Write a C program to demonstrate the use of preprocessor directives.
- Experiment 7.5: Implement a program to perform operations on bits.
- Experiment 7.6: Develop a program to demonstrate the use of macros.
- Experiment 7.7: Write a C program to implement a simple calculator using functions.
- Experiment 7.8: Implement a program to demonstrate command-line arguments.

Textbooks:

1. "The C Programming Language" by Brian W. Kernighan and Dennis M. Ritchie.
2. "Programming in ANSI C" by E. Balagurusamy.
3. "Programming in ANSI and TURBO C" by Ashon N. Kamthane.

Reference Books:

1. "C: A Reference Manual" by Samuel P. Harbison and Guy L. Steele
2. "Expert C Programming: Deep C Secrets" by Peter van der Linden.

Data Structures with Competitive Coding (140 hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUCS1002	Data Structures with Competitive Coding	6	2+4+0

Course Description:

This course combines the study of fundamental data structures with practical competitive coding techniques. Students will explore essential data structures such as arrays, linked lists, stacks, queues, trees, and graphs, and learn how to implement and utilize these structures effectively. The course also delves into advanced topics including hash tables, heaps, and balanced trees.

Course Objectives:

- To train students in algorithm analysis, recursion, and selecting suitable data structures for problem-solving, focusing on algorithm correctness.
- To implement dynamic data structures (linked lists, binary trees) and sub-quadratic sorting algorithms (quick sort, merge sort, heap sort) to solve data structure problems.
- To be able to get jobs in different IT firms as a developer with core and competitive coding skills.

Course Outcomes:

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

- **CO1:** Recall and relate algorithmic techniques and recursive methods to efficiently solve complex problems, demonstrating proficiency in analyzing and validating algorithm correctness.
- **CO2:** Describe and discuss dynamic data structures, optimizing data manipulation and storage solutions.
- **CO3:** Apply and demonstrate sorting and searching algorithms, achieving sub-quadratic performance in data processing tasks.
- **CO4:** Analyse and test coding problems using advanced data structures and algorithms under timed conditions.
- **CO5:** Formulate strategies and show readiness for software development roles by enhancing coding skills and practical data structure knowledge.

Course Outcome to Program Outcome Mapping:

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

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

Course Syllabus:

Module 1: Data Structures Basics (10

hours) Theory

- Definition, Importance, Algorithm, and Pseudocode
- Types of Data Structures, Abstract Data Types (ADTs)
- Complexity Analysis & Asymptotic Notations

Module 2: Arrays and Linked Lists (20

hours) Theory

- Array Operations
- Linked Lists: Singly, Doubly, Circular
- Operations on Linked Lists: Insert, Delete, Search, Sort, Reverse, Merge

Practice

- Experiment 2.1: Write a program to demonstrate the use of arrays.
- Experiment 2.2: Implement a program to perform insertion and deletion operations on an array.
- Experiment 2.3: Develop a program to implement a singly linked list.
- Experiment 2.4: Write a program to perform insertion and deletion operations on a singly linked list.
- Experiment 2.5: Implement a program to implement a doubly linked list.
- Experiment 2.6: Develop a program to perform insertion and deletion operations on a doubly linked list.
- Experiment 2.7: Write a program to implement a circular linked list.
- Experiment 2.8: Implement a program to perform insertion and deletion operations on a circular linked list.
- Experiment 2.9: Develop a program to reverse a linked list.
- Experiment 2.10: Write a program to merge two sorted linked lists.

Module 3: Stacks and Queues (20 hours)

Theory

- Stack Operations and Applications
- Queue Operations and Applications
- Variants: Circular Queue, Priority Queue, Deque

Practice

- Experiment 3.1: Write a program to implement a stack using an array.
- Experiment 3.2: Implement a program to perform push and pop operations on a stack.
- Experiment 3.3: Develop a program to implement a queue using an array.
- Experiment 3.4: Write a program to perform enqueue and dequeue operations on a queue.
- Experiment 3.5: Implement a program to implement a circular queue.
- Experiment 3.6: Develop a program to perform insertion and deletion operations on a circular queue.
- Experiment 3.7: Write a program to implement a priority queue.
- Experiment 3.8: Implement a program to perform insertion and deletion operations on a priority queue.

Module 4: Trees (30 hours)

Theory

- Binary Trees: Traversals, Insertion, Deletion
- Binary Search Trees (BST)
- Balanced Trees: AVL, Red-Black Trees

Practice

- Experiment 4.1: Write a program to implement a binary tree.
- Experiment 4.2: Implement a program to perform inorder, preorder, and postorder traversal on a binary tree.
- Experiment 4.3: Develop a program to implement a binary search tree (BST).
- Experiment 4.4: Write a program to perform insertion and deletion operations on a BST.
- Experiment 4.5: Implement a program to find the height of a binary tree.
- Experiment 4.6: Develop a program to implement an AVL tree.
- Experiment 4.7: Write a program to perform insertion and deletion operations on an AVL tree.
- Experiment 4.8: Implement a program to implement a red-black tree.

Module 5: Graphs (20 hours)

Theory

- Representation of Graphs
- Graph Traversal Algorithms: BFS, DFS
- Shortest Path Algorithms: Dijkstra, Floyd-Warshall

Practice

- Experiment 5.1: Write a program to represent a graph using adjacency matrix.
- Experiment 5.2: Implement a program to represent a graph using adjacency list.
- Experiment 5.3: Develop a program to perform BFS traversal on a graph.
- Experiment 5.4: Write a program to perform DFS traversal on a graph.
- Experiment 5.5: Implement a program to find the shortest path in a graph using Dijkstra's algorithm.
- Experiment 5.6: Develop a program to find the shortest path in a graph using Floyd-Warshall algorithm.
- Experiment 5.7: Write a program to find the minimum spanning tree in a graph using Kruskal's algorithm.

- Experiment 5.8: Implement a program to find the minimum spanning tree in a graph using Prim's algorithm.

Module 6: Hashing and Heaps (20 hours)

Theory

- Hash Tables: Hash Functions, Collision Handling
- Heaps: Min-Heap, Max-Heap, Operations

Practice

- Experiment 6.1: Write a program to implement a hash table.
- Experiment 6.2: Implement a program to handle collisions using chaining.
- Experiment 6.3: Develop a program to handle collisions using open addressing.
- Experiment 6.4: Write a program to implement a min-heap.
- Experiment 6.5: Implement a program to perform insertion and deletion operations on a min-heap
- Experiment 6.6: Develop a program to implement a max-heap.
- Experiment 6.7: Write a program to perform insertion and deletion operations on a max-heap.
- Experiment 6.8: Implement a program to heap sort an array.

Module 7: Sorting and Searching (20 hours)

Theory

- Linear Search, Binary Search
- Bubble Sort, Selection Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort, Radix Sort.

Practice

- Experiment 7.1: Write a program to implement linear search.
- Experiment 7.2: Implement a program to implement binary search.
- Experiment 7.3: Develop a program to implement bubble sort.
- Experiment 7.4: Write a program to implement selection sort.
- Experiment 7.5: Implement a program to implement insertion sort.
- Experiment 7.6: Develop a program to implement quick sort.
- Experiment 7.7: Write a program to implement merge sort.
- Experiment 7.8: Implement a program to implement heap sort.

Textbooks:

1. "Data Structures" by S. Lipschutz and G.A. Pai.
2. "Data Structures Using C" by Reema Thareja.

Reference Books:

1. "Data Structures Using C" by Amiya Kumar Rath, and Alok Kumar Jagadev.
2. "Expert Data Structure with C" by R.B. Patel.
3. "Competitive Programming" by Steven Halim, Felix Halim, and Suhendry Effendy.

Java Programming (112 hours)

Course Code	Course Title	Credits	Type (T+P+Pj)
CUCS1004	Java Programming	6	2+2+2

Course Description:

This course provides an in-depth introduction to Java programming, focusing on both fundamental concepts and advanced features of the language. Java is a versatile, object-oriented language widely used in industry, making it an excellent choice for learning programming and software development principles.

Course Objectives:

- Introduce the Java programming language, its features, and implement object-oriented programming concepts.
- Utilize the Java Collections Framework, manage exceptions, and perform file I/O operations.
- Develop multithreaded applications and connect to databases using JDBC.

Course Outcomes:

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

- **CO1:** Recall the features and basic syntax of Java. (*Remembering*)
- **CO2:** Explain object-oriented programming concepts. (*Understanding*)
- **CO3:** Apply collections, exception handling, and file I/O operations in Java. (*Applying*)
- **CO4:** Analyze multithreaded applications and concurrency issues. (*Analyzing*)
- **CO5:** Develop complex Java applications with advanced features. (*Creating*)

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	-	2	2	2
CO2	3	3	3	2	2	-	-	-	-	-	-	-	1	1	1
CO3	2	-	2	-	-	-	-	-	1	-	-	1	2	2	2
CO4	2	3	3	2	-	-	1	-	-	1	-	-	2	3	2
CO5	3	3	3	2	2	1	-	1	-	1	-	-	2	2	2

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

Course Syllabus:

Module 1: Introduction to Java (15 hours)

Theory

- History, Features of Java
- Setting up JDK and IDE
- Basic Syntax, Data Types

Practice

- Experiment 1.1: Write a program to print "Hello, World!" in Java.
- Experiment 1.2: Implement a program to demonstrate the use of variables and data types in Java.
- Experiment 1.3: Develop a program to perform arithmetic operations in Java.
- Experiment 1.4: Write a program to demonstrate the use of conditional statements in Java.
- Experiment 1.5: Implement a program to demonstrate the use of loops in Java.
- Experiment 1.6: Develop a program to perform string operations in Java.
- Experiment 1.7: Write a program to demonstrate the use of arrays in Java.
- Experiment 1.8: Implement a program to perform matrix operations in Java.

Module 2: Object-Oriented Programming in Java (15 hours)

Theory

- Classes, Objects, Constructors
- Inheritance, Polymorphism, Encapsulation
- Abstract Classes, Interfaces

Practice

- Experiment 2.1: Write a program to demonstrate the use of classes and objects in Java.
- Experiment 2.2: Implement a program to demonstrate the use of constructors in Java.
- Experiment 2.3: Develop a program to demonstrate the use of inheritance in Java.
- Experiment 2.4: Write a program to demonstrate the use of polymorphism in Java.
- Experiment 2.5: Implement a program to demonstrate the use of encapsulation in Java.
- Experiment 2.6: Develop a program to demonstrate the use of abstract classes in Java.
- Experiment 2.7: Write a program to demonstrate the use of interfaces in Java.
- Experiment 2.8: Implement a program to demonstrate the use of inner classes in Java.

Module 3: Java Collections Framework (15 hours)

Theory

- Collections: List, Set, Map
- Iterators, Enhanced For-Loop
- Sorting and Searching Collections

Practice

- Experiment 3.1: Write a program to demonstrate the use of ArrayList in Java.
- Experiment 3.2: Implement a program to demonstrate the use of LinkedList in Java.
- Experiment 3.3: Develop a program to demonstrate the use of HashSet in Java.

- Experiment 3.4: Write a program to demonstrate the use of TreeSet in Java.
- Experiment 3.5: Implement a program to demonstrate the use of HashMap in Java.
- Experiment 3.6: Develop a program to demonstrate the use of TreeMap in Java.
- Experiment 3.7: Write a program to demonstrate the use of Iterator in Java.
- Experiment 3.8: Implement a program to demonstrate the use of Comparator and Comparable in Java.

Module 4: Exception Handling and I/O (20 hours)

Theory

- Exception Handling Mechanisms
- Types of Exceptions: Checked, Unchecked
- File Handling: Reading, Writing, Serialization

Practice

- Experiment 4.1: Write a program to demonstrate the use of try-catch block in Java.
- Experiment 4.2: Implement a program to demonstrate the use of multiple catch blocks in Java.
- Experiment 4.3: Develop a program to demonstrate the use of nested try block in Java.
- Experiment 4.4: Write a program to demonstrate the use of finally block in Java.
- Experiment 4.5: Implement a program to demonstrate the use of throw and throws keyword in Java.
- Experiment 4.6: Develop a program to read and write data to a file in Java.
- Experiment 4.7: Write a program to demonstrate the use of BufferedReader and BufferedWriter in Java.
- Experiment 4.8: Implement a program to demonstrate the use of FileInputStream and FileOutputStream in Java.

Module 5: Multithreading and Concurrency (15 hours)

Theory

- Threads: Creation, Management
- Synchronization, Concurrency Utilities
- Thread Pooling

Practice

- Experiment 5.1: Write a program to create a thread by extending Thread class in Java.
- Experiment 5.2: Implement a program to create a thread by implementing Runnable interface in Java.
- Experiment 5.3: Develop a program to demonstrate thread synchronization in Java.
- Experiment 5.4: Write a program to demonstrate inter-thread communication in Java.
- Experiment 5.5: Implement a program to demonstrate deadlock in Java.
- Experiment 5.6: Develop a program to demonstrate thread pooling in Java.
- Experiment 5.7: Write a program to demonstrate the use of Executors framework in Java.
- Experiment 5.8: Implement a program to demonstrate the use of Callable and Future in Java.

Module 6: GUI Programming and Advanced Java Basics (15 hours)

Theory

- AWT: Container
- Components
- Layout Managers
- Event Handling
- Introduction to Swing
- Generics, Lambda Expressions, Stream API Annotations, Reflection
- Java Database Connectivity (JDBC)

Practice

- Experiment 6.1: Write a program to demonstrate the use of generics in Java.
- Experiment 6.2: Implement a program to demonstrate the use of lambda expressions in Java.
- Experiment 6.3: Develop a program to demonstrate the use of Stream API in Java.
- Experiment 6.4: Write a program to demonstrate the use of annotations in Java.
- Experiment 6.5: Implement a program to demonstrate the use of reflection in Java.
- Experiment 6.6: Develop a program to connect to a database using JDBC in Java.
- Experiment 6.7: Write a program to perform CRUD operations using JDBC in Java.
- Experiment 6.8: Implement a program to demonstrate the use of Prepared Statement in Java.

Module 7: Networking and Advanced(15 hours)

Theory

- Networking Fundamental
- Client-Server Communication
- Remote Method Invocation (RMI)

Practice

- Experiment 7.1: Write a program for one way communication.
- Experiment 7.2: Write a program for two way communication.
- Experiment 7.3: Write a program to implement RMI.
- Experiment 7.4: Write a program to implement TCP/IP protocol.

Projects (22 hours):

- Project 1: Library Management System
- Project 2: E-commerce Application Backend
- Project 3: Multithreaded Chat Application

Textbooks:

1. "Java: The Complete Reference" by Herbert Schildt.
2. "Core Java Volume I - Fundamentals" by Cay S. Horstmann and Gary Cornell

Reference Books:

1. "Effective Java" by Joshua Bloch.
2. "Head First Java" by Kathy Sierra and Bert Bates.
3. "Programming with Java" by E. Balagurusamy.

Embedded System Design with ARM-Cortex

Code	Course Title	Credit	T-P-PJ
CUTM1039	Embedded System Programming with ARM-Cortex	6	3-2-1

Objective

- To allow students in Embedded System sectors to learn programming / Interfacing peripherals to ARM Cortex based Microcontroller

Course outcome

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

CO1: Gain Knowledge about the architectural features and instructions of 32 bit ARM Cortex M3 microcontroller.

