Centurion University of Technology and Management Odisha

B.Tech. in Aerospace Engineering

CHOICE BASED CREDIT SYSTEM

COURSE STRUCTURE & SYLLABUS

BASKET – I, II, III, IV & V

Centurion
UNIVERSITY
Shaping Lives...
Empowering Communities...

School of Engineering & Technology

2022

Index
Basket - I

Basket - II

Basket - III

Basket - IV

Basket – V (Domain)

Basket – V (Elective)

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, and Aerospace Engineering to the solution of engineering problems
PO2	Problem analysis: Identify, formulate, review literature and analyze Aerospace Engineering problems to design, conduct experiments, analyze data and interpret data
PO3	Design /development of solutions: Design solution for Aerospace Engineering problems and design system component of processes that meet the desired needs with appropriate consideration for the public health and safety, and the cultural, societal and the environmental considerations
PO4	Conduct investigations of complex problems: Use research based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions in Aerospace Engineering
PO5	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to Aerospace Engineering activities with an understanding of the limitations
PO6	The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to Aerospace Engineering practice
PO7	Environment and sustainability: Understand the impact of the Aerospace Engineering solutions in societal and environmental contexts, and demonstrate the knowledge and need for sustainable development
PO8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the Aerospace Engineering practice
PO9	Individual and team work: Function affectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings in Aerospace Engineering

PO10	Communication: Communicate effectively on complex engineering activities with the engineering committee and with society at large, such as, being able to comprehend and write affective reports and design documentation, make effective presentations in Aerospace Engineering
PO11	Project Management and finance: Demonstrate knowledge & understanding of the Aerospace Engineering principles and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments in Aerospace Engineering
PO12	Life- long learning: Recognize the need for, and the preparation and ability to engage in independent research and lifelong learning in the broadest contest of technological changes in Aerospace Engineering

PEOs/PSOs

PEO1: Prepare students to build competency in current technology and its application to meet

the industry need for skilled Engineer

PEO2: Provide students with strong foundational concepts and also domain knowledge to

pursue research to build solutions or systems of varying complexity to solve the problems

identified

PEO3: Enable graduates to innovate, bring new idea and become an entrepreneur

PSO1. Graduate will be able work on high-end technology at IT Services industries.

PSO2. Graduate can acquire industry certified level of competency and work on real time IT

application projects viz; Health/Agriculture/Security/Data Management etc.

PSO3. Graduate can start its own IT service company to provide technical solution Course Outcomes Attributes

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

Course Structure

Basket - I

Course Code	Course Title	Credits	Course Type T+P+PJ
CUTM1001	Differential Equations and Linear Algebra	3	2+0+1
CUTM1002	Laplace & Fourier Transforms	3	2+0+1
CUTM1003	Complex Analysis & Numerical Methods	3	2+0+1
CUTM1004	Discrete Mathematics	3	2+0+1
CUTM1005	Probability & Statistics	3	2+0+1
CUTM1925	Calculus	3	2+0+1
CUTM1006	Mechanics for Engineers	3	2+1+0
CUTM1007	Optics and Optical Fibres	3	2+1+0
CUTM1008	Applied Analytical Chemistry	3	2+1+0
CUTM1009	Applied Engineering Materials	3	2+0+1
CUTM1010	Environmental Studies	2	0+0+2

Differential Equations and Linear Algebra

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

Course Objectives

- Introduce students to how to solve linear Differential Equations with different methods.
- 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.
- Introduce students how to solve first order and second order differential equations

Course Outcomes

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Understanding and knowledge is the importance of linear functions in mathematics.	PO1 (3)
CO2	Learn fundamental and analytical concepts of ODE theories where and how such equations arise in applications to scientific and engineering problems.	PO1(3)
CO3	Solving systems of linear equations using Gauss- elimination to reduce to echelon form.	PO1(2), PO2(3)

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. Advancedengineeringmathematics 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

Course Objectives

- 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.

Course Outcomes

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Solve differential equations with initial conditions or knowledge using Laplace transform.	PO1 (3)
CO2	Solving the Fourier transform of a continuous function and being familiar with its basic properties.	PO2(3)

COURSE CONTENT

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

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

Project-1

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

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

Second shifting theorem, Laplace transforms of Derivatives and Integrals Project-2

Find the Laplace transform of the following functions

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

Derivatives and Integrals of Transforms, Inverse Laplace transform.

Project 3:

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

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

Solution of Differential Equation by using Laplace Transform.
Project 4: Find the solution of differential equation by using Laplace Transform.

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

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

Project-5

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

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

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

Project-6

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

Module-VII(T-3)

Fourier Transforms, Fourier sine and cosine Transforms.

Text Books:

1. E. Kreyszig , Advanced Engineering Mathematics, Johnwilley& 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))
2. Highjer 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

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Derive a variety of numerical methods for finding out solutions of various mathematical problems arising in roots of linear and non-linear equations, Solving differential equations with initial conditions and Evaluating real definite integrals.	PO2(3)
CO2	To get equipped with the understanding of the analytical and fundamental concepts of functions of a complex variable along with the concepts of analyticity, Cauchy-Riemann relations and harmonic functions.	PO1 (3)
CO3	Solving complex contour integrals applying the Cauchy integral theorem, Cauchy integral formula.	PO2(3), PO1(2)

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, Trapizoidal rule, Simpson's one third rule.

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

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

Runge-Kutta 2nd & 4th order methods.

Project-6: Finding out Numerical solutions of differential equations using Runge-Kutta 2^{nd}& 4^{th} order methods

Text Book:

1. Advanced Engineering Mathematics by E. Kreyszig Publisher: Johnwilley & 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 Objectives

- 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 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

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Apply Knowledge of mathematics in truth tables and the rules of propositional and predicate calculus	PO1(2)
CO2	Apply the logical and analytical structure of proofs and work symbolically with connectives and quantifiers to produce logically valid, correct and clear arguments.	PO1 (3)
CO3	Solving elementary mathematical arguments and identify fallacious reasoning	PO1(3) , PO2(3)

COURSE OUTLINE

Module -I **(4Hours)**

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 **(3Hours)**

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 **(4 Hours)**

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

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

Text Books:

1. Discrete Mathematics and its Applications by K.H.Rosen, Publisher: TMH, Sixth Edition, 2009. Chapters: 1(1.1 ,1.2,1.3, 1.5); 7(7.1,7.6); 8(8.1 to8.5, 8.7, 8.8);9(9.1,9.4,9.5).

Reference Books:

1. Discrete Mathematical Structures with Applications to Computer Science, J. P. Trembkay,
2. R. Manohar, Tata MC Graw – Hill Edition 38th reprint, 2010.
3. Discrete and Combinatorial Mathematics by R.P.Grimaldi Publisher: Pearson, 5th Edition,
   2003.
4. Discrete Mathematics and Applications by Thomas Koshy Publisher: Elsevier, 2004.
5. 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

Course Objectives

- To translate real-world problems into probability models.
- To motivate students in an intrinsic interest in statistical thinking.
- 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 modelling, climate prediction and computer networks etc.

Course Outcomes

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Define and illustrate the concepts of sample space, events and compute the probability and conditional probability of events with knowledge.	PO1 (3)
CO2	Define, illustrate and apply the concept of the expectation to the mean, variance and covariance of random analytical and critical variables.	PO1(3)
CO3	Solving probabilities based on practical situations using the Binomial, Poisson and taking normal distributions.	PO2(3)

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:(3 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. 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	

Course Objectives

- 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.

Course Outcomes

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	knowledge in transforming double integral to line integrals, triple integrals to surface integrals, surface integrals to line integrals and vice versa.	PO2(3)
CO2	Determine the important analytical quantities associated with scalar and vector fields.	PO1(3)
CO3	Solving line integral, double integral and applying these knowledge to find out work done by a force, volume of regions in space, center of gravity of a mass etc.	PO1(2)

COURSE CONTENT

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 to8.11), 9 (9.1 to 9.7, 9.9).

Mechanics for Engineers

Code	Course Title	Credit	T-P-PJ
CUTM1006	Mechanics for Engineers	3	2-1-0

Course Objectives

- To provide the students with a clear and thorough understanding on fundamentals of mechanics as applied to solve real-world problems.

Course Outcomes

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Students will gain the knowledge on application of mechanics, will be able to construct free body diagrams and calculate the reactions necessary to ensure static equilibrium.	PO1(3)
CO2	Students will be able to think and analyse the frictional forces involved in planes and the effect of friction in static and dynamic conditions.	PO1 (3)
CO3	Students will be able to solve different problems of kinematics and kinetics.	PO2 (2), PO3(2)
CO4	Students will learn to handle different tools and instruments used in mechanics.	PO5(1)

COURSE CONTENT

Module I: Force and Moment (4 Hrs. + 2 Hrs. practices)

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-1: Verification of laws of parallelogram law of forces

Module II: Equilibrium (3 Hrs. + 2 Hrs. practice)

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-2: To verify the condition of equilibrium by finding reactions at the support of a beam

Module III: Friction (2 Hrs. + 2 Hrs. practice)

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

Practice-3: Determination of Angle of Repose

Module IV: Centroid (2 Hrs.)

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

Module V: Moment of Inertia (3 Hrs. + 2 Hrs. practice)

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

Practice-4: Determination of Moment of Inertia of a fly wheel.

Module VI: Kinematics of Linear Motion (3 Hrs.)

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

Module VII: Kinetics of Linear Motion (3 Hrs. + 4 Hrs. Practice)

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

Practice-5: Verification of Newton's second law of motion.

Practice-6: Verification of conservation of momentum in collision.

Text Books:

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

Reference Books:

1. Engineering Mechanics by S. Timoshenko, D.H. Young and J.V. Rao, Tata McGraw Hill
2. Engineering Mechanics by D.S. Kumar, S.K. Kataria and Sons.

Optics and Optical Fibres

Code	Course Title	Credit	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

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Students will gain knowledge on optical phenomena, different light sources and their uses, solar cell, laser, optical Fibre and instrumentation involved.	PO1(2)
CO2	Students will develop the understanding and analysis of the applications of Optical fibres and Lasers.	PO1 (3)
CO3	Students will learn to solve problems on various optical phenomena.	PO2 (2), PO3(2)
CO4	Students will learn to handle different tools and instruments used in optical experiments.	PO5(1)

COURSE CONTENT

Module I: Reflection and Refraction (Derivation is not required) (3hours +2hours)
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 a glass slab using a travelling microscope.

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

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) (2hours+2hours)

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

Practice: 3

Newton's Rings-Refractive index of liquid

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

Types of diffraction, Fraunhofer diffraction at a single sit, 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 the grating element of a plane transmission diffraction grating.

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

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, Defences, Nuclear energy, in communication, in consumer electronics industry)

Practice: 5

Wave length of LASER source by diffraction grating method

Module VI: Optical Fibres (3hours+1hours)

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

Practice: 6

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

Module VII: Optical Fibres (4hours+1hours)

Attenuation in optical fibres (Qualitative only-Scattering losses, Absorption losses, bending loses) Fibre Materials-Glass fibres, Plastic fibres, Light sources for fibre optics

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

Practice: 7

Measurement of bending loss.

Text Books:

1. A TextBook of Optics by M.N. Avadhanulu, BrijLal, 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 AjoyGhatak, McGraw Hill Education; 6 edition, 2017.
2. Physics-I for engineering degree studentsbyB.B. Swain and P.K.Jena.
3. Concepts in Engineering Physics by I Md. N. Kha, 2016.

Applied Analytical Chemistry

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

Course Objectives

- Explain fundamental principles for environmental analytical methods (titration, electrochemistry, instrumentation and basic parameters of water, soil, fuel, etc)
- Point out suitable analytical techniques for analysing a specific compounds in an environmental matrix

Course Outcomes:

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Able to gain Knowledge on various water softening methods, soil analysis methods, fuels, electrochemical phenomena and error analysis	PO1 (3)
CO2	Analytical skill and Critical Thinking	PO2(3), PO5(1)
CO3	Use of Tool, Design and Development (Hands-on/Technical skill)	PO3(3)

Module-I(4Hrs)

Water analysis:

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. Numerical on calculation of hardness of water, Lime-Soda calculation, Alkalinity of water.

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, Fertility of the soil.

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

Module-III (4Hrs)

Fuel Chemistry-I:

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.

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

Module-IV (3Hrs)

Fuel Chemistry-II

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.

11. Synthesis of biodiesel by transesterification process

Module-V(3Hrs)

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

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

Module-VI (2Hrs)

Electrochemical Phenomenon

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

Module-VII(2Hrs)

Error in Chemical analysis

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

Applied Engineering Material

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

Course Objectives

- 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

Course Outcomes

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Able to gain Knowledge on various materials used in the field of engineering and technology.	PO1 (3),
CO2	Analytical skill and Critical Thinking	PO2(3), PO5(1)
CO3	Use of Tool, Design and Development (Hands-on/Technical skill)	PO3(3)
CO4	Research	PO4(3), PO5(1)

Course content

Module I: New Materials/Nanomaterials (5hrs)

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

Project

Synthesis of TiO_2 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.
2. Kronberg and B. Lindman
3. Energy Scenario beyond 2100, by S. Muthukrishna Iyer

Environmental Studies

Code	Course Title	Credit	T-P-PJ
CUTM1010	Environmental Studies	2	0-0-2

Course Objectives

- To introduces the environmental consequences of Industries on the human health and methods for minimizing their impact through technology and legal system to the undergraduate students.

Course Outcomes:

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Able to gain Knowledge on Environment as well as environmental pollution and its consequences on global climate change.	PO1 (3)
CO2	Analytical skill and Critical Thinking	PO2(3), PO_5(1)
CO3	Use of Tool, Design and Development (Hands-on/Technical skill)	PO3(3)
CO4	Environment and Sustainability	PO6(2), PO_7(3)

COURSE CONTENT

Module-I: Fundamentals of Environmental Sciences

Assignment-1: Multidisciplinary nature of Environmental science
Assignment-2: Components of Environment
Assignment-3: scope and importance of environmental science

Module: II Ecology and Ecosystem

Assignment-1: Structure and function of ecosystem
Assignment-2: Types of ecosystem
Assignment-3: Ecological Succession

Module III- Biodiversity and its conservation

Assignment-1: Concepts of Biodiversity
Assignment-2: Biodiversity at local level, global level and National level
Assignment-3: Conservation of Biodiversity

Module IV- Natural resources and its conservation

Assignment-1: Land resources and its conservation
Assignment-2: Forest resources and its conservation
Assignment-3: Water resources and its conservation
Assignment-4: Energy resources and its conservation

Module V Environmental pollutions and its control measure

Assignment-1: Soil pollution
Assignment-2: Water pollution
Assignment-3: Air pollution
Assignment-4: Noise pollution

Module VI Natural Hazards and Disaster management

Assignment-1: Concepts of natural hazards
Assignment-2: Different types of natural hazards: cyclone, earthquake, volcanic eruption etc.
Assignment-3: Process of disaster preparedness and its management
Assignment-4: Solid waste management

Module VII Environmental issues and laws

Assignment-1: Major environmental issues like climate change, global warming, green house effects, Ozone layer depletion, Acid rain

Assignment-2: Water Act, 1974
Assignment-3: Air Act, 1981
Assignment-4: Environmental protection act, 1986

Reference Books:

1. Environmental Studies by U.N. Dash & H. D. Kumar, India Tech Publication, New Delhi
2. Environmental Studies by R. Rajagopalan Oxford University Press
3. Environmental Science and Engineering, 2E, by Aloka Debi, University Press

Course Structure
Basket - II

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

Syllabus

Optimization Techniques

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

Course Rationale:
Operations research (OR) have many applications in science, engineering, economics, and industry and thus the ability to solve OR problems are crucial for both researchers and practitioners. Being able to solve the real life problems and obtaining the right solution requires understanding and modelling the problem correctly and applying appropriate optimization tools and skills to solve the mathematical model. The goal of this course is to teach you to formulate, analyse, and solve mathematical models that represent real-world problems. We will also discuss how to use EXCEL for solving optimization problems

Course Objectives:

- To learn about the operations, research techniques, model formulation and applications used to solve business decisions by using computer software

Course Outcomes:

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Ability to apply the knowledge on optimization methods and algorithms to develop different types of optimization problems	PO1(3)
CO3	Ability to solve various real life optimization problems by using computer software	PO2(2)
CO5	Ability to do research by applying optimization techniques in problems of Engineering and Technology	PO4(3)

COURSE CONTENTS

Module-I: Linear Programming: Graphical Method, Simplex method, Penalty Method,

Module-II: Transportation Models, Assignment Models, Sequencing and Scheduling Models by Johnson's Algorithm

References Recommended:

Books

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

External Links:

- https://www.informs.org/Resource-Center/INFORMS-Student-Union/Consider-an-Analytics-OR-Career
- https://www.informs.org/
- https://en.wikipedia.org/wiki/Operations_research
- Google and YouTube

Journals:

- International Journal of operations Research
- European Journal of Operations Research
- International Journal of Operations Research and Optimization

Engineering Economics and Costing

Code	Course Title	Credit	T-P-PJ
CUTM1012	Engineering Economics and Costing	3	2-0-1

Course Rationale:

This course aims at providing the student with advanced concepts of engineering economic analysis and its role in engineering decision making.

Course Objectives:

CO1. Facilitate students to understand the basics of Economics and its application in the field of engineering
CO2.Enable students to understand the concepts of the time value of money and techniques for evaluation of engineering projects along with it critically analyse in identifying the actual cost of fixed assets used over a period of time in a business organization.
CO3.Equip students with the skills required to understand cost statements/records of the product and its effect on decision making

Course Outcomes:

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Students will get the knowledge of the microeconomics concepts related to business and its impact on enterprise	PO1(3)
CO2	Development of awareness and understanding time value of money and techniques for evaluation of engineering projects along with it critically analyse in identifying the actual cost of fixed assets used over a period of time in a business organization.	PO2(3) & PO11(2)
CO3	Apply cost concepts to analytical business management decisions such as pricing a product and services.	PO2(3)

COURSE CONTENTS

Module: I: Engineering Economics – Nature and scope

General concepts on Micro &Macro Economics. 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.

Books

- Riggs, Bedworth and Randhwa, "Engineering Economics", McGraw Hill Education India.
- Mithani, D.M., Principles of Economics. Himalaya Publishing House
- Mishra,S. "Engineering Economics & Costing ", PHI
- Sullivan and Wicks, " Engineering Economics", Pearson
- Paneer Seelvan,R., " Engineering Economics", PHI
- Gupta, G.S., " Managerial Economics", TMH
- Lal and Srivastav, " Cost Accounting", TMH

Links to websites:

- http://courseware.cutm.ac.in/

Project Management

Code	Course Title	Credit	T-P-PJ
CUTM1013	Project Management	3	2-0-1

Course Objectives:

- The successful development and implementation of all project's 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
- The achievement of the project's main goal within the given constraints

Course Outcomes:

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Acquire 10 knowledge area identified by PMI and its application while delivering a projects	PO1(3)
CO2	Students will acquire required technical skill to develop a Project Charter and Project Management Plan document for any project	PO2(3), PO3(3)
CO3	Acquire necessary managerial skill to build team and resolve all issues/challenges to deliver a project	PO9(3), PO7(2)
CO4	Will build soft skill to lead and comply and communicate with all stakeholder's expectation	PO10(3), PO8(3)

COURSE CONTENT:

Unit: 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.

Unit: 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

Unit: 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

Unit: 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

Note: Students can use any of these software for their project; MS. Excel/ Bitrix 24/Primavera/ Microsoft Projects

Books Recommended:

1. Project Management: A Managerial Process, Clifford F Gray & Eric W Larson, Tata McGrawHill **[Text book]**
2. A Guide to the Project Management Body of Knowledge, 6th Edition, PMI
3. Project Management- A system Approach to Planning, Scheduling and Controlling (Harold Kerzner). CBS Publishers and Distributers, New Delhi.
4. Projects, Preparation, Appraisal and Implementation (Prasanna Chandra), 3rd Edition, Tata Mc Graw Hill, New Delhi.
5. Project Management (Nagarajan, K), New Age Publishers, New Delhi.
6. Project Management. A Managerial Approach (Meredith, R.J and Mantel, S.J), Wiley (India).

Gender, Human Rights and Ethics

Code	Course Title	Credit	T-P-PJ
CUTM1014	Gender, Human Rights and Ethics	3	1.5-0-1.5

Course Objectives

- This course is about gender, human rights and ethics in which the student will be sensitized and exposed to related issues in the context of business and organisations in India. The specific objectives are:
- To develop an understanding of gender, human rights and ethics in an unequal society like India
- Sensitisation of how gender, human rights and ethics are significant in organisations.
- Integrating concerns related to gender, human rights and ethics in organisations.

Course Outcomes

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Students will get knowledge of understanding the complexity of issues and challenges relating to gender, human rights and ethics	PO1(2)
CO2	Be sensitive to gender, human rights and ethics within an analytical and organizational context	PO3(1), PO3(2)
CO3	Students will appreciate and practice ethical means in personal and professional life	PO8(3)

COURSE SYLLABUS

Module 1

Difference between sex and gender; social construction of gender and its outcomes in the form of behaviour, 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 2

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 3

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.

Session Plan

Session 1

Basic concepts on sex and gender; social construction of gender; constitutional provisions for gender equality.
PPT 1 - Introduction to Gender
1.5 mins video on Gender Equality and Poverty
https://www.youtube.com/watch?v=4viXOGvvu0Y

Session 2

Gender issues in different sectors – Health, Education, Governance, Livelihoods
PPT 2 - Gender issues in health
PPT 3 - Gender issues in education
PPT 4 - Gender issues in Governance
1.3 mins video on gender stereotypes and education
https://www.youtube.com/watch?v=nrZ21nD9I-0

Session 3

Approaches to address gender inequality – WID, WAD and GAD
PPT 5 - WID WAD GAD
TED talk by Deepa Bhardwaj - True equality is when both women and men have a voice - 13 mins
https://www.youtube.com/watch?v=BSRTZ_q4RX8

Session 4 & 5

Gender and organizational issues
PPT 6 - Gender and Organisations
PPT 7 - Gender Equality in Organisations
PPT 8 - Gender Mainstreaming and Attitude in Worksplace
PPT 9 - Gender Sensitisation
3.22 mins on The Future of Gender Equality in Work by ILO
https://www.ilo.org/global/about-the-ilo/multimedia/video/institutional-videos/WCMS_558508/lang--en/index.htm
4.22 mins video on Gender Based Analysis
https://www.youtube.com/watch?v=p6w-d1mmjFU
Free Readings
Gender and Development - Concepts and Definitions
Gender and Organisational Change Training

Project
-Gender Responsive Governance in times of COVID 19
https://in.one.un.org/gender-responsive-governance-in-the-times-of-covid-19/
- SDG - Gender Equality Goal 5
https://in.one.un.org/page/sustainable-development-goals/sdg-5/
- Gender, Sustainability and Environment
Women_Environment_and_Sustainable_Development_A_Ca
- Good Practices of Gender Mainstreaming in India
Good Practices for Gender Mainstreaming
- Gender Equality Case Study
Gender Equality - Kerala Case Study

Session 6

Basic concepts on human rights; history of human rights; current significance
Videos on Basic concepts of human rights
https://www.youtube.com/watch?v=ew993Wdc0zo
https://www.youtube.com/watch?v=JpY9s1Agbsw
Videos on History of Human Rights
https://www.youtube.com/watch?v=nDgIVseTkuE
https://www.youtube.com/watch?v=6XXGF_V8_7M

Session 7

Violation and legal framework for the protection of human rights
Video on the Paris Principles
https://www.youtube.com/watch?v=ZEgD7pdXt_c

Video on Protection of Human Rights Act 1993 (for reference, bilingual)
https://www.youtube.com/watch?v=qAiiOyL5WAw

Session 8

Human rights and sustainability framework
Video on Human Rights and Sustainable Development
https://www.youtube.com/watch?v=mHHy1gDn4x8

Session 9 & 10

Human rights in the organizational context
Video on Why should your company care about human rights
https://www.youtube.com/watch?v=mCtNx3hHZ08
Video on UN Reporting Framework: Salient Human Rights Issues
https://www.youtube.com/watch?v=LswDupgiZug
Books:
1.Arihants UGC NET Human Rights and Duties
2.Kapoor, S. K. Central Law Agency's Human Rights under International Law and National Law
Ciapham Andrew, 2015, Human Rights: A Very Short Introduction, Oxford University Press
Smith Rhona, 2015, Textbook on International Human Rights, Oxford University Press
Free Online Sources:
https://www.humanrightscareers.com/…/10-human-rights-study-books-you-can-download
https://www.humanrightscareers.com/courses/

Session 11

Basic concepts in ethics
PPT - Introduction to Ethics
Video on Ethics defined
https://www.youtube.com/watch?v=4vWXpzlL7Mo

Session 12

Theoretical perspectives – utilitarianism, virtue ethics, duty ethics
PPTs - Duty Ethics
Utilitarianism
Virtue Ethics
Video on Utilitarianism
https://www.youtube.com/watch?v=-FrZl22_79Q
Video on virtue ethics
https://www.youtube.com/watch?v=NMblKpkKYao
Video on deontology (duty) ethics

https://www.youtube.com/watch?v=wWZi-8Wji7M

Project (self exploration through case studies)

Fraudulent Books_1

Gifts from the Boss's Friend_1

Gifts from the Sales Representative_1

Session 13

Ethical relativism

PPT - Ethical Relativism

Video on Moral relativism

https://www.youtube.com/watch?v=5RU7M6JSVtk

Project (self-exploration through case studies)

Mining Data docx_1

Office Affair_2

On-time Delivery

Session 14 & 15

Ethics in organisations

Video on ethics in the workplace

https://www.youtube.com/watch?v=0mUxMpMTT28

Project (self-exploration through case studies)

Falsifying Attendance_1

Family Loyalty vs. Meritocracy_1

Rumors_1

The Supervisor's Choice_1

Books

Frankena, WK, 1973, Ethics (2nd Edition), Pearson.

Singer, P. 2011, Practical Ethics (3rd ed), Cambridge University Press.

Smart, JJC and Williams, B. 1973, Utilitarianism: For and Against, Cambridge University Press.

Climate Change, Sustainability and Organisations

Code	Course Title	Credit	T-P-PJ
CUTM1015	Climate Change, Sustainability and Organisations	3	**1.5-0-1.5**

Course Rationale:

This course is about climate change, sustainability and its implications for organisations. Climate change and sustainability are closely interlinked. Students will be exposed to related issues, challenges and debates on the subjects. They will develop an understanding of how organizational performance gets affected by climate change today. As organisations grow and diversify in India, there is a need to sensitise Management students to the significance of climate change and its impact on humanity and environment; Sustainable Development Goals (SDGs) and integrated reporting framework for sustainability of organisations.
Module 1: Climate Change and Organisations

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

Course Outcome:

COs	**Course Outcomes**	**Mapping COs with POs (High-3, Medium-2, Low-1)**
CO1	Students will get knowledge of climate change issues, challenges and debates	PO1(2)
CO2	They will be sensitive to its implications for organizations in different critical sectors	PO2(1)
CO3	The course will give students decision taking ability and to develop strategies for perspective planning of organizations for sustainability	PO3(2), PO7(3)

COURSE CONTENTS:

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

Projects: Case study, videos, small group workshops, book reviews

Session Plan for Module 1 – Climate Change and Organisations (10 one hour sessions)

Session 1: Basic concepts of climate change, impacts, issues and challenges

Session 2: Responses and mitigation efforts by state and non-state agencies

Session 3: Debates and critiques on climate change

Session 4: Climate change and ecosystem

Session 5: Climate change and social sector – health, education and livelihood/food security

Session 6: Climate change and infrastructure and services – buildings, transportation, communication, electricity/energy

Session 7: Mitigation and adaptation of climate change impacts on business organisations

Session 8 and 9: Climate change impacts of migration, disasters and pandemics – societal and organisational implication

Session 10: Develop reference points to factor into perspective planning and development of organisations

Module 2 – Sustainability in Organisations

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

Projects: Small group exercises, case analysis, video and book reviews

Session Plan for Module 2 – Sustainability in Organisations (10 one hour sessions)

Session 1: Sustainable development basics and introduction to SDGs (rationale, issues and challenges for India)

Session 2 to 6: Discussion on the 17 SDGs

Session 7: SDGs and its relevance for organisations

Session8 to 10: Integrated framework for reporting sustainability in organisations; factoring aspects of SD into performance of organisations

The 17 sustainable development goals (SDGs) to transform our world:

GOAL 1: No Poverty

GOAL 2: Zero Hunger

GOAL 3: Good Health and Well-being

GOAL 4: Quality Education

GOAL 5: Gender Equality

GOAL 6: Clean Water and Sanitation

GOAL 7: Affordable and Clean Energy

GOAL 8: Decent Work and Economic Growth

GOAL 9: Industry, Innovation and Infrastructure

GOAL 10: Reduced Inequality

GOAL 11: Sustainable Cities and Communities

GOAL 12: Responsible Consumption and Production

GOAL 13: Climate Action

GOAL 14: Life Below Water

GOAL 15: Life on Land

GOAL 16: Peace and Justice Strong Institutions

GOAL 17: Partnerships to achieve the Goal

Videos – Climate Change

1. CSE Climate Change Analysis - https://www.youtube.com/watch?v=5fyT3-9kxU4 (7.5 mins)
2. Climate Change is having Massive Impact on Indian Farmers - https://www.youtube.com/watch?v=A8gcGaIzqIw (8.5 mins)
3. Climate Change in India: The Risks we face (NDTV) - https://www.youtube.com/watch?v=AT1yi1tDenM (20.28 mins)

Videos – Sustainable Development

1. Short Videos (5) on Sustainable Development Goals and one TED Talk
2. https://developmenteducation.ie/blog/2017/09/5-videos-sustainable-development-goals-worth-view-useful-ted-talk/
3. Overview of Sustainable Development Goals - https://www.youtube.com/watch?v=s190sjqYRdg (7.43 mins)

Projects:

1. Climate change impacts on agriculture and policy responses – what is the current practice and its implications for the sector and people; give your own recommendations based on your understanding of issues, challenges, debates, critiques.
2. Marine fishing – fisherfolk
3. Forest dwellers
4. Business organisations – MSMEs, manufacturing, service industries; application of the integrated framework for sustainability reporting

Job Readiness

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

Course Objectives

- To develop additional skills (verbal, logical, quantitative and reasoning) required to enhance employability as well as the entrepreneurial ability of the students

Course Outcomes

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Ability to enhance listening, speaking, reading and writing skills of the students	PO1(3),
CO2	Students must achieve the scores in IELTS 6.5	PO2(2)
CO3	Increase the Problem solving and Decision taking ability in students.	PO2(1)
CO4	It can enable ethical principles among students and they will commit to professional ethics and responsibilities.	PO8(2)
CO5	It can improve students' soft skills to communicate while working in a team. Also it helps to engage in independent research and lifelong learning in the technology context.	PO9(2) , PO10(2), PO11(1) , PO12(2)

Note: A student will be awarded the credits and grades as outlined in the attached presentation: https://drive.google.com/file/d/1Wst-jdAJuHHVtYC4F-p3SKuw1PHWOI1U/view?usp=sharing

COURSE SYLLABUS

Course Division

Course I: IELTS - Reading, Listening, Speaking, and Writing

Course II: IELTS Verbal

Course III: Quantitative Aptitude

Course IV: Logical Reasoning

Course I: IELTS - Reading, Listening, Speaking and Writing

Module I: IELTS Reading (18hrs)

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

Module II: IELTS Listening (6hrs)

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

Module III: IELTS Speaking (18hrs)

- Speaking about yourself, your family, your work and your interests
- Introduction & Interview
- Topic Discussion (e.g, Environment, Covid 19, Job)
- Assessment on Speaking Skills

Module IV: IELTS Writing (6 hrs)

- 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
- CV Writing (2nd year)
- Letter Writing
- Email Writing (2nd year)
- Getting Started –writing an introduction

Course II: IELTS 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)

Course III: Quantitative Aptitude

Module I: Number System & Operation (14 Hrs)
- Speed Math-1: Multiplication tricks, Square, cube, square root, Cube root tricks
- Speed Math-2: Speed Calculations
- Number System-01: Operation on Numbers, Classification of Numbers, Tests of Divisibility, Unit Digit Calculation
- Number System-02: Arithmetic Progression, Geometric Progression, Factors & Factorials, Trailing Zeroes, Remainder Theorem
- HCF & LCM: Concepts, short tricks, question discussion
- Average: Concepts, short tricks, question discussion
- Assessments

Module II: Basic Arithmetic (16 Hrs)
- Percentage-01: Basics of Percentage, Effective percentage, shortcuts
- Percentage-02: Advanced questions and discussions
- Profit & Loss-01: Basics and advanced questions of Profit & Loss and shortcuts
- Profit & Loss-02: MRP, Discount, Successive discount
- Ratio & Proportion: Types of ratios, Basics & Advanced Question
- Age: Concepts & Shortcuts
- Partnership: Concepts & Shortcuts
- Mixture &Allegation: Rule of Allegation, Basics & Advanced question, Short tricks
- Assessments

Module III: Time & Analysis (17 Hrs)
- Time, Speed, Distance: Concepts, Problems based on relations, Average speed, Stoppage time
- Trains: Relative Speed & All types of train problems
- Boats & Streams: Basics, Upstream, Downstream & Shortcuts
- Race: All concepts & Shortcuts
- Time & Work: Efficiency, wages, alternative day, chain rule
- Pipes & Cistern: Positive & Negative work
- Simple Interest: Concepts & Shortcuts on Simple Interest &Instalments
- Compound Interest: Concepts & Shortcuts on Simple Interest &Instalments
- Logarithm: All Formulae, concepts & Shortcuts
- Assessments

Module IV: Advanced Arithmetic (16 Hrs)

- Equation: Linear & Quadratic
- Permutation: All concepts & Shortcuts on factorial, fundamental principles of counting
- Combination: All concepts & Shortcuts on Selection (Groups/teams)
- Probability: Terms related to Probability, Event, Theorems related Probability, Conditional Probability. Shortcuts on coins, dices, balls, cards, etc
- Data Interpretation: (Bar/Pi-Chart /Line) graph
- Mensuration: Area & Volume
- Height & Distance: Lines of Sight, Horizontal line, Angle of Elevation, Angle of Depression
- Assessments

Course IV: Logical Reasoning

Module I: Verbal Reasoning-I (14 Hrs)

- Series-1: Number series (Missing & Wrong)
- Series-2: Letter, Alpha numeric, Miscellaneous series
- Coding & Decoding: Letter Coding, Number coding, Message coding, Substitution coding, Conditional coding
- Word Problem: Analogy, Odd man out, word formation, letter pair
- Logical Thinking: Brain Riddles
- Assessments

Module II: Verbal Reasoning-II (14 Hrs)

- Order & Ranking: Ranking & Sequence
- Direction Sense Test: Shortest Distance, Angular movement concept and Dusk & Dawn
- Clock: Concepts of Angle, Reflex angle, Right angle Opposite, Coincide and Incorrect clock
- Calendar: All concepts & Shortcuts
- Blood Relation: Jumbled-up descriptions, coded relations, Relation Puzzles
- Assessments

Module III: Non Verbal Reasoning (14 Hrs)

- Cubes & Dices
- Cubes & Cuboids
- Embedded Figure& Figure series
- Figure Puzzle & Figure grouping
- Figure Counting
- Mirror & Water Image
- Paper Cutting & Paper folding
- Assessments

Module IV: Advanced Reasoning (16 Hrs)

- Sitting Arrangement: Circular, Square, Rectangular, Linear, Triangular
- Puzzle: Box, Floor, Month, Day
- Advanced Puzzle: 3 variable
- Logical Venn Diagram

- Syllogism
- Statement & Conclusion
- Data Sufficiency
- Assessments

Course Structure
Basket - III

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

Industrial IoT and Automation

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

Course Objectives

- Students will learn the new evolution in hardware, software, and data.
- While the promise of the Industrial Internet of Things (IIoT) brings many new business prospects, it also presents significant challenges ranging from technology architectural choices to security concerns.
- Students acquire the upcoming Industrial Internet of Things: Roadmap to the Connected World Course offers important insights on how to overcome these challenges and thrive in this exciting space.

Course Outcomes

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Able to gain Knowledge of key IIoT concepts including IoT technologies, architectures	PO1 (3),
CO2	Able to identify sensors, localization, wireless protocols, data storage and security	PO3(3)

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, ESp8266, Introduction to raspberry Pi.

MODULE2: IIOT Components

Theory:

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

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

Sensors -Ultrasonic Sensor, IR sensor, MQ2, Temperature and Humidity Sensors (DHT-11). Digital switch, Electro
Mechanical switches.
Practice:
2. Measurement of temperature & pressure values of the process using raspberry pi/node mcu.
3. Modules and Sensors Interfacing (IR sensor, ultrasonic sensors ,Soil moisture sensor) using raspberry pi/node mcu.
4. Modules and Actuators Interfacing (Relay, Motor, Buzzer) using raspberry pi/node mcu.

MODULE 3: Communication Technologies of IIoT

Theory:
Communication Protocols: IEEE 802.15.4, ZigBee, Z Wave, Bluetooth, BLE, NFC, RFID
Industry standards communication technology (LoRAWAN, OPC UA, MQTT), connecting into existing Modbus and Profibus
Technology, wireless network communication.
Practice:
5. Demonstration of MQTT communication
6. Demonstration of LoRa communication.

MODULE 4: Visualization and Data Types of IIoT

Theory:
Front end EDGE devices, enterprise data for IIoT, emerging descriptive data standards for IIoT, cloud data base, could
Computing, fog or edge computing,
Connecting an Arduino /raspberry pi to the Web: Introduction, setting up the Arduino/raspberry pi development
Environment, Options for Internet connectivity with Arduino, configuring your Arduino/raspberry pi board for the IoT.
Practice:
7. Visualization of diverse sensor data using dashboard (part of IoT's 'control panel')
8. Sending alert message to the user.

MODULE 5:

Theory
Extraction from Web: Grabbing the content from a web page, sending data on the web, troubleshooting basic Arduino
issues, types of IoT interaction, Machine to Machine interaction (M2M).
Practice
9. Device control using mobile Apps or through Web pages.
10. Machine to Machine communication

MODULE 6: Control & Supervisory Level of Automation

Theory
Programmable logic controller (PLC), real-time control system, Supervisory Control & Data Acquisition (SCADA).
HMI in an automation process, ERP &MES
Practice
11. Digital logic gates programming using ladder diagram
12. Implementation of Boolean expression using ladder diagram
13. Simulation of PLC to understand the process control concept.

Module 7: Application of IIOT

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

Text Books:

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

Reference Books:

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

Data Analysis and Visualization Using Python

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

Course Objectives

- How to tell a story from data
- How to marshal the data for storyline
- Get skill to quickly and easily draw plot or visualize the information through visualization technique
- The ability to develop visualization to tell the story
- Get skill on analysis of data using visualization as a tool

Course Outcomes

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Able to gain knowledge on visualization with good story line and perform job of a data analyst	PO1 (3)
CO2	Able to analyse and visualize the dataset	PO2(3)
CO3	Ability to design dashboard	PO3 (3), PO5(1)

COURSE CONTENT

Module-I

STORY BOARD DEVELOPMENT

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

Module-II

DATA READING USING PYTHON FUNCTIONS

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-III

DATA VISUALSATION USING PYTHON LIBRARIES

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

Reading materials and videos available on internet on how to use ANACONDA, JUPYTER NOTEBOOK and Python Libraries

Machine Learning using Python

Code	Course Title	Credit	T-P-PJ
CUTM1019	Machine Learning using Python	4	1-2-1

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.

Course Outcomes

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Able to gain knowledge on ML solutions in their respective fields of study	PO1 (3)
CO2	Able to analyze several problems and apply ML techniques to solve it	PO2(3)
CO3	Ability to design prediction and classification models	PO3 (3)

COURSE CONTENT

Module 1 – Application and Environmental-setup (12 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 (8 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 (24 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 (12 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

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Advanced knowledge on robotic automation	PO1 (3), PO2(2)
CO2	Design different types of circuits using devices which are connected to robotic modules	PO2(2), PO3 (2)
CO3	To write code using C++ for various types of robotic applications.	PO5 (2)
CO4	Apply the concepts in Industry based project & advanced learning.	PO5 (3)

COURSE SYLLABUS

Module – 1

Robotic Automation Introduction
1.1 Basic's of automation

1.2 Use of robots in industry.

Module - 2

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

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

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

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

- Mobile controlled robot
- Autonomous operated robot.
- Location targeted robot

Basics of Design Thinking

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

Course Rationale:

Steve Jobs famously said "Design is just not what it looks or feels like. Design it how it works". Design Thinking is described as a discipline where a designer's sensibility and methods match with the needs of users. It draws on logic, imagination, intuition and systematic reasoning to explore the possibilities of a solution to a challenge and to create desired outcomes that benefit the end user. So, if you are among the one who is constantly thinking of solving a problem of business or society, it is ideal for you. This course will help you with the basics of design thinking and through an action centric learning approach, lead to creatively exploring the challenges and by using the design thinking tool propose innovative solutions.

Course Objectives:

- To orient the participants with the basics of the design thinking process
- To familiarize participants with the elements of Design thinking

Course Outcomes

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	It can improve the Knowledge of imagination, intuition and systematic reasoning to explore the possibilities of a solution to a challenge and to create desired outcomes	PO1(3)
CO2	will help you with the basics of design thinking and through an action centric learning approach, lead to creatively exploring the challenges and by using the design thinking tool propose innovative problem solutions.	PO2(3), PO4(3)

COURSE CONTENTS:

Module: I

Basics of Design Thinking, Why Design Thinking, Design Thinking Mind-set (Inspiration, Ideation and Implementation) Design thinking process, (Empathy, Define, Ideate, Prototype, Test). Cases of application of Design thinking approach (Intuit, IDEO, Infosys, IBM, Google, Apple, Jubilant Foods)

Module: II

Executing a Design Thinking Project- Apply Interviewing and empathy building technique, Drawing inferences from the observations, Defining a point of view, Ideation process, developing and testing prototypes and writing a story of a minimum viable solution.

Projects-

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

Recommended References:

Books: 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.
- To enable users to easily build their own components or adapt existing ones to match their unique needs.
- To provide hardware-in-the-loop simulations (HILS) i.e. real-time simulation with AurdinoUno, Python, Matlab, 3D real-time animation, CAD files import capability.
- To increase the ability to integrate with complex 3D geometry for integrated simulation.
- To increase powerful model management, calibration & optimization capabilities.

Course Outcomes

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	It can improve the Knowledge to better understand the behaviour of systems and to work and communicate accurately with partners and suppliers.	PO1(3)
CO2	DYMOLA is not only capable of supporting an ad-hoc modelling level, such as functional behaviour or detailed design, but is also able to convert these predictive models into real-time models.	PO2(3), PO4(3)
CO3	Future Centurions are ready for operating in many industries including automotive, aerospace, architecture, Motorsport, energy, and high tech.	PO3(3)

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=k7lLBASaEJg

Session Plan

Session 1

Project **1**
Simulating a model – Modelling of Integrated circuits
Description: Use of Electrical and Electronics components.
Workbench Use: Behaviour Modelling, Functional and Logical Design.

Session 2

Project **2**
Simulating a model -Creating a model for Electric DC Motor
Description: Design a DC Motor Model, Test, and Simulation, creating a library for components, Creating a model for motor drive, Scripting.
Workbench Use: Behaviour Modelling, Modelica Standard Library.

Session 3

Project **3**
Simulating a model -Simple Pendulum with Frictionless joint Using Multi-Body Library

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

Session 4

Project **4**
Simulating a model – Pick and Place Robot
Description: 5 Axis Pick and Place Robot Design, Validation, and Optimization in the 3DS platform.
Workbench Use: Behaviour Modelling, Functional and Logical Design. Part design and Assembly Design.
https://www.youtube.com/watch?v=9RgdZUvEjPw

Session 5

Project **5**
Simulating a model – 3D Printer Design
Description: Design All System and Sub System of the 3D Printer, Validation and Simulation using 3Ds Platform.
Workbench Use: Behaviour Modelling, Functional and Logical Design. Part design and Assembly Design.

Session 6

Project **6**
Simulating a model – Bicycle Behaviour Modelling
Description: Design Power Train, Driving Cycle, part design, and Simulation.
Workbench Use: Behaviour Modelling, Functional and Logical Design. Part design and Assembly Design.

Session 7

Project **7**
Simulating a model – Refrigerator Compartment Door Design using Thermal Library
Description: This component models the airflow through the door of a refrigerator or freezer compartment.
Workbench Use: Behaviour Modelling, Functional and Logical Design. Part design and Assembly Design.

Session 8

Project **8**
Simulating a Model – Engine Analytic Using MultBody Library.
Description: Engine analytic, an engine with 6 cylinders, 6 planar loops, 1 degree of freedom, and analytic handling of kinematic loops.
Workbench Use: Behaviour Modelling.

Session 9

Project **9**
Simulating a model – Control the real and Digital servo motor ArduinoUno Library
Description: Control the Real and Digital Servo motor with simulation.

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

Session 10

Project **10**

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

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

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

Session 11

Project **11**

Simulating a model – Implementation of Model using Python Library

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

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

Session 12

Project 12

Simulating a model – Industrial Robot Design

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

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

Session 13

Project **13**

simulating a model – Temperature Control System Using State Graph

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

Workbench Use: Behaviour Modelling.

https://www.youtube.com/watch?v=zz-_crJOGo0&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_YI3RiTI14

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 together to build a smart live project.
- To make the centurion's think beyond engineering.
- To provide the platform to express the imagination to reality.
- To acculturate *the* diversity in engineering.
- To make the centurions industry ready.

Course Outcomes

	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	It can improve the Knowledge to Learn the new tools and use them to solve some current problems in their respective areas.	PO1(3)
CO2	Able to learn current industry software's and work on projects based on multidisciplinary fields using different analytical skills.	PO2(3), PO4(3)
CO3	Can be able to discover engineering as a quality product outcome using different tools.	PO3(3)

COURSE SYLLABUS

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

Project categories:

- Software/Hardware Based
- Real-Time
- Multidisciplinary

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

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

Hardware

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

Simulation Software's

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

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

Projects In Track:

- Analysis Design of G+10 Building using STAAD Pro
- Automated water irrigation controller for rice field
- Automatic Microgrid System
- Automation in Light and Fan in Classroom
- Speed Control Of Dc Motor using Arduino
- Bench Tapping Machine
- Modular E-Rickshaw Design using Catia
- Renewable Energy using Compressor
- Wireless Control Robotic car through MATLAB GUI
- Water Level and Temperature Indicator
- Speech Recognition using Python
- IOT Based Air Pollution Quality Monitoring with ESP8266
- Plant Disease Detection using Image Processing
- IOT Based Air Quality and Monitoring By Using Arduino

- Automatic agriculture field monitoring device
- IOT Based Weather Station Using GY-BME280 Sensor Module and ESP8266-12E Node MCU LUA Wi-Fi Module
- Bluetooth Controlled Car Using ARDUINO
- Crimes Against Women in India
- A Presentation on Analysis of QUAD COPTER
- Collecting Data and Visualizing of a Mobile Sensors of Android Device
- Manufacturing of Knuller Tool
- Smart Product Sanitization and Packaging System

Product In Track

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

Session Plan

Session 1

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

Session 2

- Review of gate zero process

Recent Comments

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

Course Structure

Basket - IV

Aerospace Engineering

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

CUTM1104	Introduction to Avionics	3	2+1+0	Introduction to Aerospace Engineering
CUTM1088	Thermodynamics	3	2+1+0	
CUTM1089	Fluid Mechanics with Finite Volume Method	3	2+1+0	
CUTM1062	Theories of Failure Using Finite Element Analysis	4	2+2+0	
CUTM1058	Programming in Java(Same as Java Technologies)	3	2-1-0	
CUTM1059	Database Management Systems	3	2-1-0	
	Total Credits	**58**		

Introduction to Aerospace Engineering

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

Course Objective

- Student will study this course to gather knowledge about the atmospheric condition with change in altitude, different component and its functions of aircraft, basic working principles behind the flight and different types of engines.

Course Outcomes

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Learn the Atmospheric parameter changes with altitude.	PO1(3), PO2(2)
CO2	Ability to identify the types & classifications of components and control systems. An ability to differentiate the types of fuselage and constructions.	PO1(3), PO2(2)
CO3	Understand the basic concepts of flight. Different types of Engines and working principles.	PO2(3), PO3(1)

COURSE CONTENT

Module I: Aerospace vehicle and atmosphere (3hrs)

Introduction to aerospace engineering, Different aerospace vehicle / airship, Atmosphere,
Practice- Write a program for variation of temperature, pressure and density with variation of altitude within troposphere and stratosphere.