CO2: Understand the basic hardware components and their selection method based on the characteristics and attributes of an Embedded System.

CO3: Understand various Sensors, Actuators & Interfacing Modules.

CO4: Implement GPIO, timers, interrupts, and other peripheral functionalities.

CO5: Develop real-time embedded solutions for IoT, automotive, or industrial automation.

Course Outcome to Program Outcome Mapping:

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

Course Content (66 Hours)

Module I: EMBEDDED C

(4 Hrs)

Embedded System, Programming Embedded system, Factor for selecting the Programming language, Embedded C programming Language, Embedded C vs C.

Practice:

1. Familiarization with tools (STM32CubeMX, KeilVision IDE, Flash Magic & Proteus Simulator).
2. Programming STM32 using KeilVision& STM32CubeMX.

Module II: ARM-32 bit MICROCONTROLLER

(6 Hrs)

ARM Design Philosophy & RISC Architecture, Programmer's Model. ARM Cortex M, Cortex M Architecture, ARM Cortex-M Internals & Debugging.

Practice:

1. Familiarization with Different Processors and Controllers Boards (8, 16, 32, 64 bits)

Module III: STM32 GPIO MANAGEMENT

(14 Hrs)

GPIO Configuration, Driving De-initialization, Interfacing IO devices and its type – LEDs, Switches, Buzzer, Seven Segment Display, LCD (4 bit, 8 bit Mode), Keypad (4*4), DC Motor, Stepper Motor, Servo motor, Relay.

Practice:

1. Write an Embedded C program to interface LEDs with STM32.
2. Write an Embedded C program to interface Switch with STM32.
3. Write an Embedded C Program to design up counter & down counter using Seven Segment Display. (1 digit, 2 digit)
4. Write an Embedded C program to interface buzzer to control with the help of Switch.
5. Write an Embedded C program to display characters on Alphanumeric LCD.
6. Write an Embedded C program to interface Keypad and LCD with STM32.
7. Write an Embedded C program to interface DC Motors, Stepper Motor, and Servo Motor rotate clockwise, anticlockwise and in angle (45° , 90° , 180°).
8. Write an Embedded C program to interface relay to control the AC Appliances.

Module IV: STM32 INTERRUPT MANAGEMENT & UART

(14 Hrs)

NVIC Controller, Enabling Interrupt, Interrupt Priority Levels, UART Initialization, UART communication in polling Mode & in Interrupt Mode. Wireless Technologies- Bluetooth, Wi-Fi, RF.

Practice:

1. Write an embedded C program to generate an Interrupt process using STM32.
2. Write an Embedded C program to interface STM32 to Bluetooth Module to send & receive Data.

3. Write an Embedded C program to interface STM32 to GPS module to get a Location Coordinate.
4. Write an Embedded C program to interface STM32 to GSM module to Send & Receive SMS.
5. Write an Embedded C program RF module with STM32 to send and receive the data wirelessly.
6. Write and Embedded C program to design a system to read the RFID cards using STM32.
7. Write and Embedded C program to connect ESP8266 with STM32 to create a Webserver.

Module V: STM32 TIMERS , ADC, & DAC

(10 Hrs)

Timers Basics, General Purpose Timer, SysTick Timer, ADC & DAC Basics, Initialization, DAC Peripherals & Modules. Analog Sensors and its Types(Ultrasonic Sensor, Temperature, Humidity, Soil Moisture Sensor, PIR sensor)

Practice:

1. Write an Embedded C Programs to generate Delay using Timer.
2. Write an Embedded C program to display output for given analog input using internal ADC. (Use of Analog Sensors like Ultrasonic Sensor, Temperature, Humidity, Soil Moisture Sensor, PIR sensor)
3. Write an embedded C program to generate Triangular and Square waves using DAC.

Module VI: STM32 I2C & SPI

(10 Hrs)

I2C specification, Protocol configuration, I2C Peripherals. SPI Specification, Protocol configuration, it's Peripheral and Modules.

Practice:

1. Write an Embedded C program to build I2C communication between STM32 and Arduino
2. Write an Embedded C program to build SPI communication STM32 to the Arduino board.

Module VII: PWM & CAN (8 Hrs)

RTC feature and its Module, CAN Protocols Overview, Application, Architecture, Data Transmission & Data Frames.

Practice:

1. Write an Embedded C program to implement a Real-Time Clock.
2. Write an Embedded C program to Speed Control of DC motor using PWM.
3. Write an Embedded C program to change the intensity of Light using PWM.

Text Books:

1. Shibu K V, —Introduction to Embedded SystemsI, Tata McGraw Hill Education Private Limited, 2nd Edition

2. Noviello, Carmine. "Mastering STM32." Obtenido de <http://www2.keil.com/mdk5/uvision,2017>.
3. Norris, Donald. Programming with STM32: Getting Started with the Nucleo Board and C/C++. McGraw Hill Professional, 2018.

Reference Books:

1. STM32F10xx User Manual
 2. <https://www.udemy.com/course/stm32cubemx-complete-training/learn/lecture/9606338#overview>
1. <https://www.udemy.com/course/embedded-c-programming-for-embedded-systems/>

VLSI Design

Code	Course Title	Credit	T-P-PJ
CUTM1040	VLSI Design	6	3-2-1

Objective

- The objective of the course is to provide understanding of the entire logic design process with the analysis from combinational and sequential digital circuit design.
- Provide understanding of the techniques essential to the Verilog programming for Verification and Testing.
- To learn the architecture of most prominent vendor in the FPGA market, Xilinx FPGAs and Altera FPGAs.

Course outcome

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

CO1: Knowledge on Analytical combinational and sequential circuit design concepts

CO2: Analytical Verilog coding, compiling, simulating and executing on any VLSI design platform.

CO3: Development for FSMs & ASMs for the given problems.

CO4: Hands-on Verilog HDL for FPGA Programming. Skill development for implementing Digital Circuits on Xilinx FPGAs and Altera FPGAs using Verilog HDL.

CO5: Illustrate the Verilog RTL Coding Techniques

Course Outcome to Program Outcome Mapping:

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

Module I: Introduction to VERILOG

(10 hrs)

Introduction to Verilog HDL & Hierarchical Modeling Concepts, Lexical Conventions & Data Types, System Tasks & Compiler Directives, Modules, Ports and Module Instantiation Methods, Modeling methods, Design Verification using Test benches

Practice

1. Introduction to Xilinx EDA Tool.
2. Introduction to XST Tool and ISIM Tool
3. Xilinx Tool Flow: Simulation and Synthesis
4. Module and Ports in Verilog
5. Data Types in Verilog Programming.

Module II: Boolean Algebra and Logic Minimization

(8hrs)

Binary Arithmetic and 1's and 2's Complementation, Basic Theorems and Properties, Canonical and Standard Form, Algebraic Simplification of Digital Logic Gates, The Karnaugh Map Method, Prime and Essential Implications, Don't Care Map Entries.

Practice

6. Gate level Modelling in Verilog.
7. Data flow Modelling in Verilog.
8. Behavioral Modelling in Verilog.

Module III: Combinational Circuit Design

(12hrs)

Arithmetic Circuits: Adder/Subtractor Circuits, Ripple Carry Adder, Universal Ripple carry Adder, BCD Adder, Multipliers Comparators, Multiplexer, Demultiplexer, Decoder, Encoder and Priority Encoder, Code Converters: Binary to Gray, Binary to BCD.

9. Design of Arithmetic Circuits using Verilog.
10. Design of Encoder and Decoder using Verilog.
11. Design of Data selector and Data Distributor using Verilog.
12. Design of comparator and Code converters using Verilog.

Module IV: Sequential Circuit Design

(14hrs)

Latch, Flip-Flop: S-R,D,J-K,T, Flip-Flop Conversion and Excitations Counter: Asynchronous and Synchronous counter Design, Register: SISO, SIPO,PISO and PIPO, Universal Shift Register, Johnson counter and Ring Counter.

Practice

13. Design SR and D-Flip Flop Using Continuous and Procedural Assignments.
14. Design JK-Flip Flop And T-Flip Flop Using Verilog.
15. Design Shift Registers (SISO, SIPO, PISO, PIPO) using Verilog.
16. Design Ripple Counter and Up/Down Synchronous Binary Counter Using Verilog.

Module V: State Machines

(10 hrs)

Basic Finite state machines (FSM) structures, Mealy and Moore type FSM, Design of controller and Data path units, Controller Design using FSMs & ASMs

Practice

17. Design of Sequence Detectors allowing overlapping as well as non-overlapping.

18. Design of Mealy and Moore type FSM using Verilog.
19. Design of data controller using ASM.

Module VI: FPGA Architecture and Prototyping

(5 hrs)

Introduction to Programmable Logic and FPGAs, Popular CPLD & FPGA Families, Architecture of Xilinx and Altera FPGAs

Practice

20. Proto-typing of a design using FPGA Design Kit

Module VII: Synthesis and Timing

(6hrs)

FPGA Design Flow, Implementation Details Advanced FPGA Design tips, Logic Synthesis for FPGA, Static Timing Analysis

Practice

21. Design mapping and optimization
22. Analyze and resolve design problems
23. Report generation
24. Verilog gate-level netlist generation and post-synthesis timing data (SDF) extraction
25. Design constraints generation for placement and routing

Text Books:

1. M.Morris Mano., "Digital Design", Pearson Education, 4th Edition.
2. Palnitkar, S. (2003). Verilog HDL: a guide to digital design and synthesis (Vol. 1). Prentice Hall Professional.

Reference Books:

1. Kohavi, Z., & Jha, N. K. (2009). Switching and finite automata theory. Cambridge University Press.
2. Jain, R. P. (2003). Modern digital electronics. Tata McGraw-Hill Education.

Electromagnetic Field Theory & Transmission Lines

Code	Course Title	Credit	T-P-PJ
CUTM1042	Electromagnetic Field Theory & Transmission Lines	3	2-1-0

Objective

- To introduce the fundamental theory and concepts of electromagnetic waves and transmission lines
- To impart knowledge on the concepts of electrostatics, electric potential, energy density and their applications.
- To impart knowledge on the concepts of magnetostatics, magnetic flux density, scalar and vector potential and its applications.
- To impart knowledge on the concepts of Faraday's law, induced emf and Maxwell's equations.
- Model and design the transmission lines at high frequencies.
- To apply the Smith chart for the solution of transmission line problems and impedance matching.

Course outcome

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

- To introduce the fundamental theory and concepts of electromagnetic waves and transmission lines
- To impart knowledge on the concepts of electrostatics, electric potential, energy density and their applications.
- To impart knowledge on the concepts of magnetostatics, magnetic flux density, scalar and vector potential and its applications.
- To impart knowledge on the concepts of Faraday's law, induced emf and Maxwell's equations.
- Model and design the transmission lines at high frequencies

Course Outcome to Program Outcome Mapping:

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

Course content (Total Hours: 33)

Module I: Electrostatics

(3hrs Theory + 2hrs Practice)

Introduction to Electrostatic Fields, Gauss's Law and Applications, Electric Potential, Maxwell's Two Equations for Electrostatic Fields, Electric Current and Current Density, Continuity Equation, Relaxation Time, Laplace's and Poisson's Equations.

Practice:

1. To Calculate the Electric field of a dipole using Coulomb's law in Matlab
2. Simulation of Electric Potential and Electric Field in Matlab

Module II: Magnetostatics

(3hrs Theory + 2hrs Practice)

Biot-Savart Law: Current Flow – which path does it take, Ampere's Circuital Law, Magnetic Flux Density: Closed Loop Circuits, Magnetic Scalar and Vector Potentials, Forces due to Magnetic Fields, Inductances and Magnetic Energy.

Practice:

1. Magnetic field by an infinitely long line current using MATLAB
2. Magnetic field of a Circular current loop using Biot Savart's Law

Module III: Maxwell's Equations

(3hrs Theory + 1hr Practice)

Maxwell's Equations and Boundary Conditions.

Practice:

1. Maxwell's Equation using matlab

Module IV: Electromagnetic Waves (3hrs Theory + 4hrs Practice)

Wave Equations for Conducting and Perfect Dielectric Media, Uniform Plane Waves, Wave Propagation in Lossless and Conducting Media, Polarization, Reflection and Refraction of Plane Waves – Normal and Oblique Incidences for both Perfect Conductor and Perfect Dielectrics, Brewster Angle, Critical Angle and Total Internal Reflection, Surface Impedance. Poynting Vector and Poynting Theorem.

Practice:

1. Linear and Circular Polarization of waves using matlab
2. 1-D standing wave using matlab
3. 2-D standing wave (TE) using matlab
4. 2-D standing wave (TM) using matlab
5. Design of Wireless Power Transfer using matlab

Module V: Introduction to Transmission Line Modelling (3hrs Theory + 3hrs Practice)

Introduction to Transmission line equations, Primary & Secondary constants Expressions for Characteristic Impedance, Propagation Constant, Phase and Group Velocities, Losslessness/Low Loss Characterization, Distortion, Loading, Transmission Line Effects, SC and OC Lines, Reflection Coefficient, VSWR, $\lambda/8$, $\lambda/4$, $\lambda/2$ line impedance Transformations, Smith Chart – Configuration and Applications, Impedance Control.

Practice:

1. Reflection and transmission of a plane wave (S-wave)
2. Reflection and transmission of a plane wave (P-wave)
3. Radiation by an infinitesimal dipole

Module VI: Waveguides (3hrs Theory)

Introduction, Rectangular Waveguides, electric and magnetic field patterns in TE₁₀ and TE₁₁ mode configuration, modes of TE wave in rectangular waveguide, field equations, impossibility of TEM wave propagation in waveguides, cutoff frequency of rectangular waveguide, propagation constant, wave impedance, phase velocity, group velocity, dominant mode and degenerate modes, related problems.

Module VII: Electromagnetic Computational Techniques (3hrs Theory)

Introduction, Finite Difference Method (FDM), Finite Element Method (FEM) and Method of moments (MOM) technique.

Text Books:

1. Matthew N.O. Sadiku, “Elements of Electromagnetics”, Oxford Univ. Press.
2. G.S.N.Raju, “Electromagnetic Field Theory and Transmission Lines”, Pearson Education (Singapore) Pvt., Ltd.

Reference:

1. E.C. Jordan and K.G. Balmain, “Electromagnetic Waves and Radiating Systems”, PHI.
2. Seungbum Hong, "Electrodynamics: An Introduction", Coursera.
3. [Seungbum Hong, "Electrodynamics: Electric and Magnetic Field", Coursera.](#)
4. [Seungbum Hong, "Electrodynamics: In-depth Solutions for Maxwell's Equations", Coursera.](#)
5. Husain Habib, "Electromagnetic Tutorials part 1 with MATLAB & GeoGebra", Udemy

Network Analysis

Code	Course Title	Credit	T-P-PJ
CUTM1043	Network Analysis	3	2-1-0

Course Objective

- To learn techniques of solving circuits involving different active and passive elements.
- To deliver problem-solving skills on circuits through the application of simulation & programming techniques and principles to common circuit problems.
- To analyze the behaviour of the circuit's response in time domain.