Module II: Airplane and their main element (5hrs)

Fuselage, Wing, Empennage, Propulsion,
General aviation-Purposes, history, Deferent configuration,
Commercial Aircraft- Purposes, history, Deferent configuration,
Military Aircraft- Purposes, history, Deferent configuration,
Practice- Draw 3-view diagram of commercial aircraft (Cessna 152) using Dassault system

Module III: Basic Aerodynamics (6hrs)

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

Module IV: Forces and moment on aircraft (7hrs)

Aerodynamic Forces and its dependencies, force Equilibrium, Lift and Drag description, Airfoil, Angle of attack, Bernoulli effect, Equation of lift and drag, Cl-alfa curve,
3D wing: Lift, Drag, Force distribution over wing, Down wash and induced drag, Wing tip, Wing configuration,
High Lift Devices, Flap and Slat, deferent types of flap, Spoiler,
Turbulence and Stall: Laminar and turbulent Flow, its impact on airfoil, Stall, 3D stall,
Practice- Find the lift and drag of 2 D airfoil (NACA 0012) at 2-degree angle of attack using Dassault system

Module V: Airplane Propulsion (5hrs)

Jet Engine Properties: Definition and overview, Component, Different type,
Inlets: Overview, Supersonic inlet, Different example,
Compressors: Overview, Types, Working principle,
Turbine and Nozzle: Overview, Afterburner,
Compressors: Multistage compressor in jet engine
Turbojet and Turbofan review: working principle, advantages and disadvantages
Practice- Study the difference between Turbojet and Turbofan engine.

Module VI: Flight Mechanics (5hrs)

Center of Gravity, variation of Center of Pressure with angle of attack
Aerodynamics Center, Stability
Control surface and maneuver: Overview, all the moments and Rotational axis, primary control surface, maneuvering, Aileron, Elevator and Rudder.
Practice- *Find out Cl, Cd and Cl/Cd* at different angle of attack using Dassault system

Module VII: Unmanned Aerial Vehicles (2hrs)

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

Text Books:

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

Reference Books:

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

Rotary-Wing Flight Dynamics

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

Course Objective

- Student will study this course to get the knowledge about different types of helicopters, and working principles of the helicopter flight.
- At end of this course student able to design a quad copter and able to fly.

Course Outcomes

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Learn the rotor reaction and how to nullify this reaction.	PO1(3), PO2(2)
CO2	Ability to identify the types & classifications of components and control systems.	PO1(3), PO2(2)
CO3	Understand the stability of helicopter. Understand the principle of VTOL/STOL. Understand of hovercraft.	PO2(3), PO3(2), PO4(1), PO5(2)

COURSE CONTENT

Module I: Rotor configuration (3hrs)

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

Module II: Methods of Control (4hrs)

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

Module III: Hovering and Vertical Flight (7hrs)

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

Module IV: Forward Flight (8hrs)

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

Module V: Helicopter Trim and Stability (4hrs)

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

Module VI: VTOL and STOL (5hrs)

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

Module VII: Ground Effect Machines (4hrs)

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

Text Books:

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

Reference Books:

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

Source of reference; NPTL

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

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

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

Aerodynamics

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

Course Objective

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

Course Outcomes

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Using Dassault system Compare the CFD data with experimental and analysing.	PO1(3), PO2(2)
CO2	Ability to estimate aircraft drag (low speed & high speed). Understanding of sensitivity of aircraft drag to various aircraft parameters.	PO1(3), PO2(3)
CO3	Designing the high-speed aircraft and nozzle.	PO2(3), PO3(2), PO4(2), PO5(3)

COURSE CONTENT

Module I: Two-dimensional Flow (4hrs)

Practice- Pressure distribution over cylinder with and without circulation using 3DS

Module II: Viscous Flow (5 hrs)

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

Practice- Flow over a flat plate at different Reynolds no using Dassault system.

Module III: Flow separation and control techniques (4 hrs)

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

Practice- Flow over a flat plate at different angles of incidence using Dassault system.

Module IV: Aerodynamics Drag (4 hrs)

Aerodynamics parameter, Wing tip vortex, down wash, different types of drag method to minimizing those. Aerodynamic efficiency and dependency,

Practice- Compare the Lift, drag and aerodynamic efficiency at different angle of attack of an airfoil using Dassault system and wind tunnel.

Practice- Design and simulate nacelles, intakes and nozzles using Dassault system

Module V: Shock Wave (4 hrs)

Normal shock and equations, Oblique shocks and corresponding equations, θ- β- M relation, Hodograph and pressure turning angle, shock polar, flow past wedges. strong, weak and detached shocks.

Practice- Design and simulate the flow over nacelles, intakes and nozzles using Dassault system

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

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

Module VII: Airfoil in High-Speed Flows (4hrs)

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

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

Text Books:

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

Reference Books:

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

Flight Mechanics

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

Course Objective

- To understand performance of aircraft
- To understand static and dynamic stability of aircraft
- Get basic knowledge of aircraft designing

Course Outcomes

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Effectively use performance calculations for Aircraft design project.	PO1(3), PO2(2)
CO2	Understand the accelerated flight performance. Understand takeoff and landing performance.	PO1(3), PO2(3)
CO3	Effectively use and understand stability for Aircraft. Able to understand the process of aerodynamic designing.	PO2(3), PO3(2), PO4(2), PO5(3)

COURSE CONTENT

Module I: Drag and power required for Steady level flight (5hrs)

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

Module II: Un-Accelerated flight performance (6 hrs)

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

Module III: Take-off and landing performance (4 hrs)

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

Module IV: Turning performance **(6 hrs)**

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

Module V: Longitudinal stability **(8 hrs)**

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

Module VI: Lateral and Directional stability **(7 hrs)**

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

Module VII: Control surface and stick forces **(4hrs)**

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

Text Books:

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

Reference Books:

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

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

Steps:

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

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

Aircraft Structures

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

Course Objective

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

Course Outcomes

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Analyse the truss structure and find forces acting in the individual members deflections of the truss with the nature using different methods.	PO1(3), PO2(2), PO3(2), PO4(2), PO5(2)
CO2	Calculate the reaction forces for indeterminate beams. Should be able to draw shear force and bending moment diagrams for indeterminate beams using different methods. Calculate the bending stresses in unsymmetrical sections using different. Calculate crippling load of columns and beam columns with various end conditions using Euler's method and Rankine's formula.	PO1(3), PO2(3), PO3(3), PO4(2), PO5(2)
CO3	Analyze the buckling and crippling characteristics of rectangular shear panels.	PO2(3), PO3(2), PO4(2), PO5(2)

COURSE CONTENT

Module I: Statically indeterminate structures (4hrs)

Shear force and bending moment of fixed-fixed beam, Propped cantilever beam, Continuous beam, Clapeyron's Three Moment Equation, Moment Distribution Method.
Practice: Bending stress of a indeterminate beams using 3D Experience Tool

Module II: Energy methods (5hrs)

Strain Energy in axial, bending, torsion and shear loadings. Castigliano's theorems and their applications. Energy theorems – dummy load & unit load methods – energy methods applied to statically determinate and indeterminate beams, frames & trusses. Deflection of indeterminate beams using energy method and unit load method
Practice: Deflection of beams using Dassult System Experience Tool free and forced Vibration of a Cantilever Beams using 3D Experience Tool

Module III: Shear flow in open sections (6hrs)

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

Module IV: Shear flow in closed sections (5hrs)

Bredt-Batho formula, Shear flow in single and multi, cell closed structures under bending and torsion, Shear stress distribution in constrained closed sections,
Practice: Locate Shear Centre for closed section
Determination of Principal axis of Unsymmetrical beams

Module V: Buckling of plates (5hrs)

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

Module VI: Crippling of panels (4hrs)

Crippling stresses by Needham's and Gerard's methods. Thin-walled column strength. Sheet stiffener panels. Effective sheet width, inter rivet and sheet wrinkling failures
Practice: Shear failure of bolted and riveted Joints using

Module VII: Stress analysis of wing and fuselage (3hrs)

shear force and bending moment distribution over the aircraft wing and fuselage
Practice: Stress Analysis of Wing and Fuselage using 3D Experience Tool

Text Books:

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

Reference Books:

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

E-BOOK

- http://www.freeengineeringbooks.com/AeroSpace/Aircraft-Structures-Books.php
- http://libguides.hcc.hawaii.edu/aero
- http://www.jdrr.yolasite.com/resources/Aeronautical_Engineering/BOOKS/Aircraft%20Structures%20by%20Megson%20-%20Book.pdf

Aerospace Structural Analysis

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

Course Objective

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

Course Outcomes

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Understand Aerospace Structures and Materials. Understand load paths and demonstrate the knowledge of structural behavior in fuselage and wing structures.	PO1(3), PO2(2), PO3(2), PO4(2), PO5(2)
CO2	Calculate the stresses in wing, fuselage, wing spar, attachments. Differentiate and analyze the types of aircraft fittings, bolt fittings, Riveted connections and their failures.	PO1(3), PO2(3), PO3(3), PO4(2), PO5(2)
CO3	Estimate the load of aircraft at different condition. Able to complete structural design of aircraft.	PO2(3), PO3(2), PO4(2), PO5(2)

COURSE CONTENT

Module I: Aerospace Structures and Materials uses (6hrs)

Monocoque, semi monocoque, corrugated, sandwich structure, reinforced and honeycomb structures, aerospace materials, metallic and non metallic materials, use of aluminum alloy, titanium, stainless steel, composite and ceramic materials.

Module II: Analysis of wings **(5hrs)**

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

Module III: Analysis of fuselage **(4hrs)**

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

Module IV: Analysis of wing spar **(5hrs)**

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

Module VI: Aircraft fittings and connections **(6 hrs)**

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

Module VII: V-N diagram with gust load **(3 hrs)**

Loads on an aircraft for different condition, V-n diagram,
Project- Students are expected to complete following

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

Steps:

1. V-n diagram for design study
2. Critical loading performance and final V-n graph calculation
3. Gust and maneuverability envelopes.

4. Structural design study- Theory approach
5. Load estimation of wings
6. Wing spar and stringer calculation
7. Wing shear flow calculation
8. Load estimation of fuselage
9. Fuselage shear flow calculations
10. Design of miscellaneous members
11. Detailed structural layouts.
12. Complete the documentation

Text Books:

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

Reference Books:

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

Jet Propulsion

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

Course Objectives

- To provide concepts of engine components of jet-propelled engines which are operated in atmosphere
- Understand the internal flow and external characteristics near the inlets. Starting problems and different modes of operation in supersonic inlets.
- Know the types and working principles of axial compressors and centrifugal compressors its velocity diagrams, blade design and performance characteristics of compressors.
- Understand the types and working methods in combustion chambers. The flame stabilization and flame techniques.
- Understand the flow through nozzle, choking, losses in nozzle, variable area nozzle and thrust vectoring.

Course Outcomes

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Understand the internal flow and external characteristics near the inlets. Starting problems and different modes of operation in supersonic inlets.	PO1(3), PO2(2), PO3(2), PO4(2), PO5(2)
CO2	Know the types and working principles of axial compressors and centrifugal compressors its velocity diagrams, blade design and performance characteristics of compressors.	PO1(3), PO2(3), PO3(3), PO4(2), PO5(2)
CO3	Understand the types and working methods in combustion chambers. The flame stabilization and flame techniques. Understand the flow through nozzle, choking, losses in nozzle, variable area nozzle and thrust vectoring.	PO2(3), PO3(2), PO4(2), PO5(2)

COURSE CONTENT

Module I: Introduction to aircraft propulsion (4hrs)

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

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

Module II: Diffuser (5hrs)

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

Practice: Velocity and pressure variation in a diffuser using 3DS as well as using apparatus

Module III: Axial compressor (5hrs)

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

Practice: Assembly of an aircraft jet engine compressor

Module IV: Centrifugal compressor (4hrs)

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

Practice: Cascade testing of a model of axial compressor blade row

Module V: Combustion chambers (4hrs)

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

Practice: Determination of heat of combustion of aviation fuel

Module VI: Nozzles (4hrs)

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

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

Module VII: Afterburner and thrust augmentation (3hrs)

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

Practice: Characteristic plots of a free jet through a non circular and circular orifice using high speed jet

Text Books:

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

Reference Books:

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

Advanced Propulsion

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

Course Objective

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

Course Outcomes

Cos	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	The operating principle of ramjet, combustion and its performance. The solid rocket operating principles and components of solid rocket motor.	PO1(3), PO2(2), PO3(2), PO4(3), PO5(3)
CO2	In detail about liquid propellant rockets and the various types of propellants used with their burning rates.	PO1(3), PO2(3), PO3(3), PO4(3), PO5(3)
CO3	About electric, ion and nuclear rockets. The basics of solar sails and its operating principle. Apply the concept of sacramjet design of inlets and its hypersonic applications.	PO2(3), PO3(2), PO4(3), PO5(3)

COURSE CONTENT

Module I: Ramjet propulsion **(4hrs)**

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

Practice: Wall pressure measurements of a subsonic diffusers and ramjet ducts

Module II: Scramjet propulsion **(4hrs)**

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

Practice: Velocity profiles of wall jets.

Module III: Supersonic combustion (4hrs)

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

Practice: Flame stabilization studies using conical and hemispherical flame holders

Module IV: Rocket propulsion (6hrs)

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

Practice: Wall Pressure measurements of supersonic nozzle

Module V: Solid propellant rockets (4hrs)

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

Practice: Preparation of solid propellant

Module VI: Liquid propellant rockets (4hrs)

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

Practice: Determination of Thrust and heat of combustion of aviation fuel.

Module VII: Advanced propulsion systems (4hrs)

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

Text Books:

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

Reference Books:

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

- *http://nptel.ac.in/courses/101106033/*
- *http://nptel.ac.in/courses/101101001/*
- https://www.youtube.com/watch?v=HESOat2iPzU
- *http://nptel.ac.in/courses/101101002/*

Experimental Aerodynamics

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

Course Objective

- To provide knowledge about different types of wind tunnel and limitations
- Knowledge about experimental instruments.

Course Outcomes

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	To provide about the subsonic and high-speed wind tunnel. To provide Knowledge on measurement techniques in aerodynamic flow.	PO1(3), PO2(2)
CO2	To cover both operating and application procedures of hot wire anemometer.	PO1(3), PO2(2)
CO3	To describe flow visualization techniques and to highlight in depth discussion of analog.	PO2(3), PO3(2), PO4(1), PO5(2)

COURSE CONTENT

Module I: Subsonic wind tunnels (4 hrs)

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

Practice- Calibration of subsonic wind tunnel

Module II: Instruments and measurement in subsonic flow (5 hrs)

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

Practice- Lift, Drag and moment measurement by using six component balances

Module III: High Sped Wind tunnel (5 hrs)

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

Module IV: Experiments in High-Speed Tunnels (4 hrs)

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

Practice- Velocity and pressure distribution in a supersonic nozzle.

Module V: Special problem in testing (4 hrs)

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

Module VI: Hot wire anemometer and laser Doppler anemometer (4 hrs)

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

Practice- - boundary layer velocity profile on a flat plate using Hot wire anemometer

Module VII: Flow Visualization Methods (4 hrs)

Smoke and Tuft grid techniques – Dye injection special techniques – Optical methods of flow visualization.
Practice- Flow Visualization in subsonic and supersonic flow (Smoke technique in subsonic and Schlieren systems in supersonic flow.

Text Books:

1. Rae W.H and Pope. A "Low speed wind tunnel testing" John Wiley Publication, 1984
2. Rathakrishnan. E "Instrumentation, Measurement and Experiments in Fluids", CRC Press, London, 2007

Reference Books:

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

Space Dynamics

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

Course Objective

- Understand the basic concepts of space mechanics and the general N- body.
- Study satellite injection and satellite orbit perturbations.
- Acquire the knowledge of interplanetary and ballistic missile trajectories.

Course Outcomes

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Understand solar time, solar system, and associated basic terms. Gain knowledge of satellite orbits relation between position and time.	PO1(3), PO2(2)
CO2	Understand satellite orbit transfer, special perturbations.	PO1(3), PO2(2)
CO3	Can know about the various phases in missile launching. Able to learn about the spacecraft trajectories between planets.	PO2(3), PO3(2), PO4(1), PO5(2)

COURSE CONTENT

Module I: Basic Concepts (3 hrs)

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

Module II: Space Environment (3hrs)

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

Module III: The General N-Body Problem (4 hrs)

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

Module IV: Satellite Injection **(2 hrs)**

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

Module V: Satellite Orbit Perturbations **(3 hrs)**

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

Module VI: Interplanetary Trajectories **(4 hrs)**

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

Module VII: Rocket Performance **(2 hrs)**

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

Text Books:

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

Reference Books:

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

Introduction to Avionics

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

Course Objective

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

Course Outcomes

Cos	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Ability to build Digital avionics architecture.	PO1(3), PO2(2)
CO2	Ability to Design Navigation system.	PO1(3), PO2(2)
CO3	Ability to design and perform analysis on air system.	PO2(3), PO3(2),

COURSE CONTENT

Module I: Introduction to avionics (4hrs)

Practice- Addition/Subtraction of binary numbers.

Module II: Digital avionics architecture (4hrs)

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

Practice- Timer Circuits, Shift Registers, Binary Comparator Circuits.

Module III: Avionics system architecture (4hrs)

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

Practice- Encoder/Decoder Circuits

Module IV: Flight decks and cockpits (6hrs)

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

Practice- Addition and Subtraction of 8-bit and 16-bit numbers.

Module V: Introduction to navigation systems (4hrs)

Navigation Systems, Multi-sensors

Practice- Interface programming with 4-digit 7 segment Display & Switches & LED‘s

Module VI: Satellite navigation systems (5hrs)

landing systems

Practice- *Greatest* in a given series & multi-byte addition in BCD mode

Module VII: Air data systems and auto pilot (4hrs)

temperature, Mach

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

Text Books:

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

References:

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

Thermodynamics

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

Course Objectives

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

Course Outcomes

Cos	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Able to gain Knowledge on concepts of work and energy to evaluate control volumes as well as closed systems	PO1 (3)
CO2	Able to identify and resolve the problems on energy analysis and determine efficiency of various thermal devices	PO2(3), PO5(1)

COURSE CONTENT

Module I: Basic Concepts of Thermodynamics 4(hrs)

System, Surroundings, Universe, State, Thermodynamic Properties, Process, Types of Process, Reversible and Irreversible process, Quasi-static Process, Cycle, Point and path functions, Thermodynamic Equilibrium, Ideal gas, Ideal gas equation

Module II: Zeroth Law of Thermodynamics 4(hrs)

Zeroth Law of Thermodynamics, Temperature, Measurement of Temperature, Temperature Measuring Instruments, Relationship between Temperature Scales

Practice:

Temperature Measurement by using Thermocouple, Thermistors and Resistance Temperature Detector (RTD)

Module III: Work Transfer and Heat Transfer 5(hrs)

Work Transfer, Sign Convention of Work, PdV Work for Various Quasistatic Processes, Heat Transfer, Different Modes of Heat Transfer

Practice:

- Simulation of Heat Transfer in Conduction, Convection and Radiation using Finite Element Method in Simulia (Plane Wall, Fin, Metal Rod)

- Thermal Stress Analysis of IC Engine Piston using Simulia
- Thermal Analysis of Intake Manifold of Engine using Simulia

Module IV: First Law of Thermodynamics 6(hrs)

First Law of Thermodynamics Applied to Closed System, Energy, PMM1, Enthalpy, Specific Heat at Constant Volume and Constant Pressure, First Law of Thermodynamics Applied to Open System, Control Volume, Mass Balance and Energy Balance, Nozzle, Diffuser, Turbine, Compressor, Throttling Device, Heat Exchanger

Practice:

- Thermal Analysis of Nozzle, Diffuser, Turbine, Compressor, Boilor, Heat exchanger using Simulia

Module V: Second Law of Thermodynamics 5(hrs)

Kelvin Planks statement, Clausius Statement, PMM2, Working of Heat Engine, Refrigerator and Heat Pump, Carnot Cycle & Carnot Theorem

Practice:

- Working of Refrigerator and Heat Engine

Module VI: Entropy4(hrs)

Introduction to Entropy, Principle of Increase of Entropy, Clausius Inequality, Change in Entropy in Different Processes

Practice:

- Entropy Change of Metal Bar with Temperature Gradient using Simulia

Module VII: Properties of Pure Substances 5(hrs)

Introduction to Pure Substance, Phase Change Processes of Pure Substances, T-V, P-V, P-T and H-S Diagram for Steam, Dryness Fraction of Steam, Different Types of Steam. Introduction to Steam Tables: Specific Volume, Pressure, Temperature, Enthalpy and Entropy

1. Y.A Cengel, M. A Boles, "Thermodynamics an Engineering Approach", Tata McGraw-Hill Publishing Company Limited

Practice:

- Conversion of water to steam
- Determination of properties of steam from Mollier Chart

Text Books:

1. P.K. Nag, "Engineering Thermodynamics", Tata McGraw-Hill Publishing Company Limited

Reference Books:

1. Sontag, Borgnakke, VanWylen, " Fundamentals of Thermodynamics", Willey

Publisher

1. R K Rajput, "A Text Book of Engineering Thermodynamics ", Laxmi Publications

Fluid Mechanics with Finite Volume Method

Code	Course Title	(Credit)	T-P-PJ
CUTM1089	Fluid Mechanics with Finite Volume Method	3	2-1-0

Course Objective

- To learn fundamentals of computational methods like FVM for solving linear and non-linear partial differential equations related to fluid dynamics
- To emphasizes the basic underlying fluid mechanical principles governing energy transfer in a fluid flow system with their performances in different field of engineering applications

Course Outcomes

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Able to gain Knowledge on finite difference/volume schemes on model problems of computational fluid dynamics.	PO1 (3)
CO2	Able to identify and resolve the problems on steady state mechanical energy balance equation for fluid flow systems, estimate pressure drop in fluid flow systems	PO2(3), PO5(1)

COURSE CONTENT

Module I: Introduction to Finite volume Method (6 hrs)

Fundamentals of Finite volume methods, different types of finite volume grids, approximation of surface and volume integrals; interpolation methods, Review of governing equations, Classification of governing equations, Staggered and co-located formulation

Practice:

1. 2D mapped Mesh for rectangular pipe

2. 2D mapped Meshing for Aerofoil.

Module II: Grid generation (6 hrs)

Grid generation, creating, updating and managing meshes, Steady diffusion equation on structured meshes, Unsteady diffusion equation on structured meshes, Linear system solvers,

finite volume discretization of steady and unsteady diffusion equation, Finite volume discretization of convection-diffusion problem

Practice:

3. 3D structure mesh of Circular Cylinder

3D unstructured mesh with primes layers for Aerofoil

3D coarse/ medium/ fine sweep mesh for pipe

Module III: Incompressible flow field calculation with finite volume method (5 hrs)

Navier-stokes equation, Discretization of the Momentum Equation: Stream Function-Vorticity approach and Primitive variable approach, Staggered grid and Collocated grid solutions of Navier-stokes equation with finite volume method, boundary condition, Reynolds averaged Navier-Stokes equations.

Module IV: Fluid kinematics (2 hrs)

Types of flow, Continuity equation (in one-, two- & three-dimension steady state fluid flow analysis with finite volume method, velocity and acceleration fields, streamline, streak line, path line, velocity potential function and stream function, Rotation and vorticity.

Module V: Fluid Dynamics with Finite volume method (4 hrs)

Lagrangian and Eulerian Approach, Euler's equation of motion along a stream line for ideal flow, Principle of conservation of energy with finite volume method, Integration of Euler's equation along a stream line, Bernoulli's equation

Practice:

6. Fluid Analysis of Bernoulli's equation: Flow in a contracting pipe through CFD simulation

Module VI: Flow through Pipes (5 hrs)

Reynolds's Experiment, Laws of Laminar and Turbulent Friction, Introduction Turbulence modeling through Finite volume method, Hagen Poiseuille Equation for laminar flow through pipe, Darcy-Weisbach Equation for Turbulent flow through pipe.

Practice:

7. Fluid Analysis of Laminar flow in 3D Circular Pipe through CFD simulation

8. CFD Simulation of the Water Flow Passing Through a Converging Pipe.

9. CFD Analysis to determine the frictional losses in the pipe

Module VII: Flow Measurement **(5 hrs)**

Flow through small orifice meter, Mouthpiece, Velocity Measurement using Pitot tube, Prandtl tube, Flow measurement in pipes-Flow, Venturi Meter, Flow rate Measurement in channel-Weir and Notches

Practice:

10. CFD Analysis of Fluid flow through Orifice meter

11. CFD Analysis of Fluid flow through adjustable channel

12. CFD Analysis of Fluid flow simulation through Venturi Meter

Text Books:

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

Reference Books:

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

Theories of Failure Using Finite Element Analysis

Code	Course Title	T-P-PJ (Credit)	Prerequisite
CUTM1062	Theories of Failure Using Finite Element Analysis	2-2-0 (4)	NIL

Course Objective

- To educate the students on basic theories behind mechanics of solids.
- To educate the students on Finite Element Analysis concept applicable to Practical conditions.
- To educate the students on Failure Criterion which will be useful for designing Practical problems.
- To educate the students on using 3D Experience Tools for analysis of various mechanical structures and load transmitting elements.

Course Outcomes

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Able to gain Knowledge on mechanical strength of structures and load transmission elements.	PO1(3), PO2(2)
CO2	Able to improve analytical skill and critical thinking	PO2(3)
CO3	Able to develop problem solving and decision-making ability	PO2(3), PO3(2), PO5(3)

COURSE CONTENT

Module I Introduction to Finite Element Analysis (FEA) and 3D Experience Platform - (4(T)+5(P)) **(9 hrs)**

Introduction to FEA: Need for Studying FEA; Types of Analysis; Discretization of a Structure; Element Shapes, Nodes and Degrees of Freedom; Mesh Refining, Element Aspect Ratio, Use of Symmetry, Principle of Convergence; General Procedure of FEA.

Material failure Behaviour: Stress–Strain Diagrams for Ductile and Brittle Materials. Equivalent stresses for varying orientations, Principal stresses, maximum shear stress, Mohr's circles.

Practice:

1. Introduction to 3D Experience Platform: About the Apps and their Applications from Engineering Point of View.

2. Analysis of Steel Bridge – Simulation using 3D Experience Tool.

3. Tensile Test using Simulation 3D Experience Tool.

4. Stress Strain Curve of a Ductile Material (Mild Steel) using Universal Testing Machine

Module II Mesh Generation and Modeling of Truss Structure (1(T)+ 4(P) (5hrs)

Mesh Generation and Methods of Meshing and Types of Meshing. Procedure for selecting the method of meshing and type of meshing. Importance and application of Stiffness Matrix for different types of elements and the procedure for getting the results.

Practice:

5. 3D Experience Simulia – Modelling and Meshing of Transmission line tower.

Module III Stresses and Deflection Criteria: (5(T)+ 4(P) (9hrs)

Procedure for Drawing Shear Force and Bending Moment Diagrams, Point of Contra Flexure. **Stresses (No Derivation):** Simple or Pure Bending, Flexure Formula, Section Modulus, Neutral Axis, Determination of Bending Stresses, Shear Stress Distribution for Different Sections. **Deflection:** Equation of Elastic Curve, Direct Integration Method

Practice:

6. 3D Experience Simulia – Modelling and Finite Element Analysis of Framed Structure subjected Earthquake Loads.

Module IV: Theories of Failure: (2(T)+ 4(P) (6hrs)

Theories of Failure: Failure Under Biaxial Loading, Rankine's Theory, Guest's or Tresca's Theory, Von Mises Theory, Graphical Representation of Failure, Safety Factors, Prevention of Failure in Design Stage, Diagnosis of Failure in Post-Manufacturing Stage.

Practice:

7. 3D Experience Simulia: Bicycle Frame Structural Analysis

Module V: Torsion: (3(T)+ 4(P) (7hrs)

Torsion: Torsion Equation, Design of Shafts, Power Transmitted by Shafts, Composite Shafts, Combined Bending and Torsion, Closed-Coiled Helical Springs, Spring Connected in Series and Parallel.

Dynamic Analysis: Fundamentals of Vibration; Evaluation of Natural Frequencies and Mode Shapes (Eigen values and Eigenvectors); Non-linear Analysis, Fatigue Analysis. Structures Subjected to Blast Loads.

Practice:

8. Simulation: Static and Dynamic Analysis of Shaft

Module VI Pressure Vessels (1(T)+ 2(P) (3hrs)

Longitudinal and Hoop Stress in Thin-walled Pressure Vessels Subjected to Internal Pressure.

Practice:

9. Simulation: Crack Analysis of Thin-walled Pressure Vessels.

Module VII Fatigue and Fracture: (3(T)+ 4(P) (7hrs)

Fatigue: Failure Under Cyclic Loading, Endurance Limit. S-N Curve, Stress Concentration, Goodman and Soderberg Criteria.

Fracture: Types of Failure, Brittle and Ductile Fracture, Basic Modes of Fracture. Griffith's Analysis, Crack Growth and Stress Intensity Factor.

10. Fatigue Analysis of Crankshaft of Two-Wheeler

Text Books:

1. Strength of Materials, S.S. Rattan, Tata Mc-Graw Hill Publication.
2. Advanced Mechanics of Materials, A.P. Boresi and R.J. Schmidt, Willey India

Reference Books:

1. Elements of Fracture mechanics, Prashant Kumar, McGraw Hill Education (India)
2. Engineering Mechanics of Solids, Egor P. Popov, Pearson publication
3. Strength of Materials, R.K. Bansal, Laxmi Publications.

Programming in Java(Same as Java Technologies)

Code	Course Title	Credit	T-P-PJ
CUTM1058	Programming in Java (Same as Java Technologies)	3	2-1-0

Course Objective

- Understand fundamentals of programming such as variables, conditional and iterative execution, methods, etc.
- Understand fundamentals of object-oriented programming in Java, including defining classes, invoking methods, using class libraries, etc.
- Be aware of the important topics and principles of software development
- Have the ability to write a computer program to solve specified problems
- Have the ability to write a computer program to solve specified problems
- Be able to use the Java SDK environment to create, debug and run simple Java programs
- Acquire java coding skill
- It helps students in getting jobs in different IT firms

Course Outcomes

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Will gain Knowledge on object oriented java programming	PO1 (3), PO12(2)
CO2	Identify and fix defects the common safety issues in code	PO2 (3)
CO3	Read and make elementary modifications to Java programs that solve real-world problems	PO3(3), PO5(2)
CO4	Design and develop several applications with hands-on	PO3 (3)

COURSE CONTENT

Module I: Introduction to Java (8 hrs)

Features and Installation, Java Programming Basics, Decision Making and Looping, Class and Object, Inheritance
Practice 1 (1 Hr)
Practice 2 (1 Hr)

Module II: Package and Safe Code (5 Hr)

Interfaces, Packages and Access Protection, Exception Handling (Fault Tolerant Programming)

Practice 3 (1 Hr)

Module III: Collection and Threads (5 Hr)

ArrayList, Vector, Set, Map, Multi-threaded Programming, Synchronization

Practice 4 (1 Hr)

Module IV: Language and Utility Packages (5 Hr)

String Handling, Wrappers, Runtime Memory Management, Cloning, Calendar, Date and Time Facilities, Scanner, Internationalization

Practice 5 (1 Hr)

Practice 6 (1 Hr)

Module V: Input/ Output and Applets (5 Hr)

Byte and Character Stream I/O, Persistence, Applet: Architecture, Skeleton, and Implementation

Practice 7 (1 Hr)

Practice 8 (1 Hr)

Module VI: GUI Programming (5 Hr)

AWT: Container, Components, Layout Managers, Event Handling

Practice 9 (1 Hr)

Practice 10 (1 Hr)

Module VII: Networking and Advanced (5 Hr)

Networking Fundamental, Client-Server Communication, Remote Method Invocation (RMI), Java Virtual Machine (JVM) Tuning, Java Profiler

Practice 11 (1 Hr)

Practice 12 (1 Hr)

Text Book(s):

1. Java The Complete Reference, Fifth Edition, C25 Herbert Schildt, McGraw-Hills

Reference Book(s):

1. Murach's Java Programming, 5th Edition, Joel Murach, Mike Murach & Associates, 2011, ISBN-78-1-943872-07-7

2. Introduction to Java Programming, Comprehensive, 10th ed., Y. Daniel Liang, 2014. ISBN-10: 0133813460, ISBN-13: 9780133813463

https://nqr.gov.in/qualification-title?nid=3002
https://www.cdac.in/index.aspx?id=DAC&courseid=0#
https://canvas.harvard.edu/courses/63117/assignments/syllabus
https://canvas.harvard.edu/courses/69911/assignments/syllabus
https://xid.harvard.edu/xid-apps/submitAccountForm.do

YouTube Resources: freeCodeCamp.org
Codearchery
Edureka
free project
Jenkov

Online Source(s):

1. https://docs.oracle.com/javase/tutorial/java/index.html

2. https://www.programiz.com/java-programming

3. https://marcus-biel.com/

Software/Tool(s): Java 8, Eclipse IDE

Online Compiler: https://ideone.com/

Online Coding Practice: https://www.hackerrank.com/

List of Practices:

Practice 1 (Module-I)

Program-1:

Write a program that computes the standard deviation of a set of floating point numbers that the user enters. First the user says how many numbers N are to follow. Then the program asks for and reads in each floating point number. Finally it writes out the standard deviation. The standard deviation of a set of numbers Xi is:

SD = Math.sqrt(avgSquare - avg2)

Here, avg is the average of the N numbers, and avg2 is its square.

avgSquare is the average of Xi * Xi. In other words, this is the average of the squared value of each floating point number.

For example, if N = 4, say the numbers were:

Xi Xi * Xi

2.0 4.0

3.0 9.0

1.0 1.0

2.0 4.0

sum 8.0 18.0

Now:

avg = 8.0/4 = 2.0

avg2 = 4.0

avgSquare = 18.0/4 = 4.5

SD = Math.sqrt(4.5 - 4.0) = Math.sqrt(.5) = 0.7071067812

To do this you will need to do several things inside the loop body for each floating point value as it comes in: add it to a sum, square it and add it to a sum of squares. Then after the loop is finished apply the formula.

Program-2 and Program-3:

Two suggested competitive programs to solve on HackerRank

https://www.hackerrank.com/domains/java

Practice 2 (Module-I)

Program-1:

Better encapsulation of the Goods class would call making instance variables private and using getter and setter methods to access them. A further refinement would be to make the class abstract and to define additional child classes. Here is a revised Goods class:

```
public abstract class GoodsSGA
{
private String description;
private double price;
private int quantity;
public GoodsSGA( String des, double pr, int quant )
{description = des;
```

price = pr;

quantity = quant;}

double getPrice()

{return price;}

void setPrice(double newPrice)

{price = newPrice;}

int getQuantity()

{return quantity;}

void setQuantity (int newQuantity)

{quantity = newQuantity;}

public String toString()

{return "item: " + description + " quantity: " + quantity + " price: " + price ;}

Revise the source code for the classes Food, Toy, and Book. (Perhaps call the revised classes FoodSG, ToySG, and BookSG.) create a new class ToiletrySG for things like bubble bath. Create a new testing class, StoreSG to test your revised classes.

Note: the child classes will need to use the getter and setter methods to access the instance variables that are declared as private in GoodsSG.

Program-2 and Program-3:

Two suggested competitive programs to solve on HackerRank

https://www.hackerrank.com/domains/java

Practice 3 (Module-II)

Program-1:

User-Friendly Division Practice:

Put in a loop so that the user is repeatedly asked for the numerator and the divisor. For each set of data, the program prints out the result, or an informative error message if there is a problem (division by zero or poor input data).

The program continues looping, even if there is a problem Exit the loop when data entered for the numerator start with characters "q" or "Q". Don't print out an error message in this case.

Don't ask for the divisor if the user just asked to quit.

Here is sample output from one run:

Enter the numerator: 12

Enter the divisor: 4

12 / 4 is 3

Enter the numerator: 12

Enter the divisor : 0

You can't divide 12 by 0

Enter the numerator: glarch

You entered bad data.

Please try again.

Enter the numerator: quit

You will need to use the method charAt() from the String class.

Program-2 and Program-3:

Two suggested competitive programs to solve on HackerRank

https://www.hackerrank.com/domains/java

Practice 4 (Module-III)

Program-1:

In mathematics, several operations are defined on sets. The union of two sets A and B is a set that contains all the elements that are in A together with all the elements that are in B. The intersection of A and B is the set that contains elements that are in both A and B. The difference of A and B is the set that contains all the elements of A except for those elements that are also in B.

Suppose that A and B are variables of type set in Java. The mathematical operations on A and B can be computed using methods from the Set interface. In particular:

A.addAll(B) computes the union of A and B; A.retainAll(B) computes the intersection of A and B; and A.removeAll(B) computes the difference of A and B. (These operations change the contents of the set A, while the mathematical operations create a new set without changing A, but that difference is not relevant to this exercise.)

For this exercise, you should write a program that can be used as a “set calcula-

tor" for simple operations on sets of non-negative integers. (Negative integers are not allowed.) A set of such integers will be represented as a list of integers, separated by commas and, optionally, spaces and enclosed in square brackets. For example: [1,2,3] or [17, 42, 9, 53,108]. The characters +, *, and - will be used for the union, intersection, and difference operations. The user of the program will type in lines of input containing two sets, separated by an operator. The program should perform the operation and print the resulting set.

Here are some examples:

Input Output

---------- ----------

[1, 2, 3] + [3, 5, 7] [1, 2, 3, 5, 7]

[10,9,8,7] * [2,4,6,8] [8]

[5, 10, 15, 20] - [0, 10, 20] [5, 15]

To represent sets of non-negative integers, use sets of type TreeSet<Integer>. Read the user's input, create two TreeSets, and use the appropriate TreeSet method to perform the requested operation on the two sets. Your program should be able to read and process any number of lines of input. If a line contains a syntax error, your program should not crash. It should report the error and move on to the next line of input. (Note: To print out a Set, A, of Integers, you can just say System.out.println(A). We've chosen the syntax for sets to be the same as that used by the system for outputting a set.)

Program-2 and Program-3:

Two suggested competitive programs to solve on HackerRank

https://www.hackerrank.com/domains/java

Practice 5 (Module-IV)

Program-1:

Password Checker:

Write a program that repeatedly asks the user for a proposed password until the user enters an acceptable password. When the user enters an acceptable password, the program writes a message and exits.

Acceptable passwords:

Are at least 7 characters long. Contain both upper and lower case alphabetic characters. Contain at least 1 digit. The logic of this program can be quite tricky. Hint: use toUpperCase(), toLowerCase, and equals(). You will also need nested ifs.

Here is a run of the program:

Enter your password:

snowflake

That password is not acceptable.

Enter your password:

SnowFlake

That password is not acceptable.

Enter your password:

snowflake47

That password is not acceptable.

Enter your password:

Snowflake47

Acceptable password.

Program-2 and Program-3:

Two suggested competitive programs to solve on HackerRank

https://www.hackerrank.com/domains/java

Practice 6 (Module-IV)

Program-1:

Secret Code:

A text message has been encoded by replacing each character of the message with an integer. Each integer is an index into a key-phrase that contains all the lower case letters of the alphabet as well as the space character. The key-phrase may contain the same character in several locations. The encoded text is series of integers, like this:

35 10 10 33 9 24 3 17 41 8 3 20 51 16 38 44 47 32 33 10 19 38 35 28 49

To decode the message, look up each integer in the key-phrase and output the corresponding character. For example, say that the key-phrase is this (the index of each character has been written above it):

1111111111222222222233333333334444444444455

01234567890123456789012345678901234567890123456789012345678901

six perfect quality black jewels amazed the governor

using each integer from the encoded text as an index into the phrase results in the decoded message:

attack the bridge at dawn

Write a program that decodes a secret message contained in a text file. The first line of the text file contains the key-phrase. Then the file contains a sequence of integers, each of which indexes the key-phrase. Find the character corresponding to each integer and output the secret message. Note if a character character such as 'e' occurs several places in the key-phrase it may be encoded as different integers in different parts of the secret message.

(The recipient of the secret message gets only the file of integers and must put the key-phrase at the top of the file.) For example, here is the contents of a secret message file ready for the program:

six perfect quality black jewels amazed the governor

35 10 10 33 9 24 3 17 41 8 3 20 51 16 38 44 47 32 33 10 19 38 35 28 49

Here is a sample run of the program:

C:\> java Decode < secretFile.txt

attack the bridge at dawn

You will need the charAt() method of String.

Here is another secret message file, with key-phrase inserted, that you can use to test your program:

six perfect quality black jewels amazed the governor

31 16 2 3 4 42 48 7 27 9 10 43 12 13 35 15 1 40 18 3

20 15 33 23 24 32 26 29 28 27 21 31 25 14 34 14 36

42 38 19 40 41 27 3 44 50 46 42 48 49 50 6

Program-2 and Program-3:

Two suggested competitive programs to solve on HackerRank

https://www.hackerrank.com/domains/java

Practice 7 (Module-V)

Program-1:

Stop Word Remover:

Write a program that reads in a file of text, perhaps the text of a novel. The program copies the same text to an output file, except that all the useless words such as "the", "a", and "an" are removed. (Decide on what other words you with to remove. The list of words removed is called a stop list.) Do this by reading the text file token by token using hasNext() and next(), but only writing out tokens not on the stop list.

Prompt the user for the names of the input and output files.

Fairly Easy: The output file will have only N tokens per line. Do this by counting tokens as you output them. N will be something like 10 or 12.

Improved Program: Preserve the line structure of the input file. Do this by reading each line using nextLine() and then creating a new Scanner for that line. (Look at the on-line documentation for Scanner.) With each line's Scanner, use hasNext() and next() to scan through its tokens.

Harder: Write out no more than N characters per line. N will be something like 50. Do this by keeping count of the number of characters written out per line. The length() method of String will be useful. If X characters has already been written to the current line, and if X plus the length of the current token exceeds N, then start a new line.

Program-2 and Program-3:

Two suggested competitive programs to solve on HackerRank

https://www.hackerrank.com/domains/java

Practice 8 (Module-V)

Program-1:

E-Mail Address Extractor:

Write a program that scans a text file for possible e-mail addresses. Addresses look like this:

someone@somewhere.net

Read tokens from the input file one by one using hasNext() and next(). With the default delimiters of Scanner, an entire e-mail address will be returned as one token. Examine each token using the indexOf() method of String. If a token contains an at sign @ followed some characters later by a period, regard it as a possible e-mail address and write it to the output file.

Programs such as this scan through web pages looking for e-mail addresses that become the targets of spam. Because of this, many web pages contain disguised e-mail addresses that can't easily be automatically extracted.

Program-2 and Program-3:

Two suggested competitive programs to solve on HackerRank

https://www.hackerrank.com/domains/java

Practice 9 (Module-VI)

Program-1:

User-friendly Fat Calculator, with Advice:

Further modify the calories from fat calculator so that it includes another TextField that will be set with the text "Too many fat calories" if the percentage of calories from fat is equal or greater than 30 percent, or to "Healthy amount of fat" if the percentage is less than that.

Program-2 and Program-3:

Two suggested competitive programs to solve on HackerRank

https://www.hackerrank.com/domains/java

Practice 10 (Module-VI)

Program-1:

Three Button Monte:

Write a program to implement a game:

There are three buttons in the frame. Two of the buttons cause the program to quit using System.exit(0); the remaining button changes the frame to green (a win!) The winning button is different each time the game is played.

The easy way to do this (although it seems unfair to the user) treats each button the same way. The actionPerformed() method does not check which button was clicked. When any button is clicked, the

method picks a random integer from 0 to 2 and performs the "winning" action if the integer happens to be 0. Otherwise, it performs the "losing" action. To the user, it seems like there is a "winning" button and two "losing" buttons. But, in fact, it does not matter which button was clicked.

This is similar to some electronic gambling devices in casinos, where it appears to the user that there are "winning moves" and "losing moves" but in fact the machine actually ignores what the user has done and just declares a "win" every now and then, according to predetermined odds.

You will need the Random class:

```
Random randNum = new Random(); // create a Random number object
. . .
int someInt = randNum.nextInt(3); // someInt gets a number from 0 to 2
```

Program-2 and Program-3:

Two suggested competitive programs to solve on HackerRank

https://www.hackerrank.com/domains/java

Practice 11 (Module-VII)

Content Delivery with Networking:

Write a Client-Server program where the client queries with a name of file and the server delivers the content of requested files to the client over the network. (Improve the program by making the server multi-threaded)

Practice 12 (Module-VII)

Greet the user with Remote Method Invocation:

Write a program using RMI, where the user invokes a method on remote object with username as parameter and receives a greeting message based on time of the day along with username.

Projects

However, not limited to:

1. Chat application
2. Text Editor application
3. GUI based Scientific Calculator
4. Paint application

5. Slam book

(*PROJECT REVIEWS WILL COMMENCE BEYOND CLASS HOURS)

Monitoring:
Credit will be received only on making an honest effort. It is expected that students will finish watching all lecture video and complete all challenge problems by the end of each lecture week.
Borrowing code from other sources is allowed only with proper attribution and credit given to the original author(s).

List of Common Programs to solve using Java:

- Program to calculate area of a triangle
- Program to solve quadratic equation
- Program to swap two zariables (with and without using third variable)
- Program to generate random numbers in various ways
- Program to convert miles to kilometers and vice-versa
- Program to convert celsius to fahrenheit and vice-versa
- Program to check if a number is odd or even
- Program to check if input year is leap year
- Program to test primality
- Program to print all prime numbers in an interval using "Sieve of Eratosthenes"
- Program to generate factorial of all elements in an array
- Program to display the multiplication table up to 20
- Program to print the fibonacci sequence
- Program to check armstrong number, perfect number, Harshad number
- Program to generate armstrong numbers in an Interval
- Program to find the sum of Harshad numbers in an interval
- Program to display powers of two Using lambda
- Program to perform conversions among decimal to binary, octal and hexadecimal
- Program to display ASCII table
- Program to find HCF/GCD and LCM
- Program to find factors of given natural number
- Program to make a simple calculator
- Program to shuffle deck of cards
- Program to generate fibonacci sequence using recursion
- Program to find sum of natural numbers using recursion
- Program to find factorial of number using recursion
- Program to convert decimal to binary using recursion
- Program to add two matrices
- Program to obtain transpose of a matrix
- Program to multiply two matrices

- Program to check if a string is palindrome
- Program to remove punctuations from a string
- Program to sort words lexicographically
- Program to illustrate different set operations
- Program to count frequency of each vowel in a string
- Program to find hash value of a file

Note: 1 credit theory=12 hrs lecture, 1 credit practice/project=15 hrs lab/workshop/field work in a semester

This course on courseware: http://courseware.cutm.ac.in/courses/java-technologies/

Database Management Systems

Code	Course Title	Credit	T-P-PJ
CUTM1059	Database Management Systems	3	2-1-0

Course Objectives

- To understand the different issues involved in the design and implementation of a database system.
- To study the physical and logical database designs, database Modeling, relational, hierarchical, and network models
- To understand and use data manipulation language to query, update, and manage a database
- To develop an understanding of essential Properties of DBMS concepts such as: database security, integrity, concurrency
- To design and build a simple database system and demonstrate competence with the fundamental tasks involved with modeling, designing, and implementing a DBMS.

Course Outcomes

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Acquire the knowledge on different database implementation for various applications	PO1 (3), PO12(1)
CO2	Solving different problems such as to convert the entity-relationship diagrams into relational tables, normalization and SQL queries	PO2(3)
CO3	Design database models and the entity-relationship diagrams of different databases using MySQL Workbench	PO3 (3)

COURSE CONTENT

Module-1: **DBMS Concepts [5 Hrs]**
Data Abstraction - Data models and data independence. Instances and Schemas. Components of a DBMS and overall structure of a DBMS- Life Cycle of a DBMS application- Database terminology.

Module-2: Data Modeling [5Hrs]
Basic concepts- Types of data models- Conceptual, physical and logical database models- E-R data model and Object-oriented data model. Components of ER Model- ER Modeling symbols. Entity and entity sets- Relations and relationship sets- E-R Diagrams- Reducing E-R Diagrams into tables.

Practice
Assume we have the following application that models soccer teams, the games they play, and the
players in each team. In the design, we want to capture the following:
• We have a set of teams, each team has an ID (unique identifier), name, main stadium, and to which city this team belongs.
• Each team has many players, and each player belongs to one team. Each player has a number
(unique identifier), name, DoB, start year, and shirt number that he uses.
• Teams play matches, in each match there is a host team and a guest team. The match takes place
in the stadium of the host team.
• For each match we need to keep track of the following:
• The date on which the game is played
• The final result of the match
• The players participated in the match. For each player, how many goals he scored, whether or not he took yellow card, and whether or not he took red card.
• During the match, one player may substitute another player. We want to capture this substitution and the time at which it took place.
• Each match has exactly three referees. For each referee we have an ID (unique identifier), name, DoB, years of experience. One referee is the main referee and the other two are assistant referee.
Design an ER diagram to capture the above requirements. State any assumptions you have that
affects your design (use the back of the page if needed). Make sure cardinalities and primary keys are clear.

Module-3: Relational DBMS Model [5 Hrs]
Basic concepts, Attributes and domains- Intention and extensions of a relation- concept of integrity and referential constraints- Relational Query Languages (Relational algebra and relational calculus (Tuple and domain relational calculus).

Module-4: Relational Database Design [6 Hrs]
Notion of normalized relations- Normalization using Functional Dependency- First Normal form- Second Normal Form- Third Normal form- BCNF.