Course Outcomes

COs	Course outcomes
CO1	Demonstrate a systematic understanding of the key aspects and concepts of their branch of engineering
CO2	Relevant analytics to solve network problems using Network simplification theorems
CO3	Use of software tools (MATLAB/DYMOLA) to design and validation of real-time problems
CO4	Infer and evaluate transient response, Steady state response, and network functions
CO5	Evaluate different network parameters, design attenuators, filters two-port, and equalizers to enhance the real-time designing skill

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	3				1			1	3	2	1
CO2	3	3	1	1	3							1	3	3	2
CO3	2	3	1	3	3							1	3	2	
CO4	3	2	1		3				3	1		2	2	2	2
CO5	3	3	1	2	3				2	1		2	1	1	2

COURSE CONTENT

Module I

(3 hrs)

Network Topology

Graph of a network, Concept of the tree, Incidence matrix, Tie-set matrix, Cut-set matrix, Formulation and solution of network equilibrium equations on loop and node basis

Module II

(8 hrs)

Network Theorems (AC Networks)

Thevenin's Theorem, Norton's theorem, Superposition theorem, Substitution theorem, Reciprocity theorem, Maximum power transfer theorem, Tellegen's theorem, Millman's theorem, Compensation theorem

Practice: (Hardware/Software)

1. Verification of Reciprocity theorem
2. Verification of Tellegen's theorem
3. Verification of Millman's theorem
4. Verification of Maximum power transfer theorem
5. Verification of Compensation theorem
6. Verification of Thevenin's Theorem
7. Verification of Nortons's Theorem
8. Verification of Superposition Theorem

Module III

Coupled Circuits

(3 hrs)

Theory

Coupled Circuits, Dot Convention for representing coupled circuits, Coefficient of coupling, Series and parallel resonant circuits: Band Width and Q-factor

Practice: (Hardware)

6. Self-inductance, mutual inductance, and coefficient of coupling to be determined for a 1- \emptyset transformer representing a coupled circuit.
7. Frequency response of a series and parallel resonant circuit by laboratory setup.

Module IV

(5 hrs)

Network Laplace Transform

Application of Laplace transform: Circuit Analysis (Steady State and Transient)

Practice: (SOFTWARE)

8. Analysis of transient characteristics using MATLAB
9. AC and DC transient response analysis for RL, RC, and RLC circuits using MATLAB

Module V

(4 hrs)

Two Port Network

Z, Y, ABCD and h-parameters, Reciprocity and Symmetry, Interrelation of two-port parameters, Interconnection of two-port networks

Practice: (Hardware)

10. Determination of Z parameters
11. Determination of Y parameters
12. Determination of h parameters
13. Determination of ABCD parameters

Module VI

(4 hrs)

Filters

A brief idea about network filters (Low pass, High pass, Band pass and Band elimination) and their frequency response

Practice:

14. Design and frequency response analysis of Low Pass filter
15. Design and frequency response analysis of High Pass filter
16. Design and frequency response analysis of Band Pass filter
17. Design and frequency response analysis of Band elimination filter

Module VII

Fourier Series

(5 hrs)

Theory

Fourier series, Fourier analysis and evaluation of coefficients, Steady-state response of network to periodic signals, Fourier transform and convergence, Fourier transform of some functions

Practice:

18. Fourier series expansion of Square wave
19. Fourier series expansion of Sine wave

Text Books:

1. M. E. VAN VALKENBURG- Network Analysis, PHI Publications
2. A K Chakraborty, "Network Theory," DhanpatRai Publication
3. MAHMOOD NAHVI – Electric Circuits, SCHAUM'S Outlines Fifth Edition

Reference Books:

1. Smarajit Ghosh- Network Theory Analysis & Synthesis, MC Graw Hill Publishers
2. Dr. B.R.GUPTA- Network Analysis & Synthesis- S.Chand

Energy Production & Transmission

Code	Course Title	Credit	T-P-PJ
CUTM1051	Energy Production & Transmission	3	2-1-0

Course Objective

<ul style="list-style-type: none"> • To understand power generation and economics • To design the transmission line parameters • To understand the mechanical design of transmission lines

Course Outcomes

COs	Course outcomes
CO1	Understand the various essential components of the power system i.e. generation, transmission, and distribution.
CO2	Calculate different transmission line parameters and analyze regarding performance of transmission lines using MATLAB.
CO3	Know about different overhead line insulators, design of overhead lines as well as regarding cause and effects of corona in overhead ..
CO4	Understand underground cables and the capacitance of single-core and three-core cables using AUTOCAD/SolidWorks
CO5	Know about different types of distribution systems, voltage control, and power factor improvement.

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	3				1			1	3	2	1
CO2	3	3	1	1	3							1	3	3	2
CO3	2	3	1	3	3							1	3	2	
CO4	3	2	1		3				3	1		2	2	2	2
CO5	3	3	1	2	3				2	1		2	1	1	2

COURSE CONTENT

Module I: Thermal & Nuclear Power Plants

(6Hours)

Introduction: Statistics of generation of electric power from Conventional and non-conventional sources of energy, Thermal & Nuclear power station: Schematic arrangement, Types of prime movers, types of reactors, speed control & auxiliaries, Environmental aspects for selecting the sites and locations, Hazards.

Practice:

1. Schematic Layout design Thermal Plant using AutoCAD
2. Schematic Layout design Nuclear Plant using AutoCAD

Module II: Hydro & Wind power plants

(4Hours)

Hydropower station: Schematic arrangement, Hydro turbines, Environmental aspects for selecting the sites and locations of hydropower stations, small hydro for irrigation, Wind power generation.

Practice:

3. Schematic Layout design of Hydro Plant using AutoCAD/3Ds

Module III: Power Generation Tariffs

(5Hours)

Tariff and Economic aspects in power Generation: Terms commonly used in system operation, various factors affecting cost of generation: Load curves, load duration curves, connected load, maximum load, Peak load, base load and peak load power plants, load factor, Plant capacity factor, Plant use factor, Demand factor, diversity factor, Cost of power plant.

Practice: MATLAB

4. Preparation of Load calculator using MATLAB

Module IV: Transmission systems

(4 Hours)

Supply System: Different kinds of supply systems and their comparison, and choice of transmission voltage. Transmission Lines: Configurations, types of conductors, resistance of line, skin effect, Kelvin's law, Proximity effect,

5. Experiments to demonstrate skin effect and proximity effect in MATLAB
6. Experiment on Load flow analysis of 400KV Transmission system.

Module V: Transmission line Parameters

(5 Hours)

Calculation of inductance and capacitance of the single-phase, three-phase, single circuit, and double-circuit transmission lines, Representation and performance of short, medium, and long transmission lines, T & Pi networks, ABCD parameters, Ferranti effect, Surge impedance loading.

Practice:

7. Designing of transmission line parameters using MATLAB

Module VI: Transmission line operation & Insulators

(5 hours)

Phenomenon of the corona, corona formation, calculation of potential gradient, corona loss, factors affecting corona, methods of reducing corona and interference Electrostatic and electromagnetic interference with communication lines.

Overhead line Insulators:

Type of insulators and their applications, potential distribution over a string of insulators, methods of equalizing the potential, and string efficiency.

Practice:

8. Designing of Insulators and calculation of voltages using MATLAB

Module VII: Design of cables

(4 Hours)

Calculation of sag & tension, effects of wind and ice loading, sag template, vibration dampers. Under Ground Insulated cables: Type of cables and their construction, dielectric stress, grading of cables, insulation resistance, the capacitance of single-phase and three-phase cables, dielectric loss, heating of cables, Transmission line tower designs

Practice:

9. Designing of Cables
10. Design of cable using AutoCAD Electrical/Solid Works Electrical/3Ds

Text Books:

1. Electrical power Generation, Transmission and Distribution S.N. Singh PHI 2nd Edition, 2009

Reference Books:

2. A Text Book on Power System Engineering A.Chakrabarti, DhanpathRai 2nd Edition

Substation Switch Gear & Protection

Code	Course Title	(Credit)	T-P-PJ
CUTM1052	Substation Switch Gear & Protection	4	2-1-1

Course Objective

- To understand the different components of substation.
- To understand the protection of different equipment in the power system.

Course Outcomes

COs	Course outcomes
CO1	Able to understand the performance of different protection methods of different equipment
CO2	Able to understand the different components of substation and their operation
CO3	Able to design the power system switch gear
CO4	Able to understand the Maintenance of substation and protection control systems
CO5	Illustrate relay coordination and earth mat sizing using ETAP software with real-time industrial examples.

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	3				1			1	3	2	1
CO2	3	3	1	1	3							1	3	3	2
CO3	2	3	1	3	3							1	3	2	
CO4	3	2	1		3				3	1		2	2	2	2
CO5	3	3	1	2	3				2	1		2	1	1	2

COURSE CONTENT

Module I: Substation Systems

(6 Hours)

Introduction to Substation System: Definition of the substation, the necessity of substation, essential features, types of the substation, single line diagram of substation, List, and functions of each component of the substation. Auxiliary systems, Overhead earthing screen, Substation earthing system.

Practice:

1. Layout Design of 220KV substation using MATLAB
2. Layout Design of 400KV & 750KV substation using MATLAB as per IEEE standards

Module II: Operation & Maintenance of Substations

(10 Hours)

Testing and maintenance of Bus Bars, and Isolators: Types and ratings – Bus bar configuration, Tests on Bus bars. Types of isolators and ratings, Load Break switches, Maintenance of isolators, testing and maintenance of Power Transformers, Current and Voltage Transformers and Insulators: Preliminary tests, Final tests, Impulse test, Partial discharge test, Transformer maintenance. Current Transformer tests, Potential Transformer tests. CT and PT maintenance, Tests and maintenance of insulator

Practice:

3. Maintenance tests of CT & PT of the substation as per manufacturers Handbook
4. Maintenance test of the Lighting Arrestor & Circuit Breaker of the substation as per manufacturer's Handbook
5. Maintenance tests of the transformer as per the manufacturers' Handbook

Module III: Protection & System Components

(5 Hours)

Need for protective schemes, Nature and Cause of Faults, Types of Fault, Effects of Faults, Zones of Protection, Primary and Backup Protection, Essential Qualities of Protection, Classification of Protective Relays, Automatic Reclosing, Current Transformers for protection, Voltage Transformers for Protection.

Module IV: Relays

(4 Hours)

Introduction, Electromechanical Relays, Static Relays – Merits and Demerits of Static Relays, Numerical Relays, Comparison between Electromechanical Relays and Numerical Relays.

Practice:

6. Designing of a Digital Relay

Module V: Relay Operations

(7 Hours)

Introduction, Time – Current Characteristics, Current Setting, Time Setting, Over current Protective Schemes, Reverse Power or Directional Relay, Protection of Parallel Feeders, Protection of Ring Mains, Earth Fault and Phase Fault Protection, Combined Earth Fault and Phase Fault Protective Scheme, Phase Fault Protective Scheme, Directional Earth Fault Relay, Static Over current Relays, Numerical Over current Relays.

7. Practice session to demonstrate relay effect and circuit breaker in ETAP

Module VI: Protection control systems

(5 hours)

Pilot Relaying Schemes: Introduction, Wire Pilot Protection, Carrier Current Protection

Numerical Differential Relays: Simple Differential Protection, Percentage or Biased Differential Relay, Differential Protection of 3 Phase Circuits, Balanced (Opposed) Voltage Differential Protection.

Rotating Machines Protection: Introduction, Protection of Generators

Transformer and Bus zone Protection: Introduction, Transformer Protection, Bus zone Protection, Frame Leakage Protection

Practice:

8. Design of Protection Scheme using MATLAB

Module VII: Circuit Breakers

(8 Hours)

Introduction, Fault Clearing Time of a Circuit Breaker, Arc Voltage, Arc Interruption, Re striking Voltage and Recovery Voltage, Current Chopping, Interruption of Capacities Current, Classification of Circuit Breakers, Air – Break Circuit Breakers, Oil Circuit Breakers, Air – Blast Circuit Breakers, SF6 Circuit Breakers, Vacuum Circuit Breakers, High Voltage Direct Current Circuit Breakers, Rating of Circuit Breakers, Testing of Circuit Breakers.

Practice:

9. Design & simulation of Circuit breaker using 3DS Tools

Project:

10. Analysis of critically operating power system using MATLAB/DYMOLA

Text Books:

1. Fundamentals of Power System Protection Y.G.Paithankar S.R. Bhide PHI 1 st Edition, 2009

Reference Books:

1. Power System Protection and Switchgear, BhuvaneshOza et al McGraw Hill 1 st Edition, 2010

System Modeling & Control

Code	Course Title	(Credit)	T-P-PJ
CUTM1053	System Modeling and Control	4	3-1-0

Course Objectives

- To teach how to convert a physical systems consist of mechanical and electrical system into a mathematical model.
- Analysis of a live system in time domain and frequency domain and application of controllers to get the desired response.

Course Outcomes

COs	Course outcomes
CO1	Able to gain Knowledge on the action of the controller and its application to control a system
CO2	Able to analyze the system and controller
CO3	Acquire skill in designing automatic control systems and controllers for a particular application such as P, PI, PID
CO4	Specify design in the S-plane in terms of settling time, rise time, and overshoot to step response
CO5	Use of software tools (MATLAB/DYMOLA) to design and validate the real-time 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	2	3				1			1	3	2	1
CO2	3	3	1	1	3							1	3	3	2
CO3	2	3	1	3	3							1	3	2	
CO4	3	2	1		3				3	1		2	2	2	2
CO5	3	3	1	2	3				2	1		2	1	1	2

COURSE CONTENT

Introduction to Control Systems: Basic Concepts of Control Systems, Open loop and closed loop systems; Servo mechanisms, Laplace transform, Transfer functions, Concept of Pole and Zero.

Practice: Hardware/MATLAB

1. Study of Temperature control system
2. Using MATLAB, find the poles, zeros, gain and draw the pole-zero plot of the transfer function.

Module II: System Dynamics

(10 Hours)

Mathematical Models of Physical Systems: Differential Equations of Physical Systems, Mechanical Translational Systems, Rotational systems, Electrical Systems, Analogy between Mechanical and electrical quantities, Derivation of Transfer functions, Block Diagram Algebra, Signal Flow Graphs and Mason's Gain Formula.

Practice: MATLAB

3. Using MATLAB, find the transfer function from the given block diagram.

Module III: Time Response Analysis

(8 hours)

Time Response Analysis: Type Test Signals, Time response of first-order systems to unit step and unit ramp inputs, Time Response of Second order systems to a unit step input, Time Response specifications, Steady State Errors, and Static Error Constants of different types of systems.

Practice: MATLAB/DYMOILA

4. Standard Test Signals
5. Time response of first-order systems to unit step and unit ramp inputs
6. Time Response of Second order systems to a unit step input
7. Using MATLAB, determine the steady state error of the given system.

Module IV: Stability in Time Domain

(4 Hours)

Stability in Time Domain: Stability and Algebraic Criteria, the concept of stability, Necessary conditions of stability, Hurwitz stability criterion, Routh stability criterion, and Application of the Routh stability criterion to the linear feedback system

Module V: Root Locus Technique

(5 Hours)

Root Locus Technique: Root locus concepts, Rules of Construction of Root locus, and Determination of Roots from Root locus for a specified open loop gain.