Practice
Perform NF on the given table

CLICK HERE FOR TABLE

Module-5: SQL [6 Hrs]
Structure of a SQL query- DDL and DML, TCL- SQL queries and sub queries- Tables, views and indexes.

Practice
To study DDL-create and DML-insert commands.

(i) Create tables according to the following definition.

CREATE TABLE DEPOSIT (ACTNO VARCHAR2(5) ,CNAME VARCHAR2(18) , BNAME VARCHAR2(18) , AMOUNT NUMBER(8,2) ,ADATE DATE);
CREATE TABLE BRANCH(BNAME VARCHAR2(18),CITY VARCHAR2(18));
CREATE TABLE CUSTOMERS(CNAME VARCHAR2(19) ,CITY VARCHAR2(18));
CREATE TABLE BORROW(LOANNO VARCHAR2(5), CNAME VARCHAR2(18), BNAME VARCHAR2(18), AMOUNT NUMBER (8,2));
(ii) Insert the data as shown below.

DEPOSIT
CLICK HERE FOR TABLE
BRANCH
CLICK HERE FOR TABLE
CUSTOMERS
CLICK HERE FOR TABLE
BORROW
CLICK HERE FOR TABLE
(1) Describe deposit, branch.
(2) Describe borrow, customers.
(3) List all data from table DEPOSIT.
(4) List all data from table BORROW.
(5) List all data from table CUSTOMERS.
(6) List all data from table BRANCH.
(7) Give account no and amount of depositors.
(8) Give name of depositors having amount greater than 4000.
(9) Give name of customers who opened account after date '1-12-96'.

Module-6:Aggregate functions [4 Hrs]

Set Operations, predicates and joins, Set Membership- Tuple variables- Set comparison- Database modifications using SQL.

Practice

Create the below given table and insert the data accordingly.

Create Table Job (job_id, job_title, min_sal, max_sal)

COLUMN NAME DATA TYPE
job_id Varchar2(15)
job_title Varchar2(30)
min_sal Number(7,2)
max_sal Number(7,2)
Create table Employee (emp_no, emp_name, emp_sal, emp_comm, dept_no)

COLUMN NAME DATA TYPE
emp_no Number(3)
emp_name Varchar2(30)
emp_sal Number(8,2)
emp_comm Number(6,1)

dept_no Number(3)
Create table deposit(a_no,cname,bname,amount,a_date).

COLUMN NAME DATA TYPE
a_no Varchar2(5)
cname Varchar2(15)
bname Varchar2(10)
amount Number(7,2)
a_date Date

Create table borrow(loanno,cname,bname,amount).

COLUMN NAME DATA TYPE
loanno Varchar2(5)
cname Varchar2(15)
bname Varchar2(10)
amount Varchar2(7,2)

Insert following values in the table Employee.

emp_n emp_name emp_sal emp_comm dept _no
101 Smith 800 20
102 Snehal 1600 300 25
103 Adama 1100 0 20
104 Aman 3000 15
105 Anita 5000 50,000 10
106 Sneha 2450 24,500 10
107 Anamika 2975 30
Insert following values in the table job.

CLICK HERE FOR TABLE
Insert following values in the table deposit.
CLICK HERE FOR TABLE
Perform following queries
(1) Retrieve all data from employee, jobs and deposit.
(2) Give details of account no. and deposited rupees of customers having account opened between dates 01-01-06 and 25-07-06.
(3) Display all jobs with minimum salary is greater than 4000.
(4) Display name and salary of employee whose department no is 20. Give alias name to name of employee.
(5) Display employee no,name and department details of those employee whose department lies in(10,20)
To study various options of LIKE predicate

(1) Display all employee whose name start with ‘A’ and third character is ‘ ‘a’.

(2) Display name, number and salary of those employees whose name is 5 characters long and first three characters are ‘Ani’.

(3) Display the non-null values of employees and also employee name second character should be ‘n’ and string should be 5 character long.

(4) Display the null values of employee and also employee name’s third character should be ‘a’.
(5) What will be output if you are giving LIKE predicate as ‘%_%’ ESCAPE ‘\’

To Perform various data manipulation commands, aggregate functions and sorting concept on all created tables.
(1) List total deposit from deposit.
(2) List total loan from karolbagh branch
(3) Give maximum loan from branch vrce.
(4) Count total number of customers
(5) Count total number of customer’s cities.
(6) Create table supplier from employee with all the columns.
(7) Create table sup1 from employee with first two columns.
(8) Create table sup2 from employee with no data
(9) Insert the data into sup2 from employee whose second character should be ‘n’ and string should be 5 characters long in employee name field.

(10) Delete all the rows from sup1.
(11) Delete the detail of supplier whose sup_no is 103.
(12) Rename the table sup2.
(13) Destroy table sup1 with all the data.
(14) Update the value dept_no to 10 where second character of emp. name is ‘m’.
(15) Update the value of employee name whose employee number is 103.

To study Single-row functions.

(1) Write a query to display the current date. Label the column Date

(2) For each employee, display the employee number, job, salary, and salary increased by 15% and expressed as a whole number. Label the column New Salary
(3) Modify your query no 4.(2) to add a column that subtracts the old salary from the new salary. Label the column Increase
(4) Write a query that displays the employee’s names with the first letter capitalized and all other letters lowercase, and the length of the names, for all employees whose name starts with J, A, or M. Give each column an appropriate label. Sort the results by the employees’ last names.
(5) Write a query that produces the following for each employee:
earns monthly
(6) Display the name, hire date, number of months employed and day of the week on which the employee has started. Order the results by the day of the week starting with Monday.
(7) Display the hiredate of emp in a format that appears as Seventh of June 1994 12:00:00 AM.
(8) Write a query to calculate the annual compensation of all employees (sal+comm.).

Displaying data from Multiple Tables (join)

(1) Give details of customers ANIL.
(2) Give name of customer who are borrowers and depositors and having living city nagpur
(3) Give city as their city name of customers having same living branch.
(4) Write a query to display the last name, department number, and department name for all employees.
(5) Create a unique listing of all jobs that are in department 30. Include the location of the department in the output
(6) Write a query to display the employee name, department number, and department name for all employees who work in NEW YORK.
(7) Display the employee last name and employee number along with their manager's last name and manager number. Label the columns Employee, Emp#, Manager, and Mgr#, respectively.
(8) Create a query to display the name and hire date of any employee hired after employee SCOTT.

Module-7: Transaction Management [8 Hrs]
Subqueries,Manupulating Data,Transaction management and Concurrency control
Practice
To apply the concept of Aggregating Data using Group functions.

(1) List total deposit of customer having account date after 1-jan-96.
(2) List total deposit of customers living in city Nagpur.
(3) List maximum deposit of customers living in bombay.
(4) Display the highest, lowest, sum, and average salary of all employees. Label the columns Maximum, Minimum, Sum, and Average, respectively. Round your results to the nearest whole number.
(5) Write a query that displays the difference between the highest and lowest salaries. Label the column DIFFERENCE.
(6) Create a query that will display the total number of employees and, of that total, the number of employees hired in 1995, 1996, 1997, and 1998
(7) Find the average salaries for each department without displaying the respective department numbers.
(8) Write a query to display the total salary being paid to each job title, within each department.
(9) Find the average salaries > 2000 for each department without displaying the respective department numbers.
(10) Display the job and total salary for each job with a total salary amount exceeding 3000, in which excludes president and sorts the list by the total salary.

(11) List the branches having sum of deposit more than 5000 and located in city bombay.

To solve queries using the concept of sub query.

(1) Write a query to display the last name and hire date of any employee in the same department as SCOTT. Exclude SCOTT
(2) Give name of customers who are depositors having same branch city of mr. sunil.
(3) Give deposit details and loan details of customer in same city where pramod is living.
(4) Create a query to display the employee numbers and last names of all employees who

earn more than the average salary. Sort the results in ascending order of salary.
(5) Give names of depositors having same living city as mr. anil and having deposit amount greater than 2000
(6) Display the last name and salary of every employee who reports to ford.
(7) Display the department number, name, and job for every employee in the Accounting department.
(8) List the name of branch having highest number of depositors.
(9) Give the name of cities where in which the maximum numbers of branches are located.
(10) Give name of customers living in same city where maximum depositors are located.

Manipulating Data

(1) Give 10% interest to all depositors.
(2) Give 10% interest to all depositors having branch vrce
(3) Give 10% interest to all depositors living in n
agpur and having branch city bombay.
(4) Write a query which changes the department number of all employees with empno 7788's job to employee 7844'current department number.
(5) Transfer 10 Rs from account of anil to sunil if both are having same branch.
(6) Give 100 Rs more to all depositors if they are maximum depositors in their respective branch.
(7) Delete depositors of branches having number of customers between 1 to 3.
(8) Delete deposit of vijay.
(9) Delete borrower of branches having average loan less than 1000.

To apply the concept of security and privileges.

To study Transaction control commands

VIRTUAL LAB

TEXT BOOKS

1. Database Management Systems: Raghu Ramakrishnan
2. ORACLE PL/SQL Programming – Scott Urman BPB Publications.

REFERENCES

1. Database Systems Concepts – Henry F Korth, Abraham Silberschatz.
2. Database Management Systems – Alexis Leon, Mathews Leon – Leon, Vikas Publications

Basket - V (Domain)

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

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

Domain Track Title: Renewable Energy Applications

Track Total Credits (4-8-10): 22 Credits

Courses Division:

1. **CURE2190 Materials for Renewable Energy applications (1-1-0)**
2. **CURE2191 Renewable Energy Technology for Industrial Process (1-2-0)**
3. **CURE2192 Micro-grid Design & Implementation (0-2-0)**
4. **CURE2193 Hybrid Renewable Energy Systems (1-2-0)**
5. **CURE2194 Solar Off-grid Entrepreneur (1-1-0)**
6. **CURE2195 project (0-0-6)**
7. **CURE2196 Internship (0-0-4)**

Domain Track Objectives:

- To gain the knowledge on different types of materials used in Renewable Energy.
- To understand the importance of Renewable Energy technology and its applications.
- To know the applications of solar thermal technology.
- To become an expert in Entrepreneurship.

Domain Track Course Outcomes

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

1. Material for Renewable Energy application (30 hrs)

1.1 Basic fundamentals of different types semiconductors (Energy band, charge carriers and their motion, generation, recombination, doping)
1.2 Practice: Crystal structure, phase identification and crystallite size determination of PV materials by XRD (using Biovia MS and phase identification by using relevant software)
1.3 Photovoltaic Cell - Construction & Working (Si based)
1.4 Practice: UV visible analysis of photovoltaic material

1.5 Concept of various types PN junction.
1.6 Practice: Measurement of photo luminescence (PL) behaviour of photovoltaic material
1.7 Role of materials for sustainable development of next generation photovoltaic cells
1.8 Practice: To study crystallites (grain) size and strain through *Williamson-Hall plot* method
https://www.youtube.com/watch?v=LJ9h77fN4-E&t=1308s
1.9 Efficiency calculation of solar cell
1.10 Practice: To determine the resistivity of semiconductors by Four probe Method.
http://vlab.amrita.edu/?sub=1&brch=282&sim=1512&cnt=1
1.11 Nano-Photovoltaic (Graphene/CNT, ZNO, TIO_2)
1.12 Practice: Study of Hall effect (Determination of nature of charge carriers in a semiconductor)
http://vlab.amrita.edu/?sub=1&brch=282&sim=879&cnt=4
1.13 Composite materials for solar cell (Graphene/Al, TiO_2-SiO_2 composite for solar cell)
1 14 Perovskite based solar cell (transition metal doped $PbTiO_2$)
1.15 Dye-sensitized solar cells
1.16 Materials (Al/hybrid glass-carbon fiber) for wind energy conversion

Text Book:

1. Vincent, D. , Materials for Sustainable Energy, Nature publishing group, 2010.
2. Paranthaman, M. Parans, Wong-Ng, Winnie, Bhattacharya, Raghu N (Eds.), Semiconductor Materials for Solar Photovoltaic Cells, Springer, 2015.

Reference Book:

1. Sabu, T., El HadjiMamour, S., Nandakumar, K., Samuel, O., Jihuai, W., Nanomaterials for Solar Cell Applications, Elsevier, 2019.
2. Peter, P. Rogers, Kazi F. Jalal, John A. Boyd, An introduction to sustainable development, Glen Educational Foundation, 2008.

2. Renewable Energy Technology for Industrial Process (48 hrs)

2.1 Relevance of economic and financial viability evaluation of renewable energy technologies, Renewable Energy Policies of India and in the state of Odisha
2.2 Practice: Site visit for acquire knowledge on different renewable energy technologies and it's system
2.3 Basics of light to energy conversion and Concept on solar PV
2.4 Practice: Measurements and estimation of solar radiation
2.5 Concept of mono-crystalline, poly-crystalline, amorphous
2.6 Practice: Identify and specify different types of components used in a solar PV system
2.7 New generation of Solar cell, working principle and applications
2.8 Practice: Simulation of solar cell by using PVSOL software
2.9 Effects of parameters on PV module power and efficiency
2.10 Practice: VI characteristics of solar cell/module
2.11 Concept on Concentrated solar thermal (CST)
2.12 Practice: Temperature tracking of solar cell/module
2.13 Concentrated solar power (CSP), new technology of solar thermal
2.14 Practice: Performance of Solar PV module at varying tilt angle

2.15 Concept of wind energy, Basic laws and efficiency limit for wind energy conversion
2.16 Practice: Modelling of solar cooker
2.17 Concept of aerodynamics effects
2.18 Practice: Modelling of solar flat plate collector
2.19 description of horizontal and vertical axis wind turbine
2.20 Practice: Generation of electricity by wind machines
2.21 Concept on Biomass, Electricity generation from biomass.
2.22 Practice: Maximum power point tracking of a wind turbine
2.23 Practice: Performance testing of bio diesel in VCR machine

Text Books:

1. D. P. Kothari, K. C. Singal and R. Ranjan, Renewable Energy Sources and Emerging Technologies, Second Edition, PHI Learning Pvt. ltd, New Delhi, 2011.
2. C. S. Solanki, Photovoltaic – Fundamentals, Technologies and Applications, PHI Learning Pvt. Ltd., 2011.

Reference Book:

1. V. V. N. Kishore, Renewable Energy Engineering and Technology: principles and practice, Teri, India, 2008.
2. Hakeem, Khalid Rehman, Jawaid, Mohammad, Rashid, Umer (Eds.), Biomass and Bioenergy Applications, Springer, 2014.
3. S. S. Das, D. D. Behera, and A. Pradhan, Clean Energy Products: A Path for Attaining Livelihood Security, Notion Press, and ISBN: 9781636691602, 2020.
4. S. S. Das, D. D. Behera, and N. C. Giri, Clean Energy Applications in Modern World, Notion Press, ISBN: 9781638069560, 2021.

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

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

Text Books:

1. Suneal Deambi, Photovoltaic System Design: Procedures, Tools and Applications, CRC Press, 2018.

2. Miguel Castilla, Antonio Carlos Zambroni de Souza, Microgrids Design and Implementation, Springer, 2019.

Reference Books:

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

4. Hybrid Renewable Energy System (48 hrs)

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

Text Books:

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

Reference Books:

1. Ersan Kabalci, Hybrid Renewable Energy Systems and Microgrids,
2. V. N. Kishore, Renewable Energy Engineering and Technology: principles and practice, Teri, India, 2008.

3. N. C. Giri, S. R. Nayak, S. P. Mishra, and S. N. Sahu, Project Management and Smart Electrical Systems, ISBN 9798587652200, Amazon; 1st edition, 27 December 2020.

5. Solar Off-grid Entrepreneur (30 hrs)

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

Text Books:

1. Rameshwari Pandya, Skill Development and Entrepreneurship in India, 2016.
2. Joseph P. Oconneor, Off Grid Solar, Second edition, Old Sequoia Publishing, 2016.
3. Poornima Charantimath, Entrepreneurship Development and small Business Enterprises, Third edition, Pearson, 2018.

Reference Books:

1. C. S. Solanki: Solar Photovoltaic – Fundamentals, Technologies and Applications, PHI Learning Pvt. Ltd., 2011.
2. Michael Boxwell -- Solar Electricity Handbook - 2014 Edition: A Simple Practical Guide to Solar Energy.

Session Plan for the Entire Domain:

1. Material for Renewable Energy Application (30 hrs)

Session 1. Basic fundamentals of different types semiconductors (Energy band, charge carriers and their motion, generation, recombination, doping)
https://www.youtube.com/watch?v=ethnHSgVbHs
https://www.youtube.com/watch?v=Yu2YpVtuOds
Session 2. Practice: Crystal structure, phase identification and crystallite size determination of PV materials by XRD (using Biovia MS and phase identification by using relevant software)
http://vlab.amrita.edu/?sub=1&brch=282&sim=370&cnt=1
Session 3 .Photovoltaic Cell - Construction & Working (Si based)

https://www.youtube.com/watch?v=sXcsKzJylrA
Session 4. Practice: UV visible analysis of photovoltaic material
https://www.youtube.com/watch?v=s5uIVQGFDE4
https://www.youtube.com/watch?v=a9fSg2TREag
Session 5. Concept of various types PN junction
https://www.youtube.com/watch?v=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 TiO_2/Raspberry based
https://www.youtube.com/watch?v=WHTbw5jy6qU
Session 9. Efficiency calculation of solar cell
https://www.youtube.com/watch?v=IxFIewx54Ok
https://www.youtube.com/watch?v=IkVLQALtdQw
Session 10. Nano-Photovoltaic (Graphene/CNT, ZNO, TIO_2)
https://www.youtube.com/watch?v=j4u09hi9DXI&t=150s
https://www.youtube.com/watch?v=BKomGuejwRA&t=55s
https://www.youtube.com/watch?v=Y2vvTPc30fE
Session 11. Practice: Calculate the sun position at a given place and time and thereby study the variation in power production in a solar photovoltaic panel with respect to the change in incidence angle
http://vlab.amrita.edu/?sub=77&brch=298&sim=1629&cnt=1
Session 12. Composite materials for solar cell (Graphene/Al, TiO_2-SiO_2 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 $PbTiO_2$)
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=xyjLd957lTk

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/1gta2ICarDw
Session 21. Practice: Measurements and estimation of solar radiation
Session 22. Concept of mono crystalline, poly crystalline, amorphous
https://youtu.be/Fip520UdeNU
Session 23. Practice: Simulation of solar cell
Session 24. New generation solar cell, working principle and applications
https://youtu.be/8t_DFI4O6v4
Session 25. Practice: Identify and specify different types of components using in a solar PV system
Session 26. Practice: VI characteristics of Solar cell/module
Session 27. Working principle and applications
https://youtu.be/ZYO83TkM0To
Session 28. Practice: Temperature tracking of solar cell/module
Session 29. Effects of parameters on PV module power and efficiency
https://youtu.be/JTDSPjDSrS8
Session 30. Practice: Performance of Solar PV module at varying tilt angle
Session 31. Concept on Concentrated solar thermal (CST)
https://youtu.be/tdivW7inP0k
HAND-NOTES-ON-SOLAR-THERMAL-ENGINEERING-pdf
Session 32. Practice: Modelling of solar cooker
https://www.youtube.com/watch?v=WPwDwjsAp4U&t=84s
Session 33. Concentrated solar power (CSP)
https://youtu.be/N1-zjbRqYXk
Session 34. Practice: Modelling of solar flat plate collector
https://www.youtube.com/watch?v=XWvr3OT1E1c
https://www.youtube.com/watch?v=s-Ysg6Xaf3c
https://www.youtube.com/watch?v=70Z5UNoywyE&t=223s
Session 35. Concept of wind energy, Basic laws and efficiency limit for wind energy conversion.
https://www.youtube.com/watch?v=qSWm_nprfqE
Session 36. Practice: Generation of electricity by wind machines
Session 37. Concept of aerodynamics effects,description of horizontal and vertical axis wind turbine
https://www.youtube.com/watch?v=65k2Nh8YHFI
https://www.youtube.com/watch?v=A-k2YGrpATo&t=13s
Session 38. Practice: Maximum power point tracking of a wind turbine
Session 39. Practice: Performance testing of bio diesel in VCR machine
https://www.youtube.com/watch?v=b1PbQ7jjVVM&list=PLniBGjZYcl478NRpoWh-YF_f2E90HZzda
https://www.youtube.com/watch?v=rrldwVGmmy4&t=161s
https://www.youtube.com/watch?v=KZ35K05SA7g&list=PLniBGjZYcl478NRpoWh-YF_f2E90HZzda&index=7

3. Micro grid Design and Implementation (36 hrs)

Session 41. Practice: Site survey (1 kW or 1MW)
Session 42. Practice: Sizing of micro grid system (1kW/1MW)

Session 43.Practice: Single line diagram of micro grid system
Session 44. Practice: Identify and specify different components used in a micro grid system
Session 45. Practice: Connection practice of solar modules in a micro grid system
Session 46. Practice: Designing of micro grid system
Session 47. Practice: Analysis of micro grid system
Session 48. Practice: Designing of micro grid system with battery storage
Session 49. Practice: Performance calculation of micro grid system
Session 50. Practice: Connection practice of CCR/Inverter in a micro grid system
Session 51. Practice: Test, record and verify the power quality of a micro grid system
Session 52.Practice: O & M of micro grid system

4. Hybrid Renewable Energy Systems (48 hrs)

Session 53.Global scenario of Hybrid renewable energy system, integrated renewable energy systems with input sources
https://youtu.be/j_fViOJbJLk
https://youtu.be/TD0jZciQcaE
Session 54. Practice: Modelling of renewable energy systems
Session 55. Selection of technology and components for efficient hybrid renewable systems
https://youtu.be/ALsOcGkrev0
Session 56. Practice: Connection practice of Solar PV-T System
Session 57. Concept on hybrid solar PVT system and 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=elZsUKcq3tw&t=9s
Session 65. Operation of hybrid PV and wind system
https://youtu.be/s458bCI8u2Q
Session 66. Practice: Modelling of hybrid PV and wind power system
https://www.youtube.com/watch?v=gzwDdo3iuSY
Session 67. Load curve
https://youtu.be/OQsk_4oqFmc
Session 68. Practice: Demonstration of Load curve in the plant
https://www.youtube.com/watch?v=b-ka2qObhzk
Session 69. Concept of hybrid PV and hydro system and it's components
https://youtu.be/9qu5ryJBIIE
Session 70. Practice: Modelling of hydro power system
https://www.youtube.com/watch?v=gdOaG8cKLuw
Session 71. Concept of hybrid PV and Biomass system and it’s components
https://youtu.be/XboxQHzJPD4

Session 72. Practice: Chemical composition of biomass system
Session 73. Practice: Study the dynamic behavior of wind turbines
https://www.youtube.com/watch?v=aSwGUVqrBMQ
Session 74.Practice: Emission testing of bio diesel/bio ethanol in gas analyser

5. Solar Off-Grid Entrepreneur (36 hrs)

Session 75. MNRE schemes and state wise subsidy process
https://www.youtube.com/watch?v=xKxrkht7CpY
https://www.youtube.com/watch?v=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/hiIb4v_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 of solar auto tracking system
6. Design and development of solar powered water pumping system
7. Design and development of solar operated grass trimmer
8. Design and development of solar powered pesticide sprayer
9. Design and development of solar powered leaf plate making machine
10. Design and development of solar powered bicycle
11. Design and development of solar powered sugarcane juice machine
12. Design and fabrication of solar dryer
13. Design and development of solar parabolic trough concentrator for water heating purpose

14. Design and development of solar cooker (box type or dish type)
15. Design and development of solar powered poly house system
16. Design and development of solar desalinization system
17. Design and development of solar operated blacksmith blower
18. Design and development of portable solar mobile charging station
19. Design and development of solar tree
20. Design and development of evacuated type of solar collector of water heating system
21.Design and development of torque control of wind turbine using energy analysis method
22.Analysis and design of generator side control of wind turbine
23.Design and development of micro-hydro power plant
24.Design and development of wind power system
25. Performance testing and comparison test of bio diesel in VCR Engine

Operation and Maintenance of Electrical Grid System & Transformers

Domain Name	Code	Type of course	T-P-P	Pre-requisite
Operation and Maintenance of Electrical Grid System & Transformers	EGCU2090	Theory + Practice + Project	6-14-4	Nil

1. Track Total Credits:

Theory + Practice + Project: [6+14+4] (24)

2. Domain Objectives:

- To create technically trained manpower readily available for recruitment to the power/energy Companies & Transformer Manufacturing firms in Electrical Sector.
- Develop digital prototypes of the products and validate them and innovate for design efficiency

3. Domain Outcomes:

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Able to gain Knowledge of making commercially used distribution transformer	PO1 (3), PO3(2)
CO2	Able to identify and resolve the problem in manufacturing of transformers.	PO2(3), PO5(1)
CO3	Able to develop skill on design of transformer and report generation of making commercially used distribution transformer	PO8(3), PO4(2)

4. **Domain Structure**: The Domain will consist of following components and these components will be reflected in the grade sheet.