Practice: MATLAB

8. Construct the root locus for the 2nd & 3rd order system and analyze its stability (Gain)

Module VI: Frequency Response Analysis

(6 hours)

Frequency Response Analysis: Frequency domain specifications, correlation between Time and Frequency Response to second-order system, bode plot, Determination of Gain Margin and Phase Margin from Bode plot. Polar Plot, Nyquist Plot, and stability analysis

Practice: MATLAB

9. Construct the bode plot for 2nd and 3rd order system and analyze its stability (PM & GM)

Module VII: Controllers

(4 Hours)

Controllers: Concept of Proportional, Derivative, and Integral Control actions, P, PD, PI, and PID controllers.

Practice: MATLAB/DYMOLA

10. Design of P, PD, PI and PID Controllers for 2nd or 3rd order system

Text Books:

1. Saeed S. Hasan, "Automatic Control Systems," Kataria Publication, 9th Edition-2017.

Reference Books:

1. Nagrath J. and Gopal M., "Control Systems Engineering," New Age International Publishers, 6th Edition-2017.

Electrical Machines Operation and Control

Code	Course Title	T-P-PJ	Prerequisite
CUTM1054	Electrical Machines Operation and Control	3-1-0	Basic Electrical Engineering

Course Objective

<ul style="list-style-type: none"> • To introduce the students about principles of electromagnetism applied to alternating machines. • To familiarize the students about the fundamental laws that governs the operation of machines and to extend its application to synchronous generator and motors. • To introduce the students about the constraints associated with starting of Induction motors.
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Course Outcomes

COs	Course outcomes
CO1	Demonstrate comprehensive knowledge of electrical machines including emerging issues of different electrical machines (both
CO2	Able to analyze the principle of operation of different electrical machines and their controlling mechanism.
CO3	Able to solve the design problems related to DC & AC Generators, Motors, and Transformers.
CO4	Explore and comprehend the integration of electrical machines in renewable energy systems.
CO5	Use of software tools (MATLAB/DYMOLA) to design and validate the real-time 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	2	3				1			1	3	2	1
CO2	3	3	1	1	3							1	3	3	2
CO3	2	3	1	3	3							1	3	2	
CO4	3	2	1		3				3	1		2	2	2	2
CO5	3	3	1	2	3				2	1		2	1	1	2

COURSE CONTENT

Module-I: D.C. Machines (9 Hrs)

Theory

Construction, Classification, and Principle of operation of DC machines.

EMF equation of DC generator, Speed Equation of DC Motor. Characteristics for Speed Armature Current, Torque Armature Current, and Speed Torque of (i) Separately Excited DC Motor, (ii) DC Shunt Motor, (iii) DC Series Motor, and (iv) DC Compound Motor, Comparison between Different types of DC Motors.

Application- DC Generator, DC Motor-Types, Armature reaction of DC machines.

Practice:

- 1) Determination of OCC (Open Circuit Characteristics) of D.C Shunt Generator.
- 2) Starting & Speed Control of D.C Shunt motor by (i) Field flux control method & (ii) armature voltage control method.
- 3) Starting & Speed Control of D.C Series motor by (i) Field flux control method & (ii) armature voltage control method.

Module-III: Induction Motors (8 Hrs)

Theory

Principles of operation of induction motors, both single and 3-phase types. Torque-speed curves, Different types of single-phase motors

Three-Phase Induction Motor

Equivalent Circuit and Phasor Diagram, No-Load and Blocked Rotor tests, Determination of Parameters, Slip-Torque Characteristics Losses and Efficiency, Effect of rotor resistance, Starting and speed control methods, Cogging, Crawling and Electrical Braking of Induction Motors.

Applications of three & single-phase motors will assist in picking the right one for an application.

Practice:

- 5) Determination of parameters of a single-phase induction motor and study of (a) Capacitor start induction motor (b) Capacitor start and capacitor run induction motor
- 6) Determination of Efficiency, Plotting of Torque-Slip Characteristics of the three-phase Induction motor by Brake Test.
- 7) Load test of a three-phase slip ring induction motor.

Module-IV: Three-Phase Synchronous Generators (4 Hrs)

Theory

Construction, Principle, Coil Pitch, Distributed Windings in A.C. Machines, The Equivalent Circuit of a Synchronous Generator (Armature Reaction Reactance, Synchronous Reactance and Impedance). The Phasor Diagram of a Synchronous Generator, Power and Torque in Synchronous Generators (Power Angle Equation and Power Angle Characteristic)

Practice:

- 8) Plotting the open circuit and short circuit characteristics of the alternator.
- 9) Calculating the voltage regulation by synchronous impedance method.
- 10) Calculating the voltage regulation by zero power factor method.

Module-V: Parallel Operation of Three Phase AC Synchronous Generators (3 Hrs)

Theory

Synchronous condenser, Hunting, paralleling conditions, Procedure, Operation of Generators in Parallel with Infinite bus bar, Effect of excitation, effect of unequal voltage and steam power supply.

Practice:

- 11) Connection & verifying the conditions of parallel operation of alternators.
- 12) Verification of direct axis reactance, quadrature axis reactance
- 13) Load Sharing during parallel operation using Dymola.

Module-VI: Three-Phase Synchronous Motors (6 Hrs)

Theory

Basic Principles of Motor operation, Construction, Starting Synchronous Motors, Synchronous Motor Ratings, Equivalent circuit & phasor diagram, Effect of excitation on varying load, the power developed in a synchronous motor.

Applications of synchronous motors

Practice:

- 14) Study of universal motor and shaded pole motor.
- 15) Use of synchronous motor as a synchronous condenser for p.f improvement.

Module-VII: Single-Phase and Three-Phase Transformers (9 Hrs):

Theory

Construction and principle of operation, EMF Equation, Transformation ratio, Practical and Ideal transformers

Three Phase Transformers: Three-phase transformer connections- Star-star, Two Single-Phase Transformers connected in Open Delta (V-Connection) and their rating, Delta-star, Zig-zag connections. Scott connection, Auto Transformers, Welding Transformer.

Application of Single & Three Phase Transformer

Practice:

- 16) Prescribed tests of single-phase and three-phase transformers.
- 17) Load balancing in a three-phase distribution Transformer.
- 18) Simulation of open delta condition of Transformer.

MODULE II: Special Precision Machines (6 Hrs)

Theory

Stepper motor drive, basic principles involved in stepper motor control, stepper motor specification, operation and commercial driver chips and packages, Brushless DC Motors, Reluctance Motor, Hysteresis Motor

Application in Medical, Automobile, Civil, Electrical etc

Practice:

- 4) Motor Voltage and Current Measurement.
- 5) ON-Load Tap changer

TEXT BOOK:

1. Electrical Machines – D P Kothari and I J Nagrath, Fourth Edition – Tata McGraw Hill.

REFERENCE BOOKS:

1. Electrical Machinery – P S Bimbhra – Khanna Publishers.
2. Electrical Machines - P. K. Mukherjee, S. Chakravarti, Dhanpat Rai & Sons

Industrial Power Electronics

Code	Course Title	Credit	T-P-PJ
CUEE1011	Industrial Power Electronics	3	2-1-0

Course Objective

- They must meet the industrial requirement for power electronic engineers.
- They must gain adequate practical knowledge on power semiconductor devices, converters and their control techniques.
- They should know the typical applications to motor drives.

Course Outcomes

COs	Course outcomes
CO1	Understand the working of various power electronic circuits and components used in industrial applications
CO2	Analyze various analog controllers and signal conditioning circuits.
CO3	Design control circuits for UPS and other industrial applications.
CO4	Understand the workings of commonly used power converters.
CO5	Practice different various power converter systems using modern tools and software (MATLAB).

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	3				1			1	3	2	1
CO2	3	3	1	1	3							1	3	3	2
CO3	2	3	1	3	3							1	3	2	
CO4	3	2	1		3				3	1		2	2	2	2
CO5	3	3	1	2	3				2	1		2	1	1	2

COURSE CONTENT

Module I

(6hrs.)

Power Semiconductor Devices

Introduction to power electronics, uncontrolled switches, semi-controlled switches, fully controlled switches, constructional features, operating principle, characteristics and specification of power semiconductor devices, hard and soft switching of power semiconductor switches.

Practice: (Hardware)

1. V-I characteristics of power diode and power transistor.
2. V-I characteristics of MOSFET & IGBT.
3. V-I characteristics of silicon-controlled rectifier.

Module II

(3 hrs.)

Triggering Circuits

R- Triggering, R-C triggering, UJT triggering, design of UJT triggering circuit.

Practice: (Hardware/Software)

4. R and RC triggering.
5. UJT triggering

Module III

(8 hrs)

AC to DC Converter

Overview of rectifiers, half wave uncontrolled rectifier with R load and R-L load, use of freewheeling diode, half wave rectifier R-L load with FWD, full wave bridge uncontrolled rectifier, half wave-controlled rectifier with R load, R-L load and R-L load with free-wheeling diode, half controlled bridge rectifier, fully controlled bridge rectifier, effect of source inductance on the performance of ac to dc converters, power factor improvement, harmonic reduction, filter design.

Practice: (Hardware/Software)

6. Single-phase half-wave and full-wave diode rectifiers using R & L load.
7. Single phase fully controlled converter using R & L load.
8. Single phase semi converter using R-L load.
9. 3-phase semi converter with R, R-L, and dc motor load with/without freewheeling diode.
10. 3-phase bridge converter with R, R-L, and dc motor load with/without freewheeling diode.

Module IV:

(10 hrs.)

DC to DC Converter

Introduction to the chopper (Type A, B, C, D, E), switching techniques, step down dc chopper with R load, R-L-E load, step up dc chopper with R, R-L, R-L-E load, buck regulator, boost regulator, Buck-boost regulator, CUK and SEPIC converter, commutation of thyristor-based circuits part-I, commutation of Thyristor-based circuits part-II, introduction to SMPS circuits, fly back type SMPS, forward type SMPS, design of a transformer for SMPS circuits.

Practice: (SOFTWARE)

11. Simulation of buck converter.
12. Simulation of boost converter.
13. Simulation of buck-boost converter.

Module V

(6 hrs.)

DC to AC Converter

Introduction to inverters, importance and application of inverters, single phase half bridge inverter with R and R-L load, single phase bridge inverter with R and R-L load, three-phase inverters, control techniques of the inverter, single/multiple pulse width modulation, sinusoidal pulse width modulation and its realization, CSI, load-commutated CSI, industrial inverter.

Practice: (SOFTWARE)

14. Simulation of single-phase inverter & three-phase inverter.

Module VI

(3 hrs.)

AC to AC Converter

AC voltage controller: Single-phase bi-directional controllers with R and R-L load, single-phase cyclo-converters.

Practice: (SOFTWARE)

15. Simulation of single-phase AC voltage controller & cyclo-converter.

Module VII

(9 hrs)

Application of Power Electronics Converters

Analysis of converter dc drives, analysis of chopper dc drives, analysis of VSI, CSI-fed induction motor drives, automotive & traction systems, industries such as rolling mills, pumps, elevators, utility systems such as FACTs, smart grid, and renewable energy such as a wind turbine.

Practice: (SOFTWARE)

16. Simulation of converter-fed DC drives (Wind Turbines).
17. Simulation of chopper-fed DC drives (PV Systems).
18. Simulation of induction motor drives (e-Vehicle).
19. Simulation of railway electrification system using Dymola

Project

1. 500 VA Sine wave Inverter
2. Industrial Battery Charger using SCR
3. Precision Illumination control of Lamp
4. Dual Converter using Thyristors

Text Books:

1. M. H. Rashid, "Power Electronics: Circuits, Devices and Applications," 4th Edition, Pearson, 2017
2. M. D. Singh & K. B. Khanchandani, "Power electronics", 2nd Edition, Tata McGraw-Hill, 2008

Reference Books:

1. J. Vithayathil, "Power Electronics: Principles and Applications", 2nd Edition TMH Edition, 1995
2. Mohan, Undeland and Robbins, "Power Electronics: Converters, Applications and Design" 3rd Edition, 2007

Digital Measurement and Instrumentation

Code	Course Title	Credit	T-P-PJ
CUTM1056	Digital Measurement and Instrumentation	3	2-1-0

Course Objective

- To understand the fundamentals of Digital instruments
- To explain the operation, performance, and application of Digital Measuring Instruments
- To choose appropriate digital instruments for the measurement of frequency, time period, harmonics, voltage, current, and other electrical quantity.

Course Outcomes

- Gain Knowledge of the Digital Measurement principle and its application to small-time interval measurement.
- Analyze the mathematical modeling of time Interval and frequency Measurements
- Implement different Software-Controlled (MATLAB) tools to validate the theory and practical studies
- Select and use different Digital Voltage Measurement Techniques and equipment in digital measurement
- Recognize the use of different recording instruments and Signal generators in the process of digital measurement

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	3				1			1	3	2	1
CO2	3	3	1	1	3							1	3	3	2
CO3	2	3	1	3	3							1	3	2	
CO4	3	2	1		3				3	1		2	2	2	2
CO5	3	3	1	2	3				2	1		2	1	1	2

COURSE CONTENT

Module I

(6 hrs)

Digital Instrument

Need for digital instruments, Advantages of digital instruments, Essentials of digital instrument, Performance characteristics of digital instrument.

Philosophy of digital measurements

Time Measurement Techniques: Error analysis in digital measurement, Measurement of time interval between two events, Error in time interval measurement, Vernier technique for small time measurement, Measurement of time interval with constraints, Measurement of periodic time, phase, Quality factor of ringing circuit, Decibel meter, Software controlled measurement.

Practice

1. Error analysis of digital measurement using Matlab
2. Simulation of Quality Factor of ringing circuit

Module II

(5 hrs)

Digital frequency measurement techniques

Measurement of frequency, Ratio of two frequencies, Product of two frequencies, High frequency, average Frequency difference, Deviation of power frequency, Peak frequency. Fast low-frequency measurement, Digital Tachometer.

Practice

3. Addition and product of different frequencies using Matlab
4. Simulation of digital tachometer using Matlab
5. Simulate the digital tachometer sensor that generates pulses as the motor rotates

Module III

(5 hrs)

Digitally Programmable Circuits

Single mode switching, Group mode switching, Resistors, Potentiometers, Amplifiers, Schmitt trigger, Dual polarity gain amplifiers. Programmable gain amplifier with dual output, Two-stage programming, Programmable Biquads.

Practice:

6. Analysis of switching using Matlab
7. Simulation of programmable biquads using Matlab
8. Design and simulation of a Programmable Gain Amplifier (PGA) with dual output

Module IV

(4 hrs)

Digital to Analog Converters

Output Input relation, DACs derived from programmable gain amplifiers, Weighted-resistor DAC, Weighted current DAC, Weighted reference voltage DAC, Ladder DAC, Switches.

Practice:

9. Simulation of programmable gain amplifier using Matlab
10. Simulation of DAC using Matlab

Module V

(5 hrs)

Digital Voltage Measurement Techniques

Sampling theorem, Time-division multiplexing, Quantization, Indirect type A/D converters, Direct type A/D converters, Input circuitry of a digital voltmeter.