- CUEG 2090: Introduction, Power Scenario, Power Quality & Faulty clearance, [1-1-0]
- CUEG 2091: Switchyard & substation Networks, [1-2-0]
- CUEG 2092: Protection scheme & Switchgear, [1-2-0]
- CUEG 2093: Cable system & Testing, [1-2-0]
- CUEG 2094: Power Markets, [1-0-0]
- CUEG 2095: Grid Safety, [0-2-0]
- CUEG 2096: Transformer Manufacturing, [1-5-0]
- CUEG 2097: Project, [0-0-4]

The Domain will be delivered through case studies, assignments and product development

Product Development Stack :

1. Distribution Transformer (Full product)
2. Smart Energy Meter (Modular Platform design and electric power train design , BIW)

Session Plan for the Entire Domain:

Course 1: Generation, Transmission & Distribution scenario in India

[Interactive + Modelling], [1-1-0], [20 Hrs]

1. Types of generation: Conventional and Non-conventional,
2. Thermal Power Plant, Hydro Power Plant,
3. Gas Power Plant, Nuclear Power Plant,
4. Co-generation Various sources Non-conventional Energy Sources.
5. Role of computers in distribution system planning-Load modelling
6. characteristics: definition of basic terms and loss factor
7. Classification of loads and their characteristics.
8. Distribution Feeders and Substations: Design consideration of Distribution feeders: Radial and loop types of primary feeders, voltage levels, and feeder-loading.

Video Links

- https://www.youtube.com/watch?v=lh5_7sHyLU4
- Hydro Power
- Gas Power Plant
- Nuclear Power Plant
- 1.4.1 Co-Generation

Practice

1. Load Modeling
2. Substation Modeling

Course 2: Switchyard/Substation Types

[Lab Practice in Own Distribution Network, Modelling], [1-2-0], [20 Hrs]

1. Single line diagram/equipments [Equipments-transformer, CB, fuse etc.]
2. Relays, Relaying schemes and auxiliariesWiring Diagram
3. Layout of Sub-Station(33/11KV S/S, 220/33KV S/S)
4. Indoor and outdoor busbars — bus-bar mountings and their clearances.
5. Designing Electrical Transmission Tower Types and Design

Video Links

- Substation layout
- Transmission Tower Design

Practice

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

Course 3: System Protection & Auxiliaries

[Field Visit+ Lab Practice in Own Distribution Network] [1-2-0] [20 Hrs]

1. CT & PTs, Local &p; Back-up Protection. Protection Schemes,
2. New Generation Relays, Different types of indoor and outdoor CB, Breaker Maintenance,
3. Lightening Arrestors/Surge Arrestors, Isolators And Insulators,
4. Grounding system, Auxiliary System in Switchyard/Substation

Video Links

- CT, PT, Relay
- Distance Protection
- Grounding/Earthing

Practice

1. Design Over current Protection for sub-station Feeder.
2. Measuring Earth Insulation Resistance

Course 4: Cables in Electrical System

[Visit to Standard Testing Lab, Workshop Practice], [1-2-0], [20 Hrs]

1. Modern trends in Underground Cabling Basic Concepts,
2. Materials Used in Cables, Conductors,
3. Testing and Commissioning of cables,

Video Links

- Under Ground Cable
- Cable Laying

Practice

1. IR Test of Cable
2. Cable Jointing

Course 5: Power System Market, Markets For Electrical Energy, Energy Conservation

[Interactive], [1-0-0] [3 Hrs]

1. Electricity Business
2. Electricity Market Models
3. Power Transfer, Inter & Intra State
4. Energy Efficiency in Grid
5. Energy conservation measures

Video Links

- Power Market Fundamental
- Power Exchange
- Energy Conservation

Practice

1. Developing Market Model for electricity trading

Course 6: GRID Safety Norms, Electrical Accidents and prevention, Electricity Costing & Audit,

[Field Survey], [0-2-0], [5 Hrs]

6.1 Safety Requirement, Hazards, Electrical Accidents and prevention, First Aid
6.2 Safety : Safety Philosophy, Safety Procedures, GRID Safety Norms, Procedures for issuing L.C.P. and cancellation, Maintenance of Safety records.
6.3 First Aid : Places of Potential Hazards, Electric Shock Treatment, Artificial Respiration, Handling Emergency Conditions, Treatment of Wounds, Injuries & Burns.
6.4 Fire Fighting: Causes of Fire, Fire Extinction, Classification of Fires, Fire Fighting, Equipment: their
operation – maintenance & refilling, Fire prevention.
6.5 Energy Audit.

Video Link

- General Grid Safety
- Industrial Safety
- Electrical Shock First Aid
- Fire Extinguisher

Practice
Hazard Analysis & Mitigation

Course 7: Principles of transformer
[DS Tools, Workshop Practice], [1-5-0], [20 Hrs]

7.1 Inner & Outer Part of Transformer,
7.2 Manufacturing of Transformer,
7.3 Transformer Test,
7.4 Conditions leading to faults in Transformer,
7.5 Maintenance of transformer

Practice
1. Transformer Manufacturing
2. Transformer Testing
3. Fault Finding & Corrective action

6. List of Projects/products to be done in domain: [200 Hrs]
1. Substation layout & Placement of equipment.
2. Protection System of 33/11/0.4 KV substation.
3. O & M of distribution substation.
4. Energy Aduit
5. Safety Practice.

6.Transformer Manufacturing & Testing.
EVALUATION: As per Central QA system policy

Industrial Automation

Code	Course Title	(Credit)	T-P-PJ
IACU2100	Industrial Automation	24	5-9-10

Course Code	Course Title	Credits	Type T-P-PJ
CUIA2100	Introduction to Industrial Automation	1	1-0-0
CUIA2101	Advanced Programming & Control Blocks of PLC	3	1-2-0
CUIA2102	Control & Signal Wiring of PLC	2	0-2-0
CUIA2103	SCADA based advanced features	2	1-1-0
CUIA2104	SCADA & PLC based sequential control	1	0-1-0
CUIA2105	Human Machine Interface	3	1-2-0
CUIA2106	OPC server base data fetching & control	2	1-1-0
CUIA2107	Project	6	0-0-6
CUIA2108	Internship	4	0-0-4
	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

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Able to gain Knowledge on installation of Industrial Automation concept	PO1 (3),

CO2	Able to identify and resolve the hardware/software problems of automation	PO2(3), PO5(1)
CO3	Able to develop skill of designing automatic control system and controller for a particular application.	PO3(3)

DOMAIN SYLLABUS

Course – 1: INTRODUCTION TO INDUSTRIAL AUTOMATION

1.1 Automation Uses
1.2 Automation - PLC Basics
1.3 Mechanical relays versus PLC
1.4 Functions of various blocks and working principle of advanced blocks.

Course – 2: ADVANCED PROGRAMMING & CONTROL BLOCKS OF PLC

2.1 CPT, ADD, SUB, MUL, DIV, SQR, NEG, TOD, FRD
2.2 MOV, MVM, AND, OR, XOR, NOT. CLR.
2.3 BSL, BSR, SQC, SQL, SQO, FFL, FFU, LFL, LFU
2.4 JMP, LBL, JSR, MCR
2.5 Connecting PLC software with SCADA software

Practice:

P2.1 - Comparison of industry based analog signals.
P2,2 - Detecting different product output of an industry
P2.3 - Sequential control of an industry by using advanced blocks.
P2.4 - Emergency control system of an industry
P2.5 - Connecting PLC software with SCADA software

Course – 3: CONTROL & SIGNAL WIRING OF PLC

3.1 Control wiring of PLC.
3.2 PLC, Sensor and field instruments signal flow wiring.
3.3 Device connectivity

Practice:

P3.1 PLC input/output wiring concept.
P3.2 Connecting relay, contactor, sensors and other field instruments.
P3.3 Controlling an industry motor using STAR-DELTA connection

Course – 4: SCADA BASED ADVANCED FEATURES

4.1 Alarms
4.2 Trends, Data base connectivity & Report generation
4.3 Recipe management
4.4 Security

Practice:

P4.1 - Data fetching and representing on graph and excel
P4.2 - Advanced controlling of industry by using SCADA

Course – 5: SCADA & PLC BASED SEQUENTIAL CONTROL

5.1 Script
5.2 Networking
5.3 Device connectivity.

Practice:

P5.1 Script
P5.2 Networking
P5.3 Device connectivity

Course – 6: HUMAN MACHINE INTERFACE

6.1 What is HMI. Use of HMI
6.2 Concept of different operational features
6.3 Connectivity of HMI and PLC.

Practice:

P6.1 Alarms
P6.2 Security
P6.3 Recipe manager

Course – 7: OPC SERVER BASE DATA FETCHING & CONTROL

7.1 Study of Open Platform Communications
7.2 OPC to control PLC, SCADA.
7.3 OPC based different protocol concept.
7.4 Data handling using OPC.

Practice:

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

Embedded System Design

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

Course Objectives

- Develop a skilled workforce with the Knowledge of the latest trending technologies to meet the Embedded Industry needs.
- To make the student industry-ready with prompt hands-on in the various Real-Time Embedded Systems.

Course Outcomes

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Gain and apply knowledge about the architectural features and instructions of 32-bit ARM microcontrollers to develop the embedded system.	PO1(3)
CO2	Identify, analyze, formulate, develop and design various product-based applications based on Embedded Systems.	PO(2), PO3(3)
CO3	A diversified team will learn, configure and build a customized Linux Kernel and also be able to set up and use the Cross Development platform, which will help them in lifelong learning.	PO9(3), PO12(3)
CO4	And apply the techniques and knowledge gained in Embedded Systems to become an entrepreneur for sustainable development.	PO5 (2), PO7(3)

Domain Syllabus:

1. Microcontroller-Based Embedded System Design (57.5 Hrs)

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

14. Real Time Clock (RTC)
15. Watch Dog timer (WDT)
16. Debugging with JTAG
17. Inter System Protocols – UART, USART, USB, Bluetooth, BLE, GPS, GSM
18. Intra System Protocols – I2C, SPI, CAN
19. Wireless Protocols and its Complete setup – NFC/ RFID, ZigBee, Bluetooth, Wi-Fi, MQTT, LORA,

2. Real-Time Operating System & Porting (57.5 Hrs)

1. Real-Time OS
2. Types of RTOS
3. GPOS vs RTOS
4. FreeRTOS
5. VxWorks
6. Task Management & its API
7. Scheduling Algorithms & its API
8. Inter Task Communication & its API
9. Resource Management & its API
10. AWS IoT Core for FreeRTOS
11. AWS IoT Green Grass setup on Raspberry Pi

3. Embedded Linux for ARM (57.5 Hrs)

1. Embedded Linux Overview
2. Linux File System
3. Types of Kernel
4. Shell Commands
5. Shell Scripting
6. Process Management System calls
7. Inter-Process Communication System calls
8. Linux Booting Sequence
9. Toolchains Configuration and Cross Compilation
10. Configuring & Installing Bootloaders (U-Boot)
11. Kernel Configuration and Compilation
12. Creating Custom Root File system
13. Remote Debugging Embedded Applications using GDB
14. Device Drivers- Char drivers
15. Static Linking & Dynamic Linking
16. Adding Static Module to the Kernel

4. AUTOSAR Design using CAN, CAN Analyser, and LIN (14 hours)

1. Introduction to Automotive System
2. Introduction to AUTOSAR
3. Details on CAN Protocols
4. SBUS CAN Analyser
5. LIN Protocol

Software Handling

1. Keil µ vision 5
2. Arduino IDE
3. ARM GCC Compiler
4. FreeRTOS, Raspbian OS, Ubuntu OS
5. VxSim
6. Proteus Professional 8.9
7. Node-RED

MPU Handling

1. Arduino
2. ESP8266
3. LPC2148/LPC2129
4. Raspberry Pi
5. STM32
6. Beagle Bone Black

List of Projects/ papers/jobs/products to be done in the domain:

(To follow the Gate Process)

1. IoT-based Apparel Tracking System
2. IoT-based Smart Agriculture Monitoring & Controlling
3. Color-based Product Sorting Machine using IoT
4. IoT-based Smart Energy Meter

Course Developed and Prepared by: Prof. Swarna Prabha Jena

Communication Systems Domain

Code	Course Title	T-P-Pj (Credit)	Prerequisite
CSCU2080	Communication Systems Domain	4-8-6 (18)	NIL

Course Division

1. Microwave & RADAR Communications (2-1-0)
2. Satellite & TV Communications (1-2-0)
3. Cell Site and BTS Operation, Maintenance and Troubleshooting: RF Planning and Drive Test (0-3-0)
4. Optics and Wireless Sensor Networks (1-2-0)
5. Project (0-0-6)

Course Objectives

- Develop the skills required to design a next generation wireless networks
- To involve the students in the theory and practice of optical and wireless sensor network

Course Outcomes

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

Evaluation Systems

As per University Norms

COURSE CONTENT

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

1. Introduction to Microwaves: Microwave frequencies

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

Text Books:

1. R E Collin, “Foundation for Microwave Engineering”, John Wiley & Sons, 2nd
2. Edition, 2007
3. 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

6. international Publishers, 2008
7. 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 3.11Frequency 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,JaanaLaiho and AchimWacker, Nokia Group, Finland, Toma´ sˇ Novosad,,Nokia Networks, Nokia Group, USA, John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex PO19 8SQ, England
4. Material: E1-E2 Upgradation Course –Consumer Mobility, RF Planning and Drive Test
5. Material: GTL , RF Optimisation.

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

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

20. Node-level Software platforms, Node-level Simulators.

TEXT Books

1. John M. Senior, "Optical fiber communication", Pearson edition, 2000
2. Uyless Black "Optical Networks ", Pearson Education , 2011.
3. Holger Karl and Andreas Willig, “Protocols and Architectures for Wireless Sensor Networks", John Wiley, 2005
4. 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 &amp
1.13 Software Design, Core Libraries
1.14 EDA Tools SoC Design Flow Guidelines for Design Reuse
1.15 Design Process for Soft and Firm Cores
1.16 Design Process for Hard Cores, System Integration
1.17 Design Methodology for Memory & Analog Cores Embedded Memories
1.18 Design Methodology for Embedded Memories
1.19 Specification of Analog Circuits
1.20 Core Level Validation, Core Interface
1.21 Verification, SoC Design Validation

Text Books:

1. Verilog HDL, 2/E By Samir Palnitkar, Pearson Education
2. Himanshu. Bhatnagar, “Advanced ASIC Chip Synthesis” (2/e).KAP.2002
3. Rochit Rajsuman, ‘System-on-a-Chip: Design and Test’, Artech House, 2000

Reference Books:

1. Maheshwari, Naresh, Sapatnekar, “Timing Analysis and Optimization of Sequential Circuits”. 1998, Springer. ISBN: 978-0-7923-8321-5
2. Modern Digital Electronics. Author, R P Jain. Edition, 3. Publisher, Tata McGraw-Hill Education

Software Tool::

- •Microwind
- •Cadence
- •Xilinx ISE

2.Digital VLSI (2-2-0):

2.1 Issues in Digital IC Design

2.2 Quality Metrics of A Digital Design
2.3 Manufacturing CMOS Integrated Circuits
2.4 Design Rules. Layouts
2.5 The Metal Oxide Semiconductor (MOS) Structure
2.6 The MOS System Under External Bias
2.7 Structure And Operation of MOS Transistor (MOSFET)
2.8 MOSFET Current-Voltage Characteristics
2.9 MOSFET Scaling And Small-Geometry Effects, MOSFET Capacitance
2.10 Static CMOS Inverter: Static And Dynamic Behavior Practices of CMOS Inverter
2.11 Components Of Energy And Power: Switching, Short-Circuit And Leakage Components
2.12 Technology Scaling And Its Impact On The Inverter Metrics
2.13 Static CMOS Design: Complementary CMOS, Ratioed Logic, Pass Transistor Logic
2.14 Dynamic CMOS Design: Dynamic Logic Design Considerations
2.15 Speed And Power Dissipation Of Dynamic Logic
2.16 Signal Integrity Issues, Cascading Dynamic Gates
2.17 CMOS Sequential Logic Circuit Design Introduction, Bi-Stable Circuit Elements
2.18 SR & JK Latch Circuits
2.19 Clocked Latch And Flip-Flop Circuits
2.20 CMOS D-Latch And Edge-Triggered Flip-Flop
2.21 Semiconductor Memory Design: Introduction, MOS Decoders
2.22 SRAM Design, DRAM Design
2.23 Memory Architecture And I/O Circuitry

Text Books

1. Sung-Mo Kang and Yusuf Leblebici, CMOS Digital Integrated Circuits: Analysis and Design, Tata McGraw-Hill Publishing Company Limited
2. Jan M,Rabaey, AnanthaChandrakasan, BorivojeNikolic, Digital Integrated Circuits–A Design Perspective, PHI

Reference Books:

1. Wayne Wolf, Modern VLSI Design System – on – Chip Design, PHI
2. K,Eshraghian and N,H,E,Weste, Principles of CMOS VLSI Design – a Systems Perspective, 2nd Edn,, Addison Wesley

Software Tool::

- Microwind
- Cadence

3.Analog VLSI (2-1-0):

3.1 Independent Sources: MOS Current Sources and Sinks
3.2 Current Mirror: Basic Current Mirrors, Cascode Current Mirrors
3.3 Current and Voltage Reference Circuits
3.4 Amplifier Design : Basic Concepts of Amplifier, Common Source Stage
3.5 Common Gate Stage, Cascode Stage
3.6 Differential Stage: Single Ended and Differential Operation
3.7 Basic Differential Pair
3.8 Frequency Response of Amplifiers: Miller Effect, Frequency Response of Common Source Stage

3.9 Common Gate Stage, Cascode Stage and Differential Pair
3.10 CMOS Op-Amps: Differential and Common Mode Circuits
3.11 Op-Amp CMRR Requirements, Need for Single and Multistage Amplifiers
3.12 Effect of Loading in Differential Stage
3.13 Digital To Analog Converters:(Binary Weighted Resistor, R-2R Ladder Network)
3.14 Analog To Digital Converters: (Dual Slope, Successive Approximation Type)
3.15 Frequency Compensation: Concepts and Techniques for Frequency Compensation
3.16 Dominant Pole, Miller Compensation, Compensation of Miller RHP Zero
3.17 Nested Miller, Compensation of Two Stage OP-Amps

Text Books:

1.Behzad Razavi, "Design of Analog CMOS Integrated Circuits", McGraw-Hill, 2000.
2.Phillip E. Allen and Douglas R. Holberg, "CMOS Analog Circuit Design", (Second Edition) Oxford University Press, February 2002.

Reference Books:

1.Gray, Hurst, Lewis, and Meyer: "Analysis and design of Analog Integrated Circuits", (4/e), John Wiley and Sons.

Software Tool::

•Microwind
•Cadence

4.Verification Using SystemVerilog (0-4-0):

4.1 Verification Concepts
4.2 Introduction to System Verilog Language
4.3 Basic SV TB - Connecting to your design
4.4 SV-OOPs concepts and Randomization
4.5 Threads and Inter Process Communication
4.6 Introduction to Verification Methodologies
4.7 Case Study : Design and Verification of a SRAM Memory Cell Using UVM Methods

Software Tool::

•Questa Sim

Text Books

1.Sutherland, Stuart, Simon Davidmann, and Peter Flake, "SystemVerilog for Design Second Edition: A Guide to Using System Verilog for Hardware Design and Modeling", Springer Science & Business Media, 2006
2.Spear, Chris. "SystemVerilog for verification: a guide to learning the testbench language features," Springer Science & Business Media, 2008

Reference 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:

- 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)
1.2Requirement gathering and feasibility study of the project
1.3understanding users' motivations and to gather deep insights about a product
1.4challenges and benefits of the products
1.5Understanding the product through literature survey and available resources
1.6Market analysis of existing products
1.7Finalizing the product specification
1.8Preparing a project plan

2.1Design Parameter Optimization in Dymola (Gate 1)

Designing and simulating system and subsystem of the product using system Engineering Dymola
2.2Final functional and logical design of integrated product in system engineering with simulation.
2.2Customizing the product properties with required inputs and analyzing the outputs.

3.1CATIA Drawing with Styling (Full product drawing) (Gate 2)

3.2CATIA part design with assembly design of the product.
3.3Behaviour experience of the product

4.1Digital Testing and Validation of the Product Using Simulia (Gate 3)

4.2Complete structural, thermal, mechanical simulations with other required simulation is done for the product**.**

5.1Regulatory Certification (Gate 4)

5.2Once the regulatory certification for a particular product is over through certain testing and validation, the product is all set for the next stage**.**

6.1BOM 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
2.2Finding energetic dimension of the desired product
2.3Designing system and subsystem using behaviour modelling work bench
2.4Getting familiar with Dymola- modellica library.
2.6Understanding the behaviour of the model through input n output data

2.7Customizing the product properties
2.8System Integration with product dimension.
2.10Functional and logical design of integrated product in system engineering.
2.11D Model using CATIA
2.12ATIA part design of different components
2.13Surface designing for creating high end complex design
2.14Assembly Designing of the complete product
2.15Wire routing and entire harnessing of the design.
2.16Mechanical system Designing of the product
2.17CATIA live rendering
2.18Behaviour experience of the complete product.
2.19Design validation/Simulation using Simulia
2.20Simulation using Simulia
2.21Classification of simulation
2.22Structural simulation, Thermal simulation and both
2.23Linear and non linear analysis
2.24CFD Analysis, Fatigue, Durability
2.25Explicit Analysis, Crash Analysis (Abaqus)

3.Process management (Using Enovia) (1-2-0)

3.1Introduction to project management, Project Definition, Project Initiation
3.2Need for Project Management
3.3Provide vision and direction, increase efficiency, Control.
3.4Project scope, manage costs, manage time, Schedule the work
3.5Deal with potential risks
3.6Project Management Principles, Project structure, Clear goals
3.7 Transparency about project status, Risk recognition,
3.8The Project Life Cycle: The project initiation stage, The project planning stage, The project execution stage, The project closure stage.
3.9Project Identification and Selection: Introduction, Project Identification Process
3.10Project Initiation, Pre-Feasibility Study, Feasibility Studies, Project Break-even point
3.11Core functionality integration with different engineering IT tools, specifically with **Catia, Delmia, Dymola, Simulia** etc.
3.12PDM (product data management) systems and their implementations in product lifecycle (Enovia)
3.13Exemplification on how PLM functionality can be used to facilitate increased information management efficiency and exchange (Enovia)
3.14Resources Considerations in Projects: Resource Allocation, Scheduling, Project Cost Estimate and Budgets, Cost Forecasts (Enovia)

4.Product Development (0-0-8)

4.1The Domain will be delivered through case studies, assignments and product development.
4.2The outcome will be an end-to-end digital prototype of a product, which may be patinized.
4.3Product 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	1.2Requirement gathering and feasibility study of the project
Session	3	1.3Market analysis of existing products
Session	4	1.4Finalizing the product specification and preparing a project plan
Session	5	1.5 Design Parameter Optimization in Dymola (Gate 1)
Session	6	1.6Designing 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:

- To familiarise the students with different systems and subsystems of automobile.
- To teach basic skill in maintenance of different types of automobiles.
- To know the operation and maintenance of electric vehicle.

Domain Track Course Outcomes:

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

Introduction to Automobile Engineering

Course Title	Course Code	Type of Course	T-P-Pr	Pre-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 Convertor, Construction and Working Principle of Automatic Transmission, Construction and Working Principle of Continuously Variable Transmission (CVT) and Automated Manual Transmission (AMT).

Practice

- Study of Single Plate Friction Clutches (Coil Spring Type And Diaphragm Type).

- Study of Synchronizer Mechanism And Synchromesh Gear Box, Continuously Variable Transmission (CVT).

Module IV **12 (hrs)**

Propeller Shaft and Differential: Function and Need of Propeller Shaft, Hotchkiss Drive and Torque Tube Drive, Construction of Propeller Shaft, Universal/Hooke's Joints, Slip Joint, Constructional Features and Working Principle of Differential Mechanism, Types of Differentials (Locking Type Differential, Limited Slip Differential).

Axles: Types of Automotive Axles, Constructional Features, Types and Working Principle of Front Axles, Lift Axles, Rear Axle, Third Differential in Tandem Axle Vehicles, Construction and Working Principle of Manual Transaxles and Transfer Cases.

Practice

- Study of Propeller Shaft, Universal Joints, Slip Joints, Centre Bearing.
- Study of Front Axle System.
- Study of Rear Axle System Including Differential Mechanism.
- Disassembly and Assembly of Manual Transaxle of Front Wheel Drive Car.