Practice:

11. Simulation of Digital voltmeter using Matlab
12. Analysis and simulation of digital multi-meter.

Module VI

(4 hrs)

Digital Recording Systems

Input Conditioning Equipment, Digitizer, Multiplexer, Programme Pinboard, Linearizer, Digital Clock, Limit Detectors, Output Devices

Practice:

13. Data fetching using controllers
14. Simulation of digital clock using Matlab
15. To create a programmable pinboard in MATLAB that allows users to place, move, and manage pins on a 2D grid.

Module VII:

(4 hrs)

Signal Generator, Analyzers, and Oscilloscopes:

Function Generator, Pulse Generator, RF Signal Generator, Harmonic Distortion Analyzer, Spectrum Analyzer, Digital Storage CROs

Practice:

16. To study block-wise Construction of a Function Generator
17. Measure Voltage, Frequency, Phase, and Modulation Index using CRO

Text Books:

1. T. S. Rathore- Digital Measurement Techniques, Alpha Science International Ltd
2. David A. Bell - Electronic Instrumentation and Measurements, Oxford Univ. Press, 1997
3. K. Sawhney – A Course in Electrical and Electronic Measurements and Instrumentation, Dhanpat Rai & Co

Reference Books:

1. PrithwirajPurkait- Electrical and Electronics Measurement and Instrumentation, MC Graw Hill Publishers
2. H.S. Kalsi-Electronic Instrumentation, Tata McGraw-Hill, New Delhi, 2010
3. R. K. Rajput- Electrical & Electronic Measurement and Instrumentation, S. Chand Publication
4. K. Lal Kishore- Electronic Measurements and Instrumentation, Pearson Education 201

Basic Electrical Engineering

Code	Course Title	(Credit)	T-P-PJ
CUEE1010	Basic Electrical Engineering	3	2-1-0

Course Objective

- In this course, student will come to know about the Basics of Electrical Engineering, Currents and Voltages across various Electrical elements.
- Their behavior in both Alternating Current and Direct Current circuits.
- Analysis of 1-phase and 3-phase AC wave forms.

Course Outcomes

COs	Course outcomes
CO1	Understand and apply scientific and mathematical principles to solve fundamental problems in their branch of engineering.
CO2	Analyze and solve complex electrical and magnetic circuits, demonstrating the ability to break down problems and apply appropriate methodologies.
CO3	Utilize software tools (MATLAB/DYMOLA) to design, simulate, and validate real-time engineering problems, demonstrating proficiency in technology and software applications.
CO4	Collaborate effectively in teams to identify, research, and develop solutions for real-time engineering problems, fostering teamwork and communication skills.
CO5	Innovate and implement new design thinking strategies to approach and solve real-time engineering challenges, encouraging creativity and critical thinking.

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	3				1			1	3	2	1
CO2	3	3	1	1	3							1	3	3	2
CO3	2	3	1	3	3							1	3	2	
CO4	3	2	1		3				3	1		2	2	2	2
CO5	3	3	1	2	3				2	1		2	1	1	2

COURSE CONTENT

Module I: Basic Concepts and Basic Law

(5 hrs)

Theory

The essence of Electricity, Electric Field; Electric Current, Potential and Potential Difference, E.M.F., Electric Power, Ohm's Law, Basic Circuit Components, Ideal and Practical Sources, Source Conversion, Renewable and Non-renewable energy sources.

Practice:

1. Design and Analysis of Basic electrical circuits using Dymola. Plotting the V-I Characteristics of Resistive Load using both Hardware and Dymola/MATLAB.

Module II: Methods of Circuit Design

(4hrs)

Theory

Circuit Design using Series and Parallel and Hybrid, Voltage and Current Divider Circuits.

Practice: (Hardware and Software)

2. Design of house wiring/switchboard connections using Series and Parallel.
3. Verification using Series and Parallel using MATLAB/Dymola

Module III: Method of Circuit Analysis

(3hrs)

Theory

KVL and KCL, Nodal Analysis, Superposition theorem,

Practice: (Software)

4. Verification of Nodal, Mesh using Dymola/MATLAB.
5. Verification of KCL and KVL in series and parallel circuits using Dymola/MATLAB.
6. Verification of Superposition theorem in series and parallel circuits using Dymola/MATLAB.

Module IV: Introduction to Electromagnetism

(4hrs)

Theory

Magnetic Circuits, B-H curve, Permeability, Reluctance, Solution of simple magnetic circuits, Hysteresis and Eddy current loss. Methods of preventing such losses. Solenoids and field coils. Application of solenoids in different circuits in Automobiles and in an electric circuit.

Practice (Hardware):

7. Observation of generation of magnetic flux for different input currents in a coil and plotting B-H Curve.
8. Application of Magnetic Circuit in Solenoid

Module V: Single-Phase Transformer

(2hrs)

Practice (Hardware):

9. Design of Small Transformers (230Volt to 12Volt), Linear Transformer Model, Ideal Transformer Model, No-load, Loss and Load-loss Calculation.

Module VI: AC Circuit Analysis

(3hrs)

Theory

Single-phase EMF Generation, Waveform and Phasor Representation, Average and Effective value of sinusoids, Peak factor & Form factor, Complex Impedance and Power using j-operator, Power factor.

Practice: (Hardware and Software)

10. Calculation of current, voltage, power & power factor of series RLC circuit excited by 1- \emptyset A.C Supply using Dymola/MATLAB.
11. Design of Small AC Generator using Magnets.

Module VII: Phasor Analysis

(3hrs)

Theory

Three-Phase AC Circuits: Comparison between single-phase and three-phase systems, Three-phase EMF Generation, Line and Phase quantities in star and delta networks, Power and its measurement in three-phase balanced circuits.

Practice: (Hardware and Software)

12. Measurement of power and power factor in a 3- \emptyset AC circuit by (one, two and three) wattmeter using Dymola/MATLAB.

Recommended Books:

1. P. K. Sathpathy, "Basic Electrical Engineering," 3rd Edition, Oxford.
2. B. L. Thereja, "Electrical Technology", Volume-I, 2005 Edition (24th Revised Edition)
3. Hughes, "Electrical & Electronic Technology", Ninth Edition (Revised by J Hiley, K Brown, and I Smith), Pearson Education

Basket - V (Domain)

Sl.No.	Course Title	Credits	Type T+P+PJ
1	Renewable Energy Applications	4+8+10	22
2	Operation and Maintenance of Electrical Grid System & Transformers	6+14+4	24
3	Industrial Automation	5+9+10	24
4	Embedded System Design	4+10+6	20
5	Communication Systems Domain	4+8+6	18
6	Chip Design and Fabrication Using VLSI	6+8+6	20
7	GTM – Domain	4+10+8	22
8	Automobile Engineering	7+9+8	24
9	Manufacturing (Conventional, CNC and Additive)	2+14+10	26
10	Welding and Inspection	8+8+6	22
11	Computational Fluid Dynamics	2+10+8	20
12	Composite Design and Manufacturing	6+12+6	24
13	Architectural and Structural Design	0+15+5	20
14	Aerial Surveying and Remote Sensing Applications	4+10+4	18
15	Construction Planning, Monitoring And Project Management	4+6+6	16
16	Data Science and Machine Learning	2+9+15	26

17	Software Technology	0+9+11	20
18	Cloud Technology	4+8+6	18
19	Cyber Security	6+10+4	20
20	Gaming and Immersive Learning (AR & VR)	5+5+10	20

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:

- | |
|---|
| <ul style="list-style-type: none"> • To gain the knowledge on different types of materials used in Renewable Energy. • To understand the importance of Renewable Energy technology and its applications. • To know the applications of solar thermal technology. |
|---|

Domain Track Course Outcomes

COs	Course Outcomes
CO1	Able To gain the knowledge on different types of materials used in Renewable Energy.
CO2	To know the applications of solar thermal technology, off-grid , on-grid and hybrid renewable energy systems.
CO3	To become an expert in Entrepreneurship.
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:

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	2	3	3				2	1		2	3	2	1
CO 2	3	3	1	3	3				1			1	3	3	2
CO 3	2	3	1	3	3				2	1		3	3	2	3
CO 4	3	3	1	3	3				1			3	2	2	2
CO 5	3	3	1	3	3				1			3	1	1	2

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

1. Material for Renewable Energy application (30 hrs)

- 1.1 Basic fundamentals of different types semiconductors (Energy band, charge carriers and their motion, generation, recombination, doping)
- 1.2 Practice: Crystal structure, phase identification and crystallite size determination of PV materials by XRD (using Biovia MS and phase identification by using relevant software)
- 1.3 Photovoltaic Cell - Construction & Working (Si based)
- 1.4 Practice: UV visible analysis of photovoltaic material
- 1.5 Concept of various types PN junction.
- 1.6 Practice: Measurement of photo luminescence (PL) behaviour of photovoltaic material
- 1.7 Role of materials for sustainable development of next generation photovoltaic cells
- 1.8 Practice: To study crystallites (grain) size and strain through *Williamson-Hall plot* method
<https://www.youtube.com/watch?v=LJ9h77fN4-E&t=1308s>
- 1.9 Efficiency calculation of solar cell
- 1.10 Practice: To determine the resistivity of semiconductors by Four probe Method.
<http://vlab.amrita.edu/?sub=1&brch=282&sim=1512&cnt=1>
- 1.11 Nano-Photovoltaic (Graphene/CNT, ZNO, 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, Jawaid, Mohammad, Rashid, Umer (Eds.), Biomass and Bioenergy Applications, Springer, 2014.
3. S. S. Das, D. D. Behera, and A. Pradhan, Clean Energy Products: A Path for Attaining Livelihood Security, Notion Press, and ISBN: 9781636691602, 2020.
4. S. S. Das, D. D. Behera, and N. C. Giri, Clean Energy Applications in Modern World, Notion Press, ISBN: 9781638069560, 2021.

3. Micro-grid Design and Implementation (36 hrs)

- 3.1 Practice: Site survey (1 kW or 1MW)

- 3.2 Practice: Sizing of micro grid system (1kW/1MW)
- 3.3 Practice: Single line diagram of micro grid system
- 3.4 Practice: Identify and specify different components used in a micro grid system
- 3.5 Practice: Connection practice of solar modules in a micro grid system
- 3.6 Practice: Designing of micro grid system
- 3.7 Practice: Analysis of micro grid system
- 3.8 Practice: Designing of micro grid system with battery storage
- 3.9 Practice: Performance calculation of micro grid system
- 3.10 Practice: Connection practice of CCR/Inverter in a micro grid system
- 3.11 Practice: Test, record and verify the power quality of a micro grid system
- 3.12 Practice: O & M of micro grid system

Text Books:

1. Suneal Deambi, Photovoltaic System Design: Procedures, Tools and Applications, CRC Press, 2018.
2. Miguel Castilla, Antonio Carlos Zambroni de Souza, Microgrids Design and Implementation, Springer, 2019.

Reference Books:

1. S. S. Das, D. D. Behera, and N. C. Giri, Clean Energy Applications in Modern World, Notion Press, ISBN: 9781638069560, 2021.
2. Federico Delfino, Renato Procopio, Massimo Brignone, Michela Robba, Mansueto Rossi, Stefano Bracco, Microgrid Design and Operation: Toward Smart Energy in Cities, Artech House, London, 2018

4. Hybrid Renewable Energy System (48 hrs)

- 4.1 Global scenario of Hybrid renewable energy system, integrated renewable energy systems with input sources
- 4.2 Practice: Modelling of renewable energy systems
- 4.3 integrated renewable energy systems with input sources
- 4.4 Practice: Connection practice of Solar PV-T System
- 4.5 Selection of technology and components for hybrid renewable systems.
- 4.6 Practice: Designing of solar PV system (On-grid/Off-grid)
- 4.7 Concept of hybrid solar PVT system
- 4.8 Practice: Designing of hybrid solar-thermal system
- 4.9 Selection of Components for Hybrid solar PV-T system
- 4.10 Practice: Analysis of hybrid solar-thermal system
- 4.11 Synchronization process of renewable systems.
- 4.12 Practice: Connection practice of PV-wind system
- 4.13 Operation of hybrid PV and wind system
- 4.14 Practice: Modelling of wind power system
- 4.15 Concept of hybrid PV and wind system and its components
- 4.16 Practice: Demonstration of Load curve in the plant
- 4.17 Load curve
- 4.18 Practice: Study the dynamic behavior of wind turbines
- 4.19 Concept of Hybrid PV and hydro system and its components
- 4.20 Practice: Modelling of hydro power system
- 4.21 Concept of hybrid PV and Biomass system and it's components
- 4.22 Practice: Chemical composition of biomass system
- 4.23. Practice: Emission testing of bio diesel/bio ethanol in gas analyzer

Text Books:

1. S. Sukhatme and J. Nayak: Solar Energy: Principle of Thermal collection and storage, Third Edition (Tata McGraw-Hill, 2008)
2. C. S. Solanki: Solar Photovoltaic – Fundamentals, Technologies and Applications, PHI.

Reference Books:

1. Ersan Kabalci, Hybrid Renewable Energy Systems and Microgrids,
2. V. N. Kishore, Renewable Energy Engineering and Technology: principles and practice, Teri, India, 2008.
3. N. C. Giri, S. R. Nayak, S. P. Mishra, and S. N. Sahu, Project Management and Smart Electrical Systems, ISBN 9798587652200, Amazon; 1st edition, 27 December 2020.

5. Solar Off-grid Entrepreneur (30 hrs)

- 5.1 MNRE schemes and state wise subsidy process
- 5.2 Practice: Identify and specify different types of Solar PV Off grid products
- 5.3 Cost of different solar off grid systems components
- 5.4 Practice: Costing sheet preparation
- 5.5 Selection criteria of suitable components
- 5.6 Practice: Proposal preparation with payment terms and condition
- 5.7 Assessment of business development
- 5.8 Practice: Analysis and assessment of project cost
- 5.9 Economic profile and power consumption trends
- 5.10 Practice: Customer financial strength calculation
- 5.11 Government and private bank funding systems
- 5.12 Practice: Identify the customer requirements for solar home lightening systems
- 5.13 Solar off grid system manufacturers and suppliers
- 5.14 Right equipment should be installed in right place
- 5.15 Attend and resolve customer queries
- 5.16 Entrepreneurship skill

Text Books:

1. Rameshwari Pandya, Skill Development and Entrepreneurship in India, 2016.
2. Joseph P. Oconeor, 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=a9fSq2TREag>

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=lxFlewx54Ok>

<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 it's system

Session 20. Basics of light to energy conversion and Concept on solar PV

<https://youtu.be/vzBkgMONIFo>

<https://youtu.be/1qta2ICarDw>

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_DF14O6v4

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-Ysq6Xaf3c>

<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 it's 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 it's components

<https://youtu.be/rPm-JHeD5Z0>

Session 64. Practice: Connection practice of PV-wind system

<https://www.youtube.com/watch?v=eIZsUKcq3tw&t=9s>

Session 65. Operation of hybrid PV and wind system

<https://youtu.be/s458bCl8u2Q>

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_4ogFmc

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 it's components

<https://youtu.be/9qu5ryJBIIIE>

Session 70. Practice: Modelling of hydro power system

<https://www.youtube.com/watch?v=qdOaG8cKLuw>

Session 71. Concept of hybrid PV and Biomass system and it's 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=xlXZmNUYcfI>

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:

	PO 1	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.