Module V **10 (hrs)**

Steering System: Purpose of Steering System, Components of Steering System, Steering Geometry (Castor, Camber, Toe-In, Toe-Out, King Pin Inclination), Types of Steering Gear Boxes and their Construction and Working Principles, Hydraulic and Electrically Power Assisted Steering Systems.

Braking System: Requirement and Key Design Parameters of Braking System, Classification and Types of Braking Systems, Mechanical Brake, Hydraulic Brake, Air Brake, Vacuum Brake, Disc Brake. Construction, Working Principle and Components of Anti-Lock Braking System (ABS)

Practice

- Study of Steering Gear Box And Hydraulic Power Assisted Steering System.
- Identifying the Different Components and Working Of Drum Brake, Disc Brake, Hydraulic Brake, Air Brake System.
- Study of Anti-Lock Braking System (ABS) In KNOW Vehicle.

Module VI **6 (hrs)**

Auto Electric System: Wiring Diagram of Horn Circuit, Lighting Circuit, Cut-Out Circuit, Voltage and Current Regulator Circuit in Commutator Type Generator, Combined Three-Unit Regulator Circuit, Voltage and Current Regulator in Alternating Current Type Generator And Flasher Circuit (Sketch And Description), Common Ignition Troubles And Its Remedies, Basic Electronic Ignition Trouble Shooting Charts, Spark Plugs: Purpose, Construction and Specifications.

Module VII **8 (hrs)**

Suspension System: Purpose and Classification of Suspension Systems, Sprung and Unsprung Mass, Major Components of Suspension System, Description of the Conventional Suspension Systems for Rear and Front Axle. Panhard Rod, Macpherson Strut, Double Wishbone Suspensions. Description of Independent Suspension System Used In Cars (Coil Spring And Torsion Bars), Constructional Features and Working of Air Suspension System, Anti-Roll Bars, Constructional Features, Types and Working of Telescopic Shock Absorber.

Practice

- Identification of Different Types of Suspension Systems: Coil Spring, Tension and Telescopic Suspension System.

Text Books

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

References

1. Crouse William H and Donald Anglin, Automotive Mechanics, Tata Mcgraw Hill Publications.
2. Newton K., Steeds W, and Garrett T K, The Motor Vehicle, Butterworth Heinemann

Electric Vehicles

Course Title	Course Code	Type of Course	T-P-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 Assembing Methods.
- Working of Circuits in Controllers with respect to Current and Voltage Rating.

Module II **3 (hrs)**

Electric Vehicle Drive Trains: EV Transmission Configurations, Basic Architecture of Electric Drive Trains, Single and Multi-Motor Drives, In Wheel Drives.

Module III **6 (hrs)**

Energy Sources: Working Principle of Battery, Types of Batteries, Lead-Acid Battery, Nickel-Cadmium Battery, Nickel-Metal-Hydride (Nimh) Battery, Lithium Batteries, Battery Parameters, Fuel Cells,

Practice:

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

Module IV **8 (hrs)**

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

Practice:

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

Module V **5 (hrs)**

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

Practice:

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

Module VI **3 (hrs)**

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

Module VII **3 (hrs)**

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

Text Books

1. Hussein Iqbal, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press
2. Chau K. T., Electric Vehicle Machines and Drives: Design, Analysis and Application,Wiley.

References

1. Chan C.C. and Chau K.T., Modern Electric Vehicle Technology, London: Oxford University.

Maintenance of Automobile (2 Wheeler & 4 Wheeler)

Course Title	Course Code	Type of Course	T-P-Pr	Pre-Requisite
Maintenance of Automobile (2 Wheeler & 4 Wheeler)	CUAE2176	Practice	0-5-0	Nil

Practice

- Safety Precautions in Automobile Maintenance.
- Identification and Functions of Various Tools and Equipments used in Automobile Workshop.
- Disassembling and Assembling of Engine of a Four Wheeler.
- Disassembling and Assembling of Engine of a Two Wheeler.
- Engine Troubleshooting.
- Nomenclature of a Spark Plug and Spark Plug Reading, Testing and Cleaning of Spark Plug.
- Checking and Replenishing Lubricating Oil, Engine Coolant, Power Steering Hydraulic Oil and Wind Screen Wiper Water.
- Overhauling and Servicing of Fuel System including Air Filter.
- Disassembling and Assembling Of Clutch, Clutch Troubles And Remedies.
- Repairing and Adjustment of Brake System.
- Disassembling and Assembling of Propeller Shaft.
- Inspection and Servicing of Gear Box.
- Inspection and Servicing Of CVT.
- Tire Change Operation, Wheel Balancing, Wheel Alignment, Tire Inspection (Tubeless & Tube) and Inflation.
- Overhauling of Suspension System.
- Disassembling and Assembling of Steering System and Adjustment of Drag Link.
- Preparation of Electrical Circuits using Switches and Fuses.
- Checking of Battery Terminal Voltage, Electrolyte Level and Specific Gravity.
- Inspection of Different Electrical Circuits and ECU.
- Checking of Ignition System Circuit & Components.

Reference Book:

1. Training Manual of Four Wheeler Maintenance (Ashok Leyland)
2. Training Manual of Two Wheeler Maintenance (Yamaha).

DOMAIN TITLE: Manufacturing (Conventional, CNC and Additive)
CMCU2150

Sl. No.	Course Code	Course Title	Course Type	T-P-Pr	Credits
1	CUCM2150	Manufacturing Requirements and Planning (Jigs & Fixtures; Process Planning & Cost Estimation)	Theory	2-0-0	2
2	CUCM2151	Conventional Machining for Cylindrical and Prismatic Shape Components	Practice+ Project	0-4-2	6
3	CUCM2152	CNC Machining (0-6-2)	Practice+ Project	0-6-2	8
4	CUCM2153	Non-Traditional Machining and 3D Printing 0-2-2	Practice+ Project	0-2-2	4
5	CUCM2154	Wood Engineering (0-2-0)	Practice	0-2-0	2
6	CUCM2155	Internship	Project	0-0-4	4
Total					**26**

Domain Track Objectives:

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

Domain Track Course Outcomes:

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

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

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

COURSE CONTENT (20 HRS)

Module I Introduction to Jigs & Fixtures (2 Hrs)

Theory
Fundamental Concept and Need of Jigs and Fixtures;Jigs and Fixtures design principles and factors; Materials used in jigs & Fixtures.

Module II Locators (3 Hrs)

Theory
General Principles of Degrees of Freedom and Constraints; Foolproofing; Basic rules for location; Locating methods, Types of locators.

Module III Clamps & Indexing Devices (3 Hrs)

Theory
Principles of clamping, Types of clamps, Liner indexing, precision linear indexing and rotary indexing

Module IV Various Jigs & Fixtures (3 Hrs)

Theory
Components of Jigs, Types of Jigs, Selection of Jigs

Module V Types of Fixtures (3 Hrs)

Theory
Salient features of milling fixtures, Classification of milling fixtures, Facing fixtures, Slotting Fixtures. Turning (Standard chucks, Spring collets, Cylindrical liners, Mandrels, Turning Fixtures), Grinding, broaching, welding and modular fixtures

Module VI Process Planning: Introduction (3 Hrs)

Theory
Objectives and Approaches to Process Planning;Process Planning Activities; Process Planning & Production Planning; Operating Sequences, Setup Documents for Process Planning.

Module VI Introduction to Cost Estimation (3 Hrs)

Theory

Objectives of Cost Estimation; Components of a Cost Estimate; Cost Estimation Procedure; Classification of Costing; Elements of Cost; Expenses; Cost accounting, Types of Cost Estimates; Methods of Cost Estimates; Data Requirements and Sources of information; Allowances in Estimation (of Standard Time)

Text Books

1. Joshi, P H, Jigs & Fixtures, 2010, 3rd Edition, McGraw Hill.
2. Nagpal, G R, Tool Engineering & Design, 2000, Khanna Publishers.

Reference Books

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

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

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

COURSE CONTENT

Course Outline

1. Cylindrical Turning Operations (Both Internal and External), Knurling, Thread Cutting, Stepped Turning)
2. Kinematic Study of Centre Lathe
3. Hole Making Operation in Turret Lathe
4. Work Holding and Tool Holding Devices For Turning Operations
5. Kinematic Study of Pillar Drilling Machine, Radial Drilling Machine and Boring Machine
6. Counter Boring , Counter Sinking and Threading Operations
7. Finishing Operations
8. Kinematic Study of Shaping Machines and 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 Fundaments, Machine Structure, Machine Control Panel, Machine Input and Output Parameters.

Module III EDM Process Parameters (5 Hrs)

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

Module IV Additive Manufacturing (10 Hrs)

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

Module V 3D Printing (10 Hrs)

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

Text Books

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

Reference Books:

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

Wood Engineering (25 Hrs)

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

COURSE OUTLINE

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

Text Books

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

Reference

1. John, K C, Mechanical Workshop Practice, 2nd Edition, 2010, PHI Learning Pvt.Ltd.
2. Hasluck, P N, Working with Hand Tools: Essential Techniques for Woodworking, 2012, Skyhorse Publishing.

DOMAIN TITLE: Welding and Inspection (WICU2160)

Domain Track Objectives:

- To develop understanding and skill of students for Welding Technology
- Students pursuing this domain will be ready for industrial employment
- The students develop passion for higher education and research in Welding Engineering

Domain Track Course Outcomes:

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

Joining Processes & Technology

Course Title	Course Code	Type of Course	T-P-Pr	Pre-Requisite
Joining Processes and Technology	CUWI1260	Theory+Practice + Project	2-2-2	Nil

COURSE CONTENT

Module-I (29 Hours)

Welding classification, advantages, disadvantages and applications of various welding processes, Gas Welding & Cutting: Oxy-acetylene welding, flux and filler, types of gas flames, Gas welding techniques, Arc welding: Physics of arc welding, SMAW Principle and equipment, types of electrodes, functions of coatings, TIG (GTAW), MIG (GMAW) & flux-

cored arc welding, submerged arc welding, weld cladding & surfacing, plasma cutting and spraying, atomic hydrogen welding.

Practice:

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

Module-II (28 Hours)

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

Practice:

1. Identification and working of spot welding machine parts

MODULE-III (26 Hours)

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

Practice:

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

Text Books:

1. Welding & Welding Technology by R.L.Little.1976. Tata McGraw Hill Education 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.

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

Metal Transfer and Weld Metallurgy

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

COURSE CONTENT

Module-I (27 Hours)

Metal transfer - Metal transfer in AC and DC arc welding, metal transfer in TIG, MIG and MAG welding, Study of different modes of metal transfer in MIG welding (Practice), Welding defects due to improper metal transfer and improper filler material, Diffusion in Soldering and Brazing. 343

Practice:

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

Module-II (28 Hours)

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

Practice:

1. Practice on stress relieving and normalising in welding

2. Experiments for demonstrating weld-ability

MODULE-III (26 Hours)

Weld ability of other metals - Defects in welded joints- hot cracks and cold cracks, porosity, embrittlement, lamellar tearing, distortion etc. weld ability of low carbon steels, HCS. Weld ability of stainless steels, weld ability of titanium and alloys, weld-ability of high strength low alloy steels. Heat treatment of welded structures, shot pinning, stress reliving 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	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Students able to write computer programs for solving elementary fluid dynamics/ heat transfer problems.	PO1(3)
CO2	Execute industry projects to produce Quality products for Clients	PO3(3)
CO3	General competency in Numerical solution of problems in fluid dynamics	PO4(3),PO6 (2)

Introduction to CFD

Course Title	Course Code	Type of Course	T-P-Pr	Pre-Requisite
Introduction to CFD	CUCF2180	Theory +Project	2+0+1	Nil

1. Introduction to CFD (2-0-1)

Module-1

Fluid, Properties of Fluid (Temperature, Vapour Pressure, Viscosity, Specific Gravity, Compressibility, Speed of Sound, Density, Energy, Specific Heat, Newtonian and Non-Newtonian Fluids

Module-2

Lagrangian and Eulerian Approaches, Classification of Fluid Flow (Inviscid vs. Viscous, Laminar vs. Turbulent, Incompressible vs. Compressible, Internal vs. External, Steady vs. Unsteady,Rotational vs. Irrotational, 1D, 2D and 3D Flows)

Project 1. Case studies in industrial pipe flows.

Module-3

Governing Equations of Flow Field (Conservation of Mass, Momentum (Navier-Stoke Equation) and Energy)- Differential Form, Integral Form.

Project 2. Case studies and generation of drag and lift for flow over bodies.

Module-4

Flow Features (Stagnation, Boundary Layer (Laminar to Transition to Turbulent), Flow Separation), Types of Boundary Conditions.

Project 3. Case studies in different types of aerofoil and its applications.

Module-5

Heat Transfer in Fluid (Conduction, Convection (Natural, Forced), Radiation), Non-dimensional Quantities, Flow Similarity between Prototype and Model.

Project 4. Case studies for various non-dimensional quantities and its importance in CFD.

Module-6

CFD and its applications, Discretization methods for the CFD (FDM, FVM, FEM, Hybrid Methods).

Project 5. Case studies for the various applications of CFD and its significance.

Module-7

Turbulence Modelling, CFD Solution Tool Chain

Project 6. Case studies for the different turbulence modelling in CFD.

Text Book:

1. An Introduction to Computational Fluid Dynamics, by H.K.Versteeg & W.Malalasekera, Longman Scientific & Technical, England

Grid Generation

Course Title	Course Code	Type of course	T-P-Pr	Pre-Requisite
Grid Generation	CUCF2181	Practice	0+2+0	Nil

2.1 Introduction to Meshes- CFD Meshing Basics

2.2 Different Element Shapes- Creating, Managing & Updating Meshes

2.3 CFD Meshing- 2D Mesh, 3D Mesh, Mapped Face Meshing,

Practice 1. 2D mapped Mesh for rectangular pipe

Practice2. 2D mapped Meshing for Aerofoil.

2.4 Structured Meshing, Un-Structured Mesh, Sweep 3D Mesh

Practice 3. 3D structure mesh of Circular Cylinder

Practice 4. 3D unstructured mesh with prims layers for Aerofoil

Practice 5. 3D coarse/ medium/ fine sweep mesh for pipe

Practice 6.3D coarse/ medium/ fine unstructured Octree Tetrahedron mesh for Aerofoil.

Practice 7. 3D hex- dominant mesh for rectangular Duct.

2.5 Visualization the Mesh- Visualization Management, Mesh Visualization Options, Section, Clipping Box, Mesh colour, Element shrink

2.6 Reviewing the Mesh- Quality Analysis, free Edges, Interfaces, Duplicate Checker, Isolate Node Checker

Practice 8. 3D hex-dominant with surface mesh, Boundary prim mesh for DS car.

Practice 9. 3D Tetrahedron filler mesh Narrowing pipe.

Practice 10. 3D Tetrahedron, surface, for Electronics Module.

Practice 11. 3D Sweep mesh for circular cylinder.

Practice 12. 3D mesh generation for Subsonic Converging-diverging Nozzel.

Practice 13. 3D Sweep mesh generation for U-Bend pipe.

Practice 14. 3D mesh generation of Dimple Ball.

Practice 15. 3D mesh generation of a wedge body.

Text Book:

1. HandBook of Grid Generation, by J.F.Thompson, B.K.Soni & N.P.Weatherill, CRC Press , New York.

Flow Solver Techniques-Simulia

Course Title	Course Code	Type of Course	T-P-Pr	Pre-requisite
Flow Solver Techniques-Simulia	CUCF2182	Practice +Project	0+3+1	Nil

3.1 Overview-Fluid Dynamics Engineer Essentials

- Connecting to the platform, Assigning roles and Apps, Platform Interface, Importing 3D XML file, Simulation Conventions in the 3DExperience Platform

Practice 1. Getting Started with the 3DExperience Platform.

3.2 Import an assembly

- Explore the imported assembly, Renamed the assembly, Search for parts/assemblies in the database, open parts/ assemblies found through search, duplicate, delete and save entities, Import a 3D XML file containing fluid materials, Create and save a new material.

3.3 Fluid Dynamics Engineer Role Overview

- Exploring Fluid Dynamics Engineer Role Apps, CFD simulations work flow, Model preparations, Material definitions, Meshing, CFD analysis, Analysis convergence, co-simulation Analysis, Post processing results, CFD solver validations.

Practice 2. CFD analysis of steady state internal Laminar Pipe flow.

Project 1. Analysis of pipe flow at Re= 500.

3.4 Getting Started with CFD Simulations

- Fluid Model Creation, Fluid Scenario Creation App Interface, Model setup, applying meshing, Scenario Setup, Results visualizations, Reviewing Simulation Features,

Practice 3. CFD analysis Steady-state external flow over an Airfoil.

Project 2. Analysis of 2D cylinder in a rectangular domain with varying radius and height.

3.5 Geometry for CFD Simulations

- Geometry Preparation- Check and Repair, Defeature Idealize, Create, Healing, Join, Local Join, surface connection Checker, Face checker, Mid surface

Practice 4. Modeling of Air intake system.

Practice 5. Extracting Fluid volume for Engine Manifold.

3.6 Material and Section Properties of Fluid

- Understanding materials, working with materials, Creating a new Material, Applying a Material, Adding New Domains, Editing a Material Domain, Simulation Domain, Material Behaviors in a Simulation Domain, Section Properties, working with Imported Meshes

3.7 Defining Physics of Fluid

- Analysis Procedures- Enabling Temperature, Compressible, Coupled vs Segregated solver, Gravity effects.
- Turbulence Modelling- SST k-w, Realizable k-e, Spalart-Almaras, Radiation Modeling, Steady-state Analysis, Transient Analysis- Courant-Freidrichs-Levy (CFL) condition, Grid Independence Study, Bad cell Treatment

Practice 6. Grid Independence study for above cases (pipe / airfoil) using different solver schemes.

Project 3. Analysis of flow an over a circular cylinder at $Re=10^7$.

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:

- 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
CUCD2134	Machineries and Technologies used for Manufacturing of Composites	2-0-0	

Module –I (7 Hours)

Introduction
Basics of Laminates, which have layers bonded together
Sandwiches
Open Mold Processes-
Hand layup process

Module –II (7 Hours)

Spray Bag, Vacuum Bagging
Automated tape laying machine,
Pressure bag molding
Closed Mold Processes
Filament Winding
Pultrusion Processes

Module –III (7 Hours)

PMC Shaping Processes.
Application of Pultrusion Process
Comparison between open and closed mold process

Book Suggested:

1. Machining Composites Materials, JP Davi, Wiley Publication
2. Mechanics of Composite Materials, Autar K. Kaw,Taylor and Fancis

Quality control and Fabrication of Composite Structure

Code	Course Title	T-P-Pj (Credit)	Prerequisite
CUCD2135	Quality control and Fabrication of Composite Structure	2-2-0	Nil

Module –I (7 Hours)

Define minimum standards for aerospace grade fiber, resin, fabric/braid
Define minimum standards for aerospace prepare – Material qualification, material specification, process control document
Factors affecting Quality of Composites made by hand lay-up

Module –II (7 Hours)

Factors affecting fabrication factors, stacking sequence, fiber volume fraction, cure
Material selection criteria for new generation aircraft
Structural Requirements for Certification,
Material Qualification Procedures, Material Property Development
Material Screening and Selection,
Material and Process Specification Development

Module –III (7 Hours)

Material and Process Control, QCs for Composite Part Manufacturing, Material Acceptance
Mechanical test of laminates and sandwiches
Test for adhesives and sealants
Chemical and physical tests for material composition
Thermal analysis for composite materials

Module –IV (7 Hours)

Aging tests by chemical aging
Thermal and humidity aging
Radiation aging test
Reappear test, fire and smoke test
Non-destructive test, Ultrasonic Phased Array test,2D X-Ray test on field

Practice

- Fabrication using Natural Fibre
- Fabrication using glass fiber
- Fabrication using carbon fiber
- Fabrication processes for polymer matrix composites (PMC)
- Matched Die mold
- Contact Mould, Filament Winding
- Pultrusion
- Fabrication processes for metal matrix composites (MMC)
- Diffusion Bonding, Powder Metallurgy Process, Casting

- Fabrication processes for ceramic matrix composites (CMC)
- Hot Press Sintering, Liquid Infiltration
- Sintering, Chemical Vapour Deposition Process

Suggested Book:

1. Composite Materials and Structural Analysis, NGR Iyengar, My learning publication
2. Composite Structures: Effects of Defects, Rani Elhajjar, Wiley Publication

Project

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

Domain

Architectural and Structural Design

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

Courses Divisions:

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

Course Objectives:

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

Course Outcomes:

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Strong understanding of architectural design and scope for innovative ideas.	PO1 (3), PO3 (2),
CO2	Case study based practical solution with actual site visits/live buildings.	PO4[3]

CO3	Modelling of structural elements and failure analysis.	PO5 (3)
CO4	Time saving estimations/structural calculations using digital tool in sustainable manner.	PO7 [2]

Domain Syllabus

Critical thinking and presenting it with digital platform

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

1.1 Introduction to Architectural Design

1.2 The need and scope of with basics of Design Principles

1.3 Ergonometric data and its application

1.4 Hands-on experience with designing their own house or hostel

1.5 The need of digital drive for 2D design expressions

1.6 Basics of AutoCAD, Conceptualization of Design: Own House drafting/Hostel

1.7 Addition of Creativity and modifying the design

1.8 Study the impact of Geological data, climatological data on design

1.9 Modification of design based on hydrology, soil, site conditions

1.10 Carving out a meaningful design in terms of architecture and structure.

1.11 Application of 2D design/ welcoming them in the world of 3D design

1.12 Basics of 3D concepts and commands

1.13 Practical techniques for saving area/cost

1.14 Presenting a wholesome idea before moving to BIM

Scope to enrich by exposing them to BIM Modelling

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

2.1 Introduction to BIM modelling
2.2 The need and scope of with live examples
2.3 Ergonometric 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

- 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	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Able to identify specific data knowledge and analyses methodology for effective mapping and evaluation resources.	PO1 (3), PO2 [1]
CO2	Understand the geospatial models skills address to the social and engineering problems.	PO4 [1], PO6[1]
CO3	Design multi-criteria geospatial systems for decision-making process.	PO3 (2)
CO4	Work in a team using geospatial tools and environment to achieve project objectives.	PO9(3)
CO5	Pursue lifelong learning for professional advancement.	PO12 (3)

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

3. 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:

1. Google earth to DEM, 3D Map preparation, Contour to DEM, TIN and Aspect
2. DEM based surface Hydrology modeling,
3. 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:

1. Mapping of catchment, command area
2. Drainage network analysis
3. Morphometric analysis
4. 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:

1. Air pollution mapping
2. Solid waste management
3. 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:

1 Scale determination from aerial photo

2 Aerial photo Interpretation

3 Use of Parallax bar and determination of Height from stereo pair

4 Satellite DEM and ortho Image generation

5 Primary and additive colour creation

6 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
Subject Name	Code	Type of course	Credit	T-P-P	Prerequisite

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:

- Students will be able to work with the latest trend of the construction industry needs.
- Understand different methods of project delivery and the roles and responsibilities of all constituents involved in the design and constant process.
- Give the students experience, supervision and direction in recognizing and applying the concepts of project management and construe planning.

Course Outcomes:

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Students will apply knowledge and plan various complex project problems relating to advanced building technology with trust.	PO1 (3), PO2 (2), PO4 (1)

CO2	Students will be able to churned as Construction Manager, Project Engineer. Site Supervisor and Project Consultant with critical thinking and skills	PO9 (3),P011 (2),
CO3	Maintain and develop the ability to put their knowledge of theory into practical problems using forms of construction focusing to society and environment.	PO6 (3), PO7 (2)

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
Preparation of Site Map • 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
Preparation of Electrical and Plumbing drawing • 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.	Theory + Drawing Practice

• 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.	
Preparation of Bar Bending Schedule and Carpentry drawing • Introduction to Bar Bending Schedule and Carpentry Drawing • Basic concepts of reinforcement and carpentry work • 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	Theory + Drawing Practice
Structural Detailing of building components • 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 • 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.	Theory+ Class Room Practice

• 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	
• Legal Requirements • Insurance and Bonding • Laws Governing Sale • 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.

Computer Science and Engineering

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

BTech	CUTM1577	Minor Project II	2	0-0-2
BTech	CUTM2598	Minor Project-III	2	0-0-2
BTech	CUTM1578	Summer Internship I	2	0-0-2
BTech	CUTM1579	Summer Internship II	2	0-0-2

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

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

Data Science and Machine Learning

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

Course Objectives

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

Course Outcomes

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

ML for Predictive Analysis (0+2+2)

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

Project/Task: (Choose two projects, Prediction and Classification)
Time Series Analysis
Health Care System

Concept Required:

3.1 Data pre-processing: -

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

3.2 Learning Algorithms: -

- Supervised Learning Algorithms
- Unsupervised Learning Algorithms

3.3 Feature extraction and selection: -

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

3.4 Model building: -

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

3.5 Performance measures: -

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

3.6 Reading and Writing Research Articles

ML for Image Analytics (0-2-2)

Project/Task: (Choose one among six Tasks)

Detection of optometry diseases using retinal fundus imaging.

1. Diabetic Retinopathy
2. Glaucoma
3. Cataract

Detection of various diseases using X-ray imaging.

1. Covid19

Leaf disease classification using RGB images.

1. Tomato leaf
2. Potato leaf

Concept Required:

Image Pre-processing:-

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

Image Feature Extraction: -

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

Creation of Feature Matrix by combining Extracted Features: -

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

Classification algorithms: -

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

Mathematics for ML (2+1+0)

When Models Meet Data:-

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

Linear Regression:-

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

Dimensionality Reduction with Principal Component Analysis:-

- Problem Setting

- Maximum Variance Perspective
- Projection Perspective
- Eigenvector Computation and Low-Rank Approximations
- PCA in High Dimensions
- Key Steps of PCA in Practice
- Latent Variable Perspective

Density Estimation with Gaussian Mixture Models:-

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

Classification with Support Vector Machines:-

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

Practice:

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

References:

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

IoT Analytics (0+2+2)

Defining IoT Analytics and Challenges

IoT
Benefits of Deploying IoT
End to End IoT architecture
IoT challenges

IoT Protocols

1 Wireless Protocol

Connectivity Protocols (when Power is Limited)
Bluetooth Low Energy (BLE)
Zigbee
LoRaWAN
NFC

2 Connectivity Protocols (when Power is Not a problem)
Wifi
3 Data Communication Protocol
MQTT
Web-Socket
HTTP

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

3 Overview of 32 -bit Controller
ESP8266
ESP32
Raspberry Pi

4 AWS IoT for Cloud
AWS IoT Core services
AWS IoT Analytics services
AWS DynamoDB Services

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

6 ThingWorx for Industrial IoT
Building Dashboard on Thingworx platform
Binding the senor value to the dashboard

Text Book:

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

Reference Books:

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

Digital video Processing (0+2+1)

UNIT 1:

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

Practice:

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

UNIT 2:

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

Practice:

- Applying fourier transformation on video
- Time domain analysis
- Frequency domain Analysis

UNIT 3:

Digital Video Formats: Significance of Video Formatting, Data rate and bandwidth trade-off, **File Formats:** MP4, MOV, WMV, AVCHD, FLV, AVI, WebM, MKV

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

Practice:

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

UNIT 4:

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

Practice:

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

Project List

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

TEXT BOOK:

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

REFERENCE BOOK:

1. Fundamentals of Digital Image Processing", Anil K. Jain, PHI, 1995.

2. "Digital Image Processing", William. K.Pratt, Wiley Interscience, 2nd Ed, 1991.

Ml for Hyperspectral imaging (0-4-2)

Project/Task: (Choose one among four Tasks)

Agriculture

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

Mining

1. Iron ore quality prediction

Concept Required:

Introduction to Remote Sensing: -

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

Scientific Principles:

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

Hyperspectral Concepts and System Trade-offs:-

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

HSI Data Processing Techniques:-

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

Classification Techniques:-

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

Clustering Techniques:-

- K-mean clustering

Project (0-0-4)

Internship (0-0-4)

Software Technology

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

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

Course Objectives

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

Course Outcomes

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

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

1.1 Understanding Web Architecture
1.2 Installation and configure java environment.
1.3 Understanding MVC Architecture
1.4 Create GIT repository for version control and teamwork
1.5 Create a web project and define a landing page.
1.6 Create controller using servlet in web project
1.7 Retrieve value from page in controller through the request parameter.

1.8 Establish Connection with database
1.9 Perform CRUD operation
1.10 Present data in JSP page using scriptlet, expression and action tag.
1.11 Declare method and variable in JSP page.
1.12 Transferring control from one resource to another using RequestDispatcher and ResponseRedirect
1.13 Set and get values in ServletContex and ServletConfig parameter.
1.14 Set and get values in application, session and request attribute.
1.15 Perform session tracking.
1.16 Upload file to the server.
1.17 Working with JSTL

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

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

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

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

Templating using JSX

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

It's all about components

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

Working with state and props

3.4 What is state and its significance, read state and set state, passing data to component using props
3.5 Validating props using propTypes, supplying default values to props using defaultProps

Rendering lists

3.6 Using React key prop, using map function to iterate on arrays to generate elements, Event handling in React
3.7 Understanding React event system, Understanding Synthetic event, Passing arguments to event handlers

Understanding Component Lifecycle & Working with Forms

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

Routing with React Router

3.9 Setting up react router, understand routing in single page applications, working with BrowserRouter and HashRouter components, configuring route with Route component, Using Switch component to define routing rules, making routes dynamic using route params
3.10 Working with nested routes, navigating to pages using Link and NavLink component, Redirect routes using RedirectComponent, Using Prompt component to get consent of user for navigation, Path less Route to handle failed matches

Just Redux

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

Immutable.js for immutable data structures

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

React Redux

Redux saga(Redux middleware)

3.13 What is React Redux, Why React Redux, Install and setup, Presentational vs Container components
3.14 Understand high order component, Understanding mapStateToProps and mapDispatchtToProps usage
3.15 Why redux middleware, Available redux middleware choices, What is redux saga, Install and setup redux saga
3.16 Working with Saga helpers, Sagas vs promises

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

Text Books:

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

Reference Books:

1. *Kogent Learning, Java Server Programming Java Ee7 (J2EE 1.7), Black Book*
2. *Alef Arendsen, Professional Java Development with the Spring Framework*
3. *Anthony Onyekachukwu Okonta , React.js Design Patterns, BPB PUBN*

http://courseware.cutm.ac.in/courses/software_technology/

Cloud Technology

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

Course Objectives

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

Course Outcomes

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Able to gain knowledge on architectural principles and services of AWS	PO1 (3)
CO2	Develop skills to analyze, design, and prepare resources in Cloud	PO2(3)
CO3	Ability to solve the real world problems	PO2(3)
CO4	Able to develop scalable and secure Cloud applications	PO3 (2), PO5(2)

AWS Solution Architect (SAA-CO2)

Module I : Overview of AWS (10 Hrs)

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

Practice:

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

Module II: Virtual Private Cloud (VPC) (14 Hrs)

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

Practice:

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

Module III: Elastic Block Store, Elastic Network Interfaces (14 Hrs)

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

Practice:

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

Module IV: Elastic Load Balancer (10 Hrs)

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

Practice:

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

Module V: Auto Scaling, Simple Notification Service (10 Hrs)

Auto Scaling Components, Auto Scaling Features, Auto Scaling Availability Zone Rebalance feature, Adding/Detaching EC2 instances to/from Auto Scaling Groups, Auto Scaling and Elastic Load Balancing Service, Auto Scaling Health Checks, Simple Notification Service, SNS Notifications & Merging Auto Scaling groups, Implementing Auto Scaling, Troubleshooting Autoscaling with new EC2 instances

Practice:

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

Module VI: AWS Elastic File System (EFS) (16 Hrs)

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

Practice:

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

Module VII: Elastic Map Reduce (10 Hrs)

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

Practice:

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

Online Resource: http://aws.amazon.com/training/awsacademy

http://aws.amazon.com/awseducate

AWS Developer

Module I: IAM and EC2 **(14 Hrs)**

IAM Introduction, IAM Hands-On, EC2, Connect to SSH using Linux / Mac and Windows and Troubleshooting, Security Groups, Private vs Public vs Elastic IP, Configuring Webserver - Apache and Tomcat, Elastic Network Interfaces
ELB and ASG: High Availability and Scalability, Elastic Load Balancing (ELB), Classic Load Balancer (CLB), Application Load Balancer (ALB), Network Load Balancer (NLB), Elastic Load Balancer - Cross Zone Load Balancing, Elastic Load Balancer - SSL Certificates, Elastic Load Balancer - Connection Draining, Auto Scaling Groups - Scaling Policies
EBS and EFS: EBS Volume Types Deep Dive, EBS vs Instance Store
RDS ,Aurora and ElastiCache: AWS RDS Overview, RDS Read Replicas vs Multi AZ, RDS Encryption and Security, Aurora, ElastiCache and its Strategies
Practice:

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

Module II: Route53 **(10 Hrs)**

Route 53: EC2 Setup, Route 53 - TTL, CNAME vs Alias, Routing Policy - Simple, Weighted, Latency Route 53 Health Checks, Routing Policy - Failover, Geolocation, Multi Value
VPC: VPC, Subnets, IGW and NAT, NACL, SG, VPC Flow Logs, VPC Peering, Endpoints, VPN, DX, VPC Cheat Sheet & Closing Comments, Three Tier Architecture.
AWS CLI, SDK, IAM Roles & Policies: AWS CLI Setup, Configuration on Windows and Linux, CLI Installation Troubleshooting, Using CLI - EC2, S3, IAM Roles and Policies, AWS Policy Simulator, AWS CLI Dry RunAWS CLI STS Decode, AWS EC2 Instance Metadata, AWS CLI Profiles, AWS CLI with MFA, AWS SDK, Exponential Backoff & Service Limit Increase, AWS Credentials Provider & Chain, AWS Signature v4 Signing
Practice:

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

Module III: AWS S3 **(10 Hrs)**

Amazon S3: Amazon S3 - S3 Buckets and Objects, S3 Versioning and Encryption, S3 Security & Bucket Policies, S3 Consistency Model
S3 and Athena: S3 MFA Delete, S3 Default Encryption, S3 Access Logs, S3 Replication (Cross Region and Same Region), S3 Pre-signed URLs, S3 Storage Tiers + Glacier, S3

Lifecycle Policies, S3 Performance, S3 & Glacier Select, S3 Event Notifications, Athena, S3 Lock Policies & Glacier Vault Lock

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

Practice:

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

Module IV: AWS ECR (14 Hrs)

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

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

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

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

Practice:

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

Module V: Monitoring and Audit (10 Hrs)

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

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

Practice:

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

Module VI: Serverless Using Lambda **(18 Hrs)**

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

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

Serverless using API Gateway: API Gateway - API Gateway Stages and Deployment, Canary Deployments, Integration Types & Mappings, Swagger & Open API, Caching, Usage Plans & API Keys, Monitoring, Logging and Tracing, Authentication and Authorization, REST API vs HTTP API vs WebSocket API

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

Practice:

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

Module VII: AWS cognito **(08 Hrs)**

Cognito: Cognito, User Pools, Identity Pools, Cognito User Pools vs Cognito Identity Pools, Sync

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

Practice:

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

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

Project

- Locally Debug a Serverless App
- Build a Serverless Web Application

- Design a database for a mobile app with Amazon DynamoDB
- Create a Load Balanced WordPress website
- Building serverless applications
- Add Voice to Your WordPress Site
- Deploy a Python Web App
- Migrate a Git Repository to AWS
- Build a Drupal Website
- Build a Modern Application
- Build, Train, and Deploy a Machine Learning Model
- Handle Errors in Serverless Applications
- Create and Manage a Nonrelational Database
- Launch and Configure a LAMP Website
- Deploy and Host a ReactJS App
- Set Up a Compliant Archive
- Host a Static Website
- Launch a Linux Virtual Machine
- Launch a WordPress Website
- Remotely Run Commands on an EC2 Instance
- Launch a Windows Virtual Machine
- Create and Query a NoSQL Table
- Introduction to Deep Learning
- Train a Deep Learning model
- Create a machine learning model automatically with Amazon SageMaker Autopilot
- Setting up a Document Database With Amazon DocumentDB (with MongoDB compatibility) and AWS Cloud9
- Detect, Analyze, and Compare Faces
- Create an AWS DeepLens Project
- Provision Desktops in the Cloud
- Publish Amazon SNS Messages Privately
- Deploy WordPress with Amazon RDS
- Create and Manage a Nonrelational Database
- Create an Audio Transcript

Gate Process for Project

Gate 0: Planning
Gate 1: Analysis
Gate 2: Design
Gate 3: Implementation
Gate 4: Testing
Gate 5: Deployment

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

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

Cyber Security

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

Course Objectives

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

Course Outcomes

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

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

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

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

2. CUCS2046 -Advanced Hacking Techniques (56 HRs)

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

2.28 Server Password Hacking

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

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

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

4.1 To gain knowledge about how VAPT works, as well as network security protocols, devices, and controls.
4.2 Initiate and manage incidents, as well as do penetration testing.
4.3 Comprehend packet sniffing techniques.
4.4 Learn about network penetration testing models and procedures, security analysis
4.5 scanning and its types(network, port and vulnerability scanning)
4.6 Nmap and live scanning on ports and networks
4.7 Netcat usage on TCP/UDP ports
4.8 Wireshark basics and capturing data
4.9 NFS ,SMB ,SMTP enumeration
4.10 Vulnerability scanning overview
4.11 Different types of vulnerability scanning
4.12 Nessus installation and configuration
4.13 Vulnerability scanning with Nessus
4.14 Web application assessment with nikto, burp suite and Vega
4.15 Vulnerability analysis with Metasploit framework

4.16 Application security testing using acunetix
4.17 OWASP mobile vulnearibility
4.18 Tools for Mobile application vulnearibility
4.19 Identify and mitigate security issues using Microsoft TMT
4.20 Automated software testing using VAF tool
4.21 password security auditing and password recovery using John the Ripper
4.22 Penetration testing using BeEF tool

Text Books:

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

Reference Books:

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

Sample Project

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

Course outline Prepared by: Suvendu Kumar Nayak ***Date:02-07-2022***

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

Gaming and Immersive Learning (AR & VR)

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

Course Objectives

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

Course Outcomes

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

1. Introduction to Gaming & Simulation

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

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

Module II: Introduction to Game Production (1)

Video Game Platforms and Genres, Describing the Game Production Pipeline, Game Development Jobs and Roles, The Game Design Document, The Technical Design Document, Getting Started in Unity, Creating a New Unity Project, Using the Unity Asset Store, Source Control for Working in Team.

Module III: The Game Engine User Interface **(2+2)**

Introduction to the Unity Editor Interface, Analyzing the Unity Editor User Interface, Utilizing the Unity Editor User Interface, Navigating the Scene View Window, Utilizing the Game View Window, Navigating the Hierarchy Window, Using the Inspector Window, Managing Assets in the Project Window, Searching and Filtering in the Project Window, Organizing the Scene with Layers.

Module IV: Using Game objects and assets **(1+2)**

Creating and Modifying Game Objects, Defining Unity Editor Units, Describing Assets in the Production Pipeline, Review: Defining an Asset, Organizing Assets in the Unity Editor, Defining a Game Object.

Module V: Defining a Game Object **(2+2)**

Creating Unity-native Game Objects, Manipulating Game Objects in the Unity Editor, Describing What is a Unity-native Game Object, The Role of Components in the Unity Editor, Defining Prefabs and Scene Structure, Defining the Role of the Prefab in Unity, Creating and Saving a Scene.

Module VI: The Hierarchy of Scenes within a Game **(1+2)**

Importing Assets into a Project, Importing and Configuring a 3D Model, Importing Textures for Use in Materials, Importing FBX Files with Animation, Working with Sprites, Introduction to Sprites in Game Development.

Module VII: Managing Projects and Assets **(1+2)**

Project Management in Unity, Introduction to Game Project Management, Managing Assets, Using the Unity Asset Store (Reprise), Importing Offline Content, Creating Project Structure Based on Assets, Sorting the Zombie Toys Prop Model Assets, Setting Resolution and Type of Texture Files.

2. Game Assets and Objects

Module I: Preparing Assets for implementation **(1+2.5)**

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

Module II: Discovering the Standard Shader in Unity **(1+2)**

Exploring other Material Types, Analyzing the Benefits of Customer Shaders, Creating the Materials for Zombie Toys Props, Duplicating and Modifying Materials, Case Studies in Material Creation, Managing and Using Textures in the Unity Editor, Texturing for Game Development, Optimization and Reuse of Textures.

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

Branching and Hierarchies, Creating Hierarchies in Unity, Using Empty Game Objects as Pivots, Introduction to Physics in Unity, Understanding the Physics System in Unity, Introduction to the Rigid body Component.

Module IV: Introduction to Colliders **(1+2)**

Creating the Colliders for Zombie Toys Props, Introduction to Game Level Design, Introduction to Game Level Design, The Level Design in Zombie Toys, Placing Objects in a Scene, Importing the Prop Prefabs into the Scene, Cloning the Stars, Creating the Level Boundaries.

Module V: Lighting in Games **(1+2)**

Introduction to Game Lighting, Introduction to Game Lighting, Differences in Lighting for Games and for Film, Placing and Adjusting Lights in a Scene, Analyzing the Different Lights and Properties, Light Types and Behaviors, Using Layers to Exclude Objects from Lighting, Casting and Modifying Shadows, Mesh Renderer Attributes for Shadows.

Module VI: Differentiating Shadow Types **(1+2)**

Creating Cookies to Shape Lights, Faking Shadows for Better Performance, Benefits of Faking Shadows in Games, Utilizing Painted Shadows, Using Projectors to Project Shadow Cookies, Lighting the Zombie Toys Game, Lighting the Zombie Toys Scene, Lighting Variations for Changing the Mood.

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

Light Baking in Video Games, Introduction to Light Baking in Video Games, Setting Objects to Participate in Light Baking, Marking Objects as Static for Light Baking, Creating UV Coordinates for Light Baking, Baking Lighting, Continuous and Manual Light Baking, Placing Light Probes for Moving Objects, Creating Reflection Probes, Baking the Lighting in Zombie Toys, Creating the Light Probes in Zombie Toys.

3. Building Game Environment

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

Creating a Player Controller, Examining Why to Use a Custom Controller, Creating the Player Controller Game Object, Adding a Game Manager, Explaining the, Purpose of the Game Manager, Making the Controller Functional, Adding Scripts for Behaviour, Configuring the Camera, Creating the Sheep Ally, Building the Sheep Ally From a Model, Creating the Dog Ally, Building the Dog Ally From a Model.

Module II: Building the Enemies **(2+2)**

Creating an Enemy, Designing the Enemy Behaviours, Creating the First Enemy Character, Creating the Enemy Animator Controller, Creating Additional Enemies, Creating the Zombear

Enemy, Creating the Zombie Duck Enemy, Creating the Other Enemies, Integrating Enemies into the Game, Placing the Spawn Points, Spawning the Enemies.

Module III: Introduction to Unity's Particle System (1+1)

Analyzing Existing Particle Effects, Setting Up the Interface for Effects, Case Study: Developing the Lightning Attack, Overview of the Lightning Attack, Building the Lightning Attack Hit, Building the Lightning, Attack Emitter, Building the Lightning Bolt, Integrating the Lightning Attack into the Game.

Module IV: Creating Particle Systems (1+2)

Intro to the Particle Systems in the Unity Editor, Examples of Unity Particles in Video Games, the Role of the Effects Artist in Video Games, Comparing Game Effects with Other Media, And Production Best Practices for Particle Systems.

Module V: Case Study (1+2)

Developing the Frost Attack, Introduction to the Frost Attack, Building the Frost Debuff, Building the, Frost Attack Emitter, Building the Frost Cone Effect, Integrating the Frost Attack into the Game, Case, Study: Developing the Stink Bomb Attack, Introduction to the Stink Bomb Attack, Creating the Stink Bomb Hit Effect.

Module VI: Case Study (1+2)

Developing the Slime Attack, Introduction to the Slime Attack, Creating the Slime Hit Effect, Creating the Slime Debuff, Creating the Slime Attack Reticle, Building the Slime Attack Emitter, Building the Slime Projectile, Integrating the Slime Attack into the Game, Finalizing Player Attacks, Adding the Ally Manager.

Module VII: Adding Audio to Game Levels (1+2.5)

Introduction to Audio in Game Development, Introduction to Audio in Game Development, Importing Audio into Unity, Introduction to Importing Audio in Unity, Supported Audio Formats in Unity, Playing Audio in the Unity Editor, , Testing Audio Sources in the Scene, Mixing Audio in Unity, Using Audio Mixers and Audio Mixer Groups, Setting up the Zombie Toys Audio Mixers, Creating Audio Effects, Introduction to Audio Effects.

4. Game Animation, Scripting & UI

Module I: Animating Game Objects in the Unity Editor (1+2)

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

Module II: Bringing Animation into the Game **(1+2)**

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

Module III: Animation Creation and Controlling **(1+2)**

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

Module IV: Scripting in Game Development **(2+2.5)**

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

Module V: Designing User Interfaces for Games **(1+2)**

Introduction to Designing the User Interface, Assessing User Interface Design Needs, Examining the UI Tools in the Unity Editor, Creating a User Interface, Investigating the Canvas Functionality, Utilizing the Power of the Rect Transform, Creating a UI Button, Creating a UI Image, Creating UI Text, Creating Interaction in the UI with Events.

Module VI: Introduction to Looping **(1+2)**

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

Module VII: Implementing Navigation and Path Finding **(1+2)**

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

5. Binary Deployment and Cross-Platform Controls

Module I: Building the Camera and Player Selection System **(1+3)**

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

Module II: Creating another Player Option **(2+2.5)**

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

Module III: Adding Camera Animations **(2+2)**

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

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

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

Module V: Protecting Your Creation **(1)**

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

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

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

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

Modifying Zombie Toys for Mobile, Introduction to Mobile Development in Unity. Changing the Build Platform to Mobile, Adding the Mobile Interface UI, Implementing Mobile Input Behaviors.

Text Books:

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

Course outline Prepared by: Abhi Mitra ***Date: July 6, 2020***
Source of reference: UCA Courseware.

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

Basket V(Elective)

Software Testing and Test Automation

Course Title	Code	Type of Course	T-P-PJ	Prerequisite
Testing and Test Automation		Theory+ Practice	2-2-0	Nil

Course Objectives:

- Develop methods and procedures for software development that can scale up for large systems and that can be used to consistently produce high-quality software at low cost and with a small cycle time
- Students will learn how to use available resources to develop software, reduce cost of software and how to maintain quality of software methods and tools of testing and maintenance of software's
- Students will get employability on software testing

Course Outcomes

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Able to gain knowledge on modern software testing processes in relation to software development and project management	PO1 (3), PO12(3)
CO2	Contribute to efficient delivery of software solutions and implement improvements of various problems in the software development processes. It stimulate analytical skill and critical thinking among students	PO2(3)
CO3	Ability to solve the real world problems	PO2(3)
CO4	To create and design test strategies and plans, design test cases, prioritize and execute them	PO3 (2), PO5(2)

Module I: Introduction to Software Engineering (8 Hours)

Evolving of software engineering, Software requirements, Requirement engineering process: feasibility studies, requirements elicitation and analysis, requirements validation, requirements management. Process models: waterfall model, incremental process models, evolutionary process models, the unified process. System models: context models, behavioral models, data models, object models, structured methods.

Module II: System Design (8 Hours)

Software architecture, Data design, Architectural styles and patterns, Architectural design, SDLC, Conceptual model of UML, Basic structural modeling, Class diagrams, Sequence diagrams, Collaboration diagrams, Use case diagrams, Component diagrams, Design scenario and case studies. Test case examples.

Module III: Testing (8 Hours)

A strategic approach to software testing, Software testing life-cycle (STLC), Test scenario, Test execution, Bug tracking. Quality management: Statistical software quality assurance, Software reliability. Basics of manual testing**:** Concepts, Types, Tools, Automation testing Vs Manual testing, Unit testing, Integration testing, System testing, Black-box and white-box testing, Validation testing, Sanity Vs Smoke Testing, Regression Testing and Functional and non-functional Testing.

Module IV: Selenium - Web Testing (10 Hours)

Web Application Testing, Cross-browser Testing, Test Case Management: Sample Test Case Template, Requirements Traceability Matrix (RTM) - Test Coverage ,Test Data Management, Automation Testing using Selenium: Introduction to Selenium, Basics of Selenium Automation Testing, Selenium Web Driver and its contrast operation with RC, Web Driver Basics : First Selenium Web Driver Script: JAVA Code Example, Locators in Selenium IDE: CSS Selector, DOM, XPath, Link Text, ID, Find Element and Find Elements in Selenium Web Driver, Selenium Form Web Element: TextBox, Submit Button, sendkeys(), click()

Module V: Selenium - Web Driver Essentials (8 Hours)

How to Select Check Box and Radio Button in Selenium Web Driver, How to Click on Image in Selenium Webdriver, How to Select Value from Drop Down using Selenium Webdriver, Locate Elements by Link Text & Partial Link Text in Selenium Webdriver, Mouse Click