- CUED2100 Power Scenario, Power Quality & Generation System [2-2-0]
- CUED2101: Switchyard & Substation Types upto 33kV, [2-1-0]
- CUED2102: Cable, Switchgear, Protection system [2-2-0]
- CUED2103: Transformer Manufacturing, and Testing [1-6-0]
- CUED2104: 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, NBL(S(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 arrestor 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	Type T-P-PJ
CUIA2100	Introduction to Industrial Automation	1	1-0-0
CUIA2101	Advanced Programming & Control Blocks of PLC	3	1-2-0
CUIA2102	Control & Signal Wiring of PLC	2	0-2-0
CUIA2103	SCADA-based advanced features	2	1-1-0
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:

	PO 1	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

<ul style="list-style-type: none"> • 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)

1. Introduction to Embedded System
2. Embedded System Development Life Cycle
3. Introduction to ARM
4. AMBA & AHB
5. Features of ARM7, ARM9, ARM 11, ARM Cortex
6. Datasheet analysis
7. GPIO programming – LED, Seven Segment Display, LCD, Matrix keypad, Actuators(Relay, Motors and valves)
8. System control block-
9. ADC & DAC -- Sensors(Analog and Digital),
10. Timer/Counter
11. Pulse Width Modulation(PWM)
12. Vectored Interrupt Controller(VIC)
13. Real Time Clock (RTC)
14. Watch Dog timer (WDT)
15. Debugging with JTAG
16. Inter System Protocols – UART, USART, USB, Bluetooth, BLE, GPS, GSM
17. Intra System Protocols – I2C, SPI, CAN
2. 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

- | |
|--|
| <ul style="list-style-type: none"> • 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.
4. Merrill I skolnik, "Introduction to Radar Systems", McGraw Hill, 2nd Edition, 2007.
5. G S N Raju, "Radar Engineering and Fundamentals of Navigational Aids", IK international Publishers, 2008
6. G S N Raju, "Microwave Engineering ", IK international Publishers, 2008.
8. 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, Tommaso 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. Uyles Black "Optical Networks ", Pearson Education , 2011.
3. Holger Karl and Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley, 2005
4. KazemSohraby, Daniel Minoli, &TaiebZnati, "Wireless Sensor Networks-Technology, Protocols, and Applications", John Wiley, 2007.
Anna Hac, "Wireless Sensor Network Designs", John Wiley, 2003

Reference books:

1. Rajiv Ramswami and K. N. Sivarajan, "Optical Networks", Morgon Kauffman 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
	TOTAL CREDITS	T-P-PJ (4-10-8)	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:

- | |
|---|
| <ul style="list-style-type: none"> • 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	1.7Final functional and logical design of integrated product in system engineering with simulation.
Session	8	1.8CATIA Drawing with Styling (Full product drawing) (Gate 2)
Session	9	1.9Digital 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	1.3Market analysis of existing products and finalizing the product specification and preparing a project plan
Practice(2h)	3	Review (Gate 0)
Practice(2h)	4	1.5Design Parameter Optimization in Dymola
Practice(2h)	5	1.6Designing and simulating system and subsystem of the product using system Engineering Dymola
Practice(2h)	6	Review (Gate 1)
Practice(2h)	7	1.7Final functional and logical design of integrated product in system engineering with simulation.
Practice(2h)	8	1.8CATIA Drawing with Styling (Full product drawing) (Gate 2)
Practice(2h)	9	Review
Practice(2h)	10	1.9Digital 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- modellica 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- modellica 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=gVlvp1RDi2s
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(2 h)	12	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:

<ul style="list-style-type: none"> • 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.
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Domain Track Course Outcomes:

Cos	Course Outcomes
CO1	Students will gain knowledge about the construction and working of different systems and subsystems of automobile.
CO2	They will be able to disassemble and assemble major aggregates of the automobile
CO3	Students will be able to do vehicle trouble shooting

COURSE OUTCOME TO PROGRAM OUTCOME MAPPING:

	PO 1	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

Introduction to Automobile Engineering

Course Title	Course Code	Type of Course	T-P-Pr	Pre-Requisite
Introduction to Automobile Engineering	CUAE2170	Theory+Practice	2-1-0	Nil

COURSE CONTENT

Module I 3 (hrs)

Automobile Architecture: Definition and Classification of Automobiles, Major Units of the Automobile, Types of Automobile Layouts, Automobile Chassis Types and Components, Automobile Body Types and Components, Automobile Safety Parameters.

Module II 6 (hrs)

Engine: Classification of Engine, Engine Nomenclature, Components of Engine, Valve Timing Diagram of SI & CI Engines, Variable Valve Timing, Working Principles of Modern Engine Combustion Technologies (CRDI, GDI, HCCI, Dual Fuel Engine, Stratified Charge Engine.

Practice

- Valve Timing Diagram of SI Engine.
- Valve Timing Diagram of CI Engine.

Module III 5 (hrs)

Carburetion: Air-Fuel Ratio, Mixture Requirements for Different Load Conditions, Factors Affecting Carburetion, Principle of Carburetion, Limitations of Simple Carburettor, Additional Systems in Carburettor, Concept of Electronic Carburettor.

Practice

- Model Study of a Solex Carburettor

Module IV 5 (hrs)

Fuel Injection: Classification of Injection Systems, Fuel Feed Pump, Injection Pump, Injection Pump Governor, Fuel Injector, Nozzle, Electronic Injection Systems, Multi-Point Fuel Injection (MPFI) System, Direct And Indirect Fuel Injection.

Practice

- Study of Fuel Injection System of a Diesel Engine.

Module V 5 (hrs)

Transmission System: Layout of Power Flow from Engine to Wheels, Brief Construction and Working Principles of - Clutch, Transmissions, Propeller Shaft, Final Drive and Differential, Front and Rear Axles.

Practice

- Study of Transmission System of Automobile.
- Model Study of Differential of Automobile.

Module VI 5 (hrs)

Cooling and Lubrication System:

Direct Air Cooled and Indirect Liquid Cooled Cooling Systems, Types and Components of Liquid Cooled Cooling System, Engine Coolant and Antifreeze Solution, Desired Properties of Lubricants, Classification, Construction, Working Principles and Components of Various Types of Lubricating Systems.

Practice

- Model Study of Air Cooling System.
- Model Study of Liquid Cooling System.

Module VII

4 (hrs)

Super Charging & Turbo Charging: Naturally Aspirated and Forced Induction Engine, Effect of Forced Induction, Method of Supercharging, Types of Super Chargers, Basic Principle and Method of Turbo Charging, Types of Turbo Charging, Concept of Variable Geometry Turbocharging.

Practice

- Study of Working Model of Supercharger
- Study of Working Model of Turbocharger.

Text Books

1. Gupta R. B., Automobile Engineering, Satya Prakashan, New Delhi.
2. Giri N. K., Automobile Technology, Khanna Publishers.

References

1. Gupta H. N., Fundamentals of Internal Combustion Engines, PHI Learning.

Subsystems of Automobile

Course Title	Course Code	Type of course	T-P-Pr	Pre-Requisite
Subsystems of Automobile	CUAE2171	Theory + Practice	3-2-0	Nil

COURSE CONTENT

Module I

6 (hrs)

Engine Emissions: Sources of Air Pollution from Automobiles and Their Control, Crank Case Emission Control System, Evaporative Emission Control System, Exhaust Emission Control System: Air Injection, EGR, Catalytic Converters, Selective Catalytic Reduction (SCR) Technology, EURO/Bharat Stage Norms: I, II, III, IV, V And VI, Road Map for Implementation of Bharat Stage Norms In India.

Practice

- Identification of Different Sub-Systems of Automobile.
- Studies of Exhaust Gas Recirculation System (EGR) in KNOW Vehicle.

Module II

5 (hrs)

Ignition System: Effect of Spark Timing on Emission and Ignition Timing Controls, Drawbacks of Conventional Ignition Systems, Electronic Ignition Systems (TCI And CDI), Engine Cylinder Numbering Scheme and Firing Order of Multi Cylinder Engines.

Practice

- Study of Battery Ignition and Magneto Ignition System.

- Disassembly and Assembly of 6-Cylinder Diesel Engine

Module III

8 (hrs)

Transmission System: Power Transmission in Automobile (Front Wheel Drive, Rear Wheel Drive, Four-Wheel Drive, All-Wheel Drive).

Clutch System: Key Design Considerations of Clutches, Types of Clutches, Construction and Working Principle of Single Plate Friction Clutch, Diaphragm Clutch, Cone Clutch, Centrifugal Clutch.

Gear Box: Purpose of Gear Box, Types of Automobile Gear Boxes, Construction and Working Principle of Sliding Mesh, Constant Mesh, Synchronizer Mechanism and Synchromesh Gear Boxes, Planetary Gear Mechanism, Fluid Coupling and Torque 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
1. Giri N. K., Automobile Technology, Khanna Publishers

References

1. Crouse William H and Donald Anglin, Automotive Mechanics, Tata Mcgraw Hill Publications.
1. 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-Hydride (Nimh) Battery, Lithium Batteries, Battery Parameters, Fuel Cells,

Practice:

- Maintenance of Lead Acid Batteries.
- Wiring & Harnessing of Battery Circuit.

Module IV **8 (hrs)**

Electric Motors: Classification of Electric Motors, DC Motor, Types of DC Motors, Brushless DC Motor, AC Motor, Types of AC Motors, Induction Motor, Synchronous Motor, Regenerative Braking.

Practice:

- Study of Different Parts of D.C. Motor and Make Connection.
- Performance Characteristics of a Shunt and Series DC Motor
- Load Test on Three Phase Induction Motor.
- Speed Control of DC Shunt Motor by Armature and Field Control.

Module V

5 (hrs)

Electric Vehicle Maintenance & Safety: Maintenance & Trouble Shooting of Different Components of EV, High Voltage Electrical Safety, Tool and Equipment Usage, High Voltage Safety Rules, Electrical Isolation.

Practice:

- Maintenance of BLDC Motor.
- Maintenance of Hub Motor.

Module VI

3 (hrs)

Design Concept of Electric Vehicle: Power and Torque Calculation of Electric Vehicles, Sizing of Components, Initial Acceleration, Maximum Velocity, Maximum Gradability.

Module VII

3 (hrs)

Hybrid Electric Vehicles: Types of Hybrids, Series and Parallel HEVs, Advantages and Disadvantages, Series-Parallel Combination, Hybrid Drivetrains, Sizing of Component

Text Books

1. Hussein Iqbal, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press
1. 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
CO1	Knowledge to do machining effectively & Efficiently.
CO2	Able to identify and solve problems in product machining.
CO3	Use of advanced CAD & CAM software
CO4	Research in advancement in machining

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.
1. Nagpal, G R, Tool Engineering & Design, 2000, Khanna Publishers.

Reference Books

1. Venkataraman, K, Design of Jigs, Fixtures & Press Tools, 2015, Wiley & Sons
1. Mehta, N K, Metal Cutting and Design of Cutting Tools, Jigs & Fixtures, 2015, McGraw Hill

Conventional Machining for Cylindrical and Prismatic Shape Components (75 Hrs)

Course Title	Course Code	Type of course	T-P-Pr	Pre-Requisite
Conventional Machining for Cylindrical and Prismatic Shape Components	CUCM2151	Practice+ Project	0-4-2	

COURSE CONTENT

Course Outline

1. Cylindrical Turning Operations (Both Internal and External), Knurling, Thread Cutting, Stepped Turning)
2. Kinematic Study of Centre Lathe
3. Hole Making Operation in Turret Lathe
4. Work Holding and Tool Holding Devices For Turning Operations
5. Kinematic Study of Pillar Drilling Machine, Radial Drilling Machine and Boring Machine
6. Counter Boring , Counter Sinking and Threading Operations
7. Finishing Operations
8. Kinematic Study of Shaping Machines and Planning Machine
9. Work Holding and Tool Holding Devices Used for Shapers, Planers and Grinders
10. Machining Operations Using Flat Grooves, Flat and Bevel Surfaces, Dovetailed Surfaces
11. Kinematic Study of Horizontal Milling Machine, Vertical Milling Machine
12. Surface Grinding Machines
13. Work Holding and Tool Holding Devices Employed in Milling Machines
14. Flats, Grooves, Slots and Keyways Cutting Using Milling Machine
15. Gear Cutting Using Milling Machine
16. Process Planning of Prismatic Components, Logical sequencing of Operations
17. Estimation of Machining Operations Time and Cost

Text Books

1. Rajput, R K, A Text Book of Manufacturing Technology, 2007, 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 Publisers.
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 Fundamentals, Machine Structure, Machine Control Panel, Machine Input and Output Parameters.

Module III EDM Process Parameters (5 Hrs)

Machining Parameters, Plotting of Output graphs, Machining of Brass and Bright Steel. Performance Characteristics, Dielectric Fluid.

Module IV Additive Manufacturing (10 Hrs)

Concept, Rapid Prototyping Process, Various Rapid Prototyping Technologies: SLA, LOM, SLS and FDM.

Module V 3D Printing (10 Hrs)

Fundamentals of 3D Printing, Machine structure and its Controller. Advantage, Disadvantage and its Applications, Performance Evaluation.

Text Books

1. Pandey, P C, Modern Machining Processes, 2008, McGraw Hill
2. Jain, V K, Advanced Machining Processes, 2010, Allied Publishers

Reference Books:

1. Abdel, H, Advanced Machining Processes: Nontraditional and Hybrid Machining Processes, 2005, McGraw Hill
2. Rao, P N, Manufacturing Technology, Volume 1, 2009, Tata McGraw Hill Publication.

Wood Engineering (25 Hrs)

Course Name	Code	Type of course	T-P-P	Prerequisite
Wood Engineering	CUCM2154	Practice	0-2-0	Nil

COURSE OUTLINE

1. Introduction, Safety and serviceability, Measurements & Marking
2. Identification of Timber & Hand Tools
3. Maintenance & Sharpening of Tools, Fasteners Carpentry hand tools and their maintenance.
4. Wood joints and Structural assemblies
5. Advanced Tools in Tool Engineering (Basic working principles and Operations)

6. Product Development: Interior Designs, Furniture, Structures & construction.

Text Books

1. Williamson, T G, Wood Engineering and Construction Handbook, 2016, McGraw Hill.
2. Garg, S K, Comprehensive Workshop Technology (Manufacturing Processes), 2008, Laxmi Publications.

Reference

1. John, K C, Mechanical Workshop Practice, 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:

<ul style="list-style-type: none"> • 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	CUWII260	Theory+Practice + Project	2-2-2	Nil

COURSE CONTENT

Module-I (29 Hours)

Welding classification, advantages, disadvantages and applications of various welding processes, Gas Welding & Cutting: Oxy-acetylene welding, flux and filler, types of gas flames, Gas welding techniques, Arc welding: Physics of arc welding, SMAW Principle and equipment, types of electrodes, functions of coatings, TIG (GTAW), MIG (GMAW) & flux-cored arc welding, submerged arc welding, weld cladding & surfacing, plasma cutting and spraying, atomic hydrogen welding.

Practice:

1. Identification and working of gas welding equipment
2. Identification and working of gas cutting equipment
3. Identification and working of arc welding equipment
4. Identification and working of TIG welding equipment
5. Identification and working of MIG welding equipment

Module-II (28 Hours)

Resistance Welding: Spot and seam welding parameter, flash butt welding, friction welding, explosive welding, thermit welding of rails, electro-slag welding, electro-gas welding, stud welding, projection welding. Other Welding Methods like plasma arc, laser beam, electron beam, ultrasonic, explosive welding, under water welding, high frequency induction welding.

Practice:

1. Identification and working of spot welding machine parts

MODULE-III (26 Hours)

Welding Power Source: Electricity in welding, power source and equipment used for AC, DC welding, AWS classification and coding, Welding positions, types of joints, Residual stress, Identifying defects and remedial measures for welded joints.

Practice:

1. Identification and working of power source for welding equipment in AC and DC
2. Practice in different welding positions 3
3. Practice for producing different types of welded joint

Text Books:

1. Welding & Welding Technology by R.L.Little.1976. Tata McGraw Hill Education Privet Limited
2. Welding Technology by R. S. Parmar, 3 rd Edition, Reprint 2011, Khanna Publishers,
3. AWS Hand Book, Volume- 1, 2 and 3 , 9th Edition, American welding society

Reference Books:

1. Manufacturing Engineering and Technology by Serape. K. Kalpak Jain, Pearson Edition

Metal Transfer and Weld Metallurgy

Course Title	Course Code	Type of Course	T-P-Pr	Pre-Requisite
Metal Transfer and Weld Metallurgy	CUWI1261	Theory+Practice + Project	2-2-0	Nil

COURSE CONTENT

Module-I (27 Hours)

Metal transfer - Metal transfer in AC and DC arc welding, metal transfer in TIG, MIG and MAG welding, Study of different modes of metal transfer in MIG welding (Practice), Welding defects due to improper metal transfer and improper filler material, Diffusion in Soldering and Brazing.

Practice:

1. Metal transfer in TIG welding
2. Different modes of Metal transfer in MIG welding
3. Welding defects in TIG welding
4. Welding defects in MIG welding

Module-II (28 Hours)

Weld Metallurgy - Fe-C equilibrium diagram, Cooling curve, HAZ, Microstructure, Preheat & post heat treatment, Stress relieving and normalizing, Weld-ability: concept and significance, Percentage equivalence of carbon in weld-ability.

Practice:

1. Practice on stress relieving and normalising in welding
2. Experiments for demonstrating weld-ability

MODULE-III (26 Hours)

Weld ability of other metals - Defects in welded joints- hot cracks and cold cracks, porosity, embrittlement, lamellar tearing, distortion etc. weld ability of low carbon steels, HCS. Weld ability of stainless steels, weld ability of titanium and alloys, weld-ability of high strength low alloy steels. Heat treatment of welded structures, shot pinning, stress relieving through vibration. Ultra-sonic welding for dissimilar metals

Practice:

1. Identification of general welding defects
2. Heat treatment of welded structures

Text Books:

Welding Technology by R. S. Parmar. 3 rd Edition, Reprint 2011, Khanna Publishers, 2. Welding Metallurgy by J.F. Lancaster, 6th Edition, WOODHEAD Publishing Limited

Reference Books: 1. Manufacturing Engineering and Technology, Serape. K. Kalpak Jain Pearson Edison

Design of Welded Joints

Course Title	Course Code	Type of Course	T-P-Pr	Pre-Requisite
Design of Welded Joints	CUWI1262	Theory + Practice + Project	2-2-2	Nil

COURSE CONTENT

Module-I (16 Hours)

Design of weld joints - Introduction to design; engineering properties of steels; Type of welds and weld joints; description of welds: terminology, definitions and weld symbols; sizing of welds in structure, welding symbols and definition.

Module-II (14 Hours)

Weld Calculations - Design for Static loading, Weld Calculations in lap, butt and fillet welds; design for fatigue loading, Introduction to Fatigue; nature of the fatigue process; fatigue strength; factors affecting fatigue life; improvement methods for fatigue strength; reliability analysis and safety factors applied to fatigue design.

Practice:

1. Design of lap joint
2. Design of butt joint

MODULE-III (21 Hours)

Mechanisms of Failure - Failure mechanisms in welded joints, How to design various kinds of welding joints. Design of a butt joint, the main failure mechanism of welded butt joint, tensile failure of weld, Design of transverse fillet joint, Shear mechanism in fillet weld, Design stresses of welds. Use of CATIA Weld Design Module 345

Practice:

1. Tensile testing of welded joints
2. Bend test of welded joints

Text Books:

1. Lecture Notes
2. ASME section IX, IBR Software Used: CATIA

Testing of Welding Joints

Course Title	Course Code	Type of Course	T-P-Pr	Pre-Requisite
Testing of welding joints	CUWI1263	Theory+Practice + Project	2-2-2	Nil

COURSE CONTENT

Weld Defects and NDT Welded Joints.

ASME Section IX

WPS and PQR

Practice:

Destructive Tests:

- Experiment 1 Tensile test using Standard Equipment.
- Experiment 2 Impact test using Standard Equipment
- Experiment 3 Bend test using Standard Equipment
- Experiment 4 Hardness test using Standard Equipment

Non Destructive Tests:

- Experiment 5 Visual Inspection
- Experiment 6. Liquid Penetrant Test
- Experiment 7 Magnetic Particle Inspection

Microstructure:

- Experiment 8 Analysis of Microstructure by Image Analyzer
- Experiment 9 Analysis of Microstructure by SEM

DOMAIN TITLE: Computational Fluid Dynamics (CFCU2180)

Sl. No.	Course Code	Course Title	Course Type	T-P-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
CO1	Students able to write computer programs for solving elementary fluid dynamics/ heat transfer problems.
CO2	Execute industry projects to produce Quality products for Clients
CO3	General competency in Numerical solution of problems in fluid dynamics

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 $Re=10^7$.

Practice 7. Conjugate Heat Transfer (CHT) Analysis of an Electronics Module.

Project 4. Analysis of temperature rise through cross flow heat exchanger.

3.8 Boundary and Initial Conditions

- Boundary Conditions, wall boundary conditions, Thermal wall boundary, Initial Conditions, Initializing Compressible flows, Turbulence Specifications at Boundaries, Surface- to – surface Radiation specification at Boundaries, Time- dependent Boundary Conditions, Spatially- Varying Boundary conditions, User defined Boundary conditions.

3.9 Turbulence Modeling & Modeling Techniques.

Practice 8. Aerodynamics analysis of DS car.

Practice 9. Unsteady Flow across a Circular Cylinder.

Practice 10. Transonic Flow over an Airfoil.

Project 5. Analysis and estimation of Drag lift coefficients flat plate at $Re=10,000$.

3.10 Solution Convergence

Practice 11. Cavitating Flow through a Narrowing Pipe.

Project 6. Analysis of compressible flow nozzle with atmospheric pressure at the nozzle exit.

3.11 Post-processing Results.

Practice 12. Creating Post processing reports for all the above cases.

Simulation and Validation

Course Title	Course Code	Type of Course	T-P-Pr	Pre-Requisite
Simulation and Validation	CUCF2183	Practice	0+5+0	Nil

Practice

4.1 Fluid flow in the rear duct of an automotive HVAC system.

4.2 CFD Analysis of an Air intake system.

4.3 CFD Steady-state External flow over a Drone in cruise.

4.4 DE featuring of a Lens Component.

4.5 CFD analysis for Conjugate Heat Transfer in a fan –cooled CPU Board.

4.6 CFD analysis Energy computations in a Contact Analysis.

4.7 Thermo-mechanical Analysis of a Laser Powder Bed Fusion Build.

4.8 CFD analysis in Turbulent pipe flow.

4.9 CFD Supersonic flow analysis for 3D cone.

4.10 CFD analysis over a Ahmed body.

DOMAIN TITLE: Composite Design and Manufacturing

Sl. No.	Course Code	Course Title	Course Type	T-P-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:

<ul style="list-style-type: none"> • 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: Kevlor, Carbon Applications: Boron, Silicon Carbide

Module-II (6Hours)

Constituent materials for composite, Basic structural application of Composite, Advanced structural application of Composite,

Module-III(6Hours)

Multifunctional Applications of Composites, Fabrication Processes, Elements of Mechanical Behavior of Composites, Review of Basic Mechanics of Materials Equations

Book Suggested:

1. Composite material and structure, By PK Sinha, Wiley Publications
2. Introduction to composite Ever J. Barbero, Wiley Publications

Biovia - Composite materials and characterization techniques

Code	Course Title	T-P-Pj (Credit)	Prerequisite
CUCD2131	Biovia - Composite materials and characterization techniques	0-2-0	Nil

Module –I (25 Hours) Practice

Polymer menu

Build menu using new molecule Blends menu Synthia menu

Polymer-polymer composite

Nanoparticle-polymer composite

Inorganic composite

SEM analysis

FTIR analysis

XPS analysis

Gaussian menu

Reflex menu

CATIA-Composites Design

Code	Course Title	T-P-Pj (Credit)	Prerequisite
CUCD2132	CATIA-Composites Design	0-4-0	Nil

Module –I (35 Hours) Practice

Composite Part Design topics: Preliminary design, Manual Ply Creation, Zone Design, ply Management, Mirroring, Creating IML's & Solids, Analyzing Drop Off and Slicing, composite Grid Design, Grid Panel Definition, Grid Definition, Composite Grid Design, Grid Panel Definition, Grid Definition, Virtual Stacking Management, Plies Generation, Grid Ramp Support Definition, Remove Useless Ramp Supports, Swap Edge, Reroute Ply Contour, define Local Drop Off, Create Standard Contour, Define No Drop Off Area, Synchronize Stacking, Limit Plies from Panel Limits, Creating a Manufacturing Document, Synchronizing, Skin Swapping, Defining the Edge of Part, Material Excess, Producibility Flattening, Flatten Optimization, Geometry Transfer, Producibility Inspection, Fibre Direction, Unfold Entity, Splicing and Splice Zones, Darting, Exporting, Exporting Ply Data as IGES or DXF, XML Export, Drafting Standards, Creating a Ply Book, Adding Material to Plies, Stagger Origin Points, Grid Angle Cut.

Composite Product Validation; Simulia(Abaqus FEA)

Code	Course Title	T-P-Pj (Credit)	Prerequisite
CUCD2133	Composite Product Validation; Simulia(Abaqus FEA)	0-4-0	

Module –I (7 Hours)Practice

Defining a Problem

Defining anisotropic elasticity with Hookean models for combining the fiber-matrix response

Defining composite layups using Abacus/CAE

Defining discrete or layered reinforcing within an element using rebar

Membrane elements and truss elements

Achieving the correct material orientation of the layers of composite shells

Modeling sandwich composite structures

Modelling stiffened composite panels

Define No Drop Off Area, Synchronize Stacking, Limit Plies from Panel Limits

Modeling progressive damage and failure in composites

Modeling delamination of composite structures

Modelling low cycle fatigue of composite structures

Machineries and Technologies used for Manufacturing of Composites

Code	Course Title	T-P-Pj (Credit)	Prerequisite
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CUCD2134	Machineries and Technologies used for Manufacturing of Composites	2-0-0	
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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

1. Fabrication using Natural Fibre
2. Fabrication using glass fiber
3. Fabrication using carbon fiber
4. Fabrication processes for polymer matrix composites (PMC)
5. Matched Die mold
6. Contact Mould, Filament Winding
7. Pultrusion
8. Fabrication processes for metal matrix composites (MMC)
9. Diffusion Bonding, Powder Metallurgy Process, Casting
10. Fabrication processes for ceramic matrix composites (CMC)
11. Hot Press Sintering, Liquid Infiltration
12. 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:

<ul style="list-style-type: none"> • 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 build-ings.	PO4[3]
CO3	Modelling of structural elements and failure analysis.	PO5 (3)
CO4	Time saving estimations/structural calculations using digital tool in sus-tainable 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	CUSD	Practice	5	0+5+0	NIL

modelling	2121				
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- 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

DOMAIN

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 - 4	Nil

Courses Division:

DOMAIN: Aerial Surveying and Remote Sensing Applications (4-10-4)					
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.	CUAS2022	PHOTOGRAMMETRY AND ITS APPLICATION	0-2-0	2	25
4.	CUAS2023	LIDAR REMOTE SENSING AND ITS APPLICATIONS	0-2-0	2	25
5.	CUAS2024	HYPER-SPECTRAL REMOTE SENSING AND ITS APPLICATION	0-2-0	2	25
6.	CUAS2025	PROJECT	0-0-4	4	54
Total				18	

Course Objectives

<ul style="list-style-type: none"> • 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

COs	Course Outcomes
CO1	Able to identify specific data knowledge and analyses methodology for effective mapping and evaluation resources.
CO2	Understand the geospatial models skills address to the social and engineering problems.
CO3	Design multi-criteria geospatial systems for decision-making process.
CO4	Work in a team using geospatial tools and environment to achieve project objectives.
CO5	Pursue lifelong learning for professional advancement.

Evaluation System: As per university norms

Remote Sensing and Digital Image Processing CUAS2020 (2-2-0)

Subject Name	Code	Type of course	Credit	T-P-P	Prerequisite
Remote Sensing and Digital Image Processing	CUAS2020	T+P	4	2-2-0	NIL

Module: I Basic Concept of Remote Sensing (4+6) Hours

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:

- Installation of Image Processing software's
- Download satellite data from GLOVIS / Earth Explorer / Bhuvan etc.
- Layer stacking
- LUT and Image Subset
- Spectral Signature mapping (soil, vegetation, water)

Module: II Digital Image (2+3) Hours

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:

- FCCs and TCC
- Resolution
- Image Interpretation

Module: III Satellite Information and Principles (2+3) Hours

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:

- Image filtering and Band ratioing
- Mosaicking

Module: IV Image Acquisition and Format (2+4) Hours

Digital Image Processing; Export and import, Data formats; BSQ, BIL, BIP, Run length encoding, Image Compression Data products.

Practice:

- Export and Import
- Histogram
- Subset using AOI

Module: V Image Processing (3+4) Hours

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)

- Geometric correction
- Radiometric correction
- Atmospheric correction

Module: VI Image Classification (4+4) Hours

IMAGE CLASSIFICATION; Classification techniques, types, Supervised and Un-supervised; Principal Component Analysis (PCA); Image Enhancement; Accuracy assessment.

Practice:

- PCA analysis (spectral Python and ENVI)
- NDVI, DVI, NDWI calculation
- Image classification in Spectral angel Mapper
- MNF Ratoing
- Supervised Classification (spectral Python and ENVI)
- Un-supervised Classification (spectral Python and ENVI)
- Image Enhancement (ENVI)
- Accuracy Assessment (ENVI)

Module: VI Remote Sensing and Its application (3+4) Hours

Microwave RS and its application; Thermal RS and its application; Optical RS and its application; Sensor and its types.

Practice: Using Spectral Python

- Application of microwave remote sensing (Structural Trend line mapping)
- Application of thermal remote sensing and case study (Land surface Temp. estimation)
- Application of optical remote sensing and case study

Geospatial Technology and its Application CUAS2021 (2-2-0)

Subject Name	Code	Type of course	Credit	T-P-P	Prerequisite
Geospatial Technology and its Application	CUAS2021	T+P	4	2-2-0	NIL

Module I: GIS & Cartography (2+4) Hours

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:

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
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 (2+4) Hours

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:

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
2. Buffering and Creation of Contour
3. Network Analysis

Module: III Multi-criteria analysis and decision making (3+4) Hours

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:

1. Mapping accident locations using Linear Referencing technique.
2. Preparation of raster layers for Multicriteria Analysis

- Solving a spatial problem using Multicriteria Analysis (Spatial AHP)

Module: IV Digital Elevation Model (DEM) (2+4) Hours

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:

- Google earth to DEM, 3D Map preparation, Contour to DEM, TIN and Aspect
- DEM based surface Hydrology modeling,
- LiDAR classification, DEM from LiDAR

Module: V Geospatial Technology for Water resources Engineering (3+4) Hours

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 ground water studies.

Practice:

- Mapping of catchment, command area
- Drainage network analysis
- Morphometric analysis
- Mapping of Groundwater potential zones

Module: VI Geospatial Technology for Environmental Engineering (3+4) Hours

Monitoring atmosphere constituents; air pollution, industrial activity, modeling using GIS, Resource development in remote areas, Impacts of anthropogenic activity, Solid Waste management; Water Pollution, Shortest path Identification, Network analysis.

Practice:

- Air pollution mapping
- Solid waste management
- Water pollution

3. Photogrammetry and Application CUAS2022 (0-2-0)

Subject Name	Code	Type of course	Credit	T-P-P	Prerequisite
Photogrammetry and Application	CUAS2022	T+P	2	0-2-0 25Hours	NIL

Practice Experiments:

- Scale determination from aerial photo
- Aerial photo Interpretation
- Use of Parallax bar and determination of Height from stereo pair
- Satellite DEM and ortho Image generation
- Primary and additive colour creation
- Stereo test

- 7 Mosaic
- 8 Stereoscopic vision
- 9 Relief displacement
- 10 Analog to digital conversion, Orientation of stereo model and Determination of Height
- 11 Aerial mapping using DRONE
- 12 Mosaicking of aerial Photo
- 13 Correction and rectification
- 14 DTM generation Image correction, Link between GIS and Digital Photogrammetry and Ortho Image generation

4. LIDAR Remote Sensing and Application CUAS2023 (0-2-0)

Subject Name	Code	Type of course	Credit	T-P-P	Prerequisite
LIDAR Remote Sensing and Application	CUAS2023	T+P	2	0-2-0 25Hours	NIL

Practice Experiments:

- 1 Download of LIDAR data
- 2 Layer stacking
- 3 Data Validation
- 4 Georeferencing Technology
- 5 Boresight Calibration - Lidar Data Pre-processing
- 6 Project Coverage Verification - Review Lidar Data against Field Control
- 7 Lidar data errors and rectifications, - processes calibration of Lidar data - artifacts and anomalies - Lidar Error Budget.
- 8 Noise Removal and other sensor-related artifacts - Layer Extraction - Automated Filtering
- 9 Manual Editing and Product Generation – Surface Editing - Hydrologic Enforcement
- 10 Breaklines, Contours, and Accuracy Assessment
- 11 Topographic Mapping, flood inundation analysis, line-of-sight analysis
- 12 Forestry, various types of LIDAR sensors-, vegetation metric calculations - specific application software.
- 13 Corridor mapping system, data processing and quality control procedures.
- 14 Modelling

5. Hyperspectral Remote Sensing and Application CUAS2024 (0-2-0)

Subject Name	Code	Type of course	Credit	T-P-P	Prerequisite
Hyperspectral Remote Sensing and Application	CUAS2024	T+P	2	0-2-0 25Hours	NIL

Practice Experiments:

- 1 Introduction to ENVI, Python and Downloading, Displaying, and Analyzing Hyperspectral Imagery
- 2 Atmospheric Correction of Hyperspectral Imagery.
- 3 MNF rationing from Hyperspectral (EO1)
- 4 Hyperspectral Image Classification Using Spectral Angle Mapper (SAM) & Spectral Feature Fitting (SFF).
- 5 Hyperspectral Imagery Classification Using an Unsupervised Neuron fuzzy System.
- 6 Application of Hyperspectral Imagery in Geological Studies.
- 7 Hyperspectral Signatures & Feature Fitting.
- 8 Hyperspectral Remote Sensing for Agriculture and soil Studies.
- 9 Hyperspectral Remote Sensing for Forestry Applications.
- 10 Hyperspectral Remote Sensing for Urban Studies.
- 11 Mineral identification from Hyperspectral imagery
- 12 Python Programming for Hyperspectral data analysis.

6. Project CUAS2025 (0-0-4)

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 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. Ground water 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

CONSTRUCTION PLANNING, MONITORING AND PROJECT MANAGEMENT

Course Title	Type of course	T+P+PJ	Prerequisite
Construction Planning, Monitoring and Project Management	Theory + Practice + Project	4+6+6	Nil

DOMAIN: Construction Planning, Monitoring and Project Management (4+6+6)					
Sl. No.	Code	Subject Name	T+P+P	Credits	Hrs.
1.	CUCP2110	Study of Drawings and Plan	2+1+0	3	25
2.	CUCP2111	Project Scheduling & Management	0+2+0	2	36
3.	CUCP2112	Site Study and Study on Contract Laws	2+1+0	3	50
4.	CUCP2113	Concepts of Quality Control and Checking	0+1+1	2	45
5.	CUCP2114	Quantity Estimation and Equipment Management	0+1+1	2	45
6.	CUCP2115	Site Supervision Project	0+0+4	4	48
Total				16	

Course Objectives:

<ul style="list-style-type: none"> • 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 construction planning.
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Course Outcomes:

COs	Course outcomes
CO1	Students will apply knowledge and plan various complex project problems relating to advanced building technology with trust.

CO2	Students will be able to churned as Construction Manager, Project Engineer. Site Supervisor and Project Consultant with critical thinking and skills
CO3	Maintain and develop the ability to put their knowledge of theory into practical problems using forms of construction focusing to society and environment.

PHASE-I STUDY OF DRAWINGS AND PLAN

(2+1+0)

Inputs required completing the project

1. To ensure the student to read about the technical terms in various building drawings.
2. To give hands on practice to the students in preparing blue prints of a proposed construction.

To fulfill the requirement of the INPUTS the candidate has to learn the following steps:

Types of input	Type of study
<p>Preparation of Site Map</p> <ul style="list-style-type: none"> • Conduct a site survey to gather information about the topography, soil conditions, vegetation, and existing structures on the site. • 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. • Develop a conceptual site plan that includes the proposed layout of the development, including the location of buildings, roads, sidewalks, and other infrastructure. • Prepare detailed engineering plans and specifications for the site, including grading plans, drainage plans, and utility plans. 	Theory + Drawing Practice
<p>Preparation of Electrical and Plumbing drawing</p> <ul style="list-style-type: none"> • Review the architectural plans and specifications to understand the electrical and plumbing requirements of the project. • Develop a rough electrical layout, which includes the location of electrical panels, switches, outlets, and lighting fixtures. • Develop a rough plumbing layout, which includes the location of plumbing fixtures, water supply, and drainage lines. • Prepare single line diagrams, load schedules, and other technical documents as needed. • 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. 	Theory + Drawing Practice
<p>Preparation of Bar Bending Schedule and Carpentry drawing</p> <ul style="list-style-type: none"> • Introduction to Bar Bending Schedule and Carpentry Drawing • Basic concepts of reinforcement and carpentry work 	Theory + Drawing Practice

<ul style="list-style-type: none"> • Reading and interpreting architectural and structural drawings • Understanding the different types of reinforcement and carpentry elements • Calculating the quantities of reinforcement and carpentry materials • Preparing the Bar Bending Schedule and Carpentry Drawings • Site execution and quality control of reinforcement and carpentry work • Safety precautions in reinforcement and carpentry work 	
<p>Structural Detailing of building components</p> <ul style="list-style-type: none"> • Introduction to structural detailing and its importance in building design • Basic concepts of structural steel and reinforced concrete detailing • Reading and interpreting architectural and structural drawings • Detailing of structural steel members, such as beams, columns, and bracings • Detailing of reinforced concrete members, such as beams, columns, slabs, and foundations • Connection design and detailing of structural steel and reinforced concrete members • Standards and codes for structural detailing 	Theory + Drawing Practice
Preparation of Building layouts	Field Work
Report Preparation	Report
Review	Presentation

Phase II PROJECT SCHEDULING & MANAGEMENT

(0+2+0)

Inputs required completing the project

1. WBS
2. Equipment Scheduling
3. Labour Scheduling
4. Material Scheduling
5. Financial Resource allocation.

To fulfill the requirement of the INPUTS the candidate has to learn the following steps:

TYPES OF INPUT	TYPE OF STUDY
Preparation of Functional Planning	Practice
Detail analysis report about the information of an equipment	Practice
Preparation of datasheet of construction labours	Practice
Preparation of materials list required for the project	Project
Scheduling the resources of the project	Project
Report Preparation	Report
Review	Presentation

PHASE III SITE STUDY AND STUDY ON CONTRACT LAWS

(2+1+0)

Inputs required completing the project

- To learn about the methods of marking layouts and pre construction process.
- To study the various types of construction contracts and their legal aspects and provisions.

To fulfill the requirement of the INPUTS the candidate has to learn the following steps:

Types of input	Type of study
Marking Layouts of proposed plan.	Field work
Preparation of Site Map	Surveying Practice
Design of contract documents <ul style="list-style-type: none"> • Introduction to contract documents and the design-bid-build process • Types of contracts and their characteristics • Basic concepts of legal and contract principles • Preparation and interpretation of specifications • Preparation of contract drawings and documents • Cost estimation and budgeting • Bid evaluation and contract award • Contract administration and change order management • Risk management and insurance • Case studies and examples of contract documents 	Theory+ Class Room Practice
Tenders Prequalification–Bidding–Accepting–Evaluation of Tender from Technical, Contractual and Commercial Points of View. <ul style="list-style-type: none"> • Introduction to tenders and prequalification • Types of tenders and procurement methods • Basic concepts of project management • Preparation of tender documents • Prequalification criteria and evaluation • Evaluation of tenders and bid analysis • Contract negotiation and award • Compliance and ethics in tenders • Case studies and examples of tenders and prequalification 	Theory+ Class Room Practice
<ul style="list-style-type: none"> • Legal Requirements • Insurance and Bonding • Laws Governing Sale <ul style="list-style-type: none"> • Purchase and Use of Urban and Rural Land–Land Revenue Codes • Tax Laws 	Theory+ Class Room Practice
Assessment (Lab)	Examination

PHASE IV CONCEPTS OF QUALITY CONTROL AND CHECKING (0+1+1)

Inputs required completing the project

- To enlighten the student with the tools of total quality management process.

- To give hands on practice to the students in preparing quality assessment schedules and inspection check lists
- Carryout the field and laboratory tests for quality assessment in construction industry.

To fulfill the requirement of the INPUTS the candidate has to learn the following steps:

TYPES OF INPUT	TYPE OF STUDY
Generation of sample QC inspection Check list for Industrial building.	Practice
Generation of sample QC inspection Check list for Institutional building.	Practice
Generation of sample QC inspection Check list for Apartment building.	Practice
Generation of sample QC inspection Check list Road Structures.	Practice
Report Preparation.	Report
Review.	Presentation

PHASE V QUANTITY ESTIMATION AND EQUIPMENT MANAGEMENT (0+1+1)

Inputs required completing the project

- Identify the particular equipment to be used in the construction project they will undertake.
- Prepare plans for economic management by estimating the costs of the total construction works.
- To appraise the student with the aspects related to functioning, operation and maintenance of various construction equipment.

To fulfill the requirement of the INPUTS the candidate has to learn the following steps:

Types of input	Type of study
Planning & Selection of Equipment.	Practice (Self-Learning)
Economics of Equipment and procurement techniques.	Practice (Self-Learning)
Estimation for total construction cost.	Practice (Self-Learning)
Estimation for total labor and material cost.	Practice (Self-Learning)
Preparation of BOQ.	Estimator 2.0 (Lab)
Review	Presentation

PHASE VI SITE SUPERVISION PRACTICES (0+0+4)

Inputs required completing the project

1. To demonstrate supervision of concreting task such as form finish concrete structure, complex structure, slip form concreting and concreting in extreme weather condition.
2. Supervise, monitor and evaluate performance of subordinates at workplace.
3. To study about the processes of various stages of construction on the field.

To fulfill the requirement of the INPUTS the candidate has to learn the following steps:

Types of input	Type of study
Supervise and monitor the execution of System/shuttering Carpentry works.	Practice (Self-Learning)
Supervise and monitor the execution of concreting works.	Practice (Self-Learning)
Supervise and monitor the execution of bar bending works.	Practice (Self-Learning)
Supervise and monitor the execution of scaffolding works.	Practice (Self-Learning)
Supervise and monitor the daily labour works (DPR).	Practice (Self-Learning)
Assessment (Review)	Presentation

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.

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 OUTCOME TO PROGRAM OUTCOME MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	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

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 Udemey
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
CO1	Able to gain knowledge on modern software testing processes in relation to software development and project management
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
CO3	Ability to solve the real world problems
CO4	To create and design test strategies and plans, design test cases, prioritize and execute them

COURSE OUTCOME TO PROGRAM OUTCOME MAPPING:

	PO 1	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

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

<ul style="list-style-type: none"> To learn the basic control technique involved in power system operation To demonstrate the economic operation of power systems, hydrothermal scheduling To provide a solid foundation in mathematical and engineering fundamentals required to control the governing system in turbine models

Course outcome

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

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 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

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 of load between units within a plant, Transmission losses as function of plant generation, Calculation of loss coefficients, Distribution of loads between plants with special reference to steam and hydel plants, Automatic load dispatching. Optimal Power Flow.

Module-V (6 hours)

Load frequency control, PF versus QV control, Modelling of speed governing system, Division of power system into control areas, Single area control and two area control. On load tap changing transformer and block regulating transformer, effects of regulating transformers.

HARDWARE-BASED

1. To determine the negative and zero sequence synchronous reactance of an alternator.
2. To determine the sub-transient direct axis and sub-transient quadrature axis synchronous reactance of a 3-ph salient pole alternator.
3. To determine fault current for L-G, L-L, L-L-G and L-L-L faults at the terminals of an alternator at very low excitation.
4. To study the IDMT over-current relay and with different plug settings and time setting multipliers and plot its time-current characteristics.
5. To determine the operating characteristics of biased differential relays with different % of biasing.
6. To determine the location of fault in a cable using a cable fault locator.
7. Insulation test for Transformer oil.

SOFTWARE PRACTICE

1. To obtain steady-state, transient, and sub-transient short circuit currents in an alternator.
2. To study the load flow analysis using Newton Raphson method.
3. To compute voltage, current, power factor, regulation at the sending end of a 3- ϕ 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 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
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Course content

Module I: ENERGY AUDITING Theory	(6 Hours)
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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)
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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)
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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)
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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)
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The Time Value of Money Concept, Developing Cash Flow Models, Payback Analysis,

Depreciation, Taxes and Tax Credit — Numerical Problems. Management and Organization of Energy Conservation Awareness Programs.

Practice: HVAC System: Cost Saving through Heat Transfer and Cooling

Module VI: DEMAND SIDE MANAGEMENT	(5 Hours)
Theory	

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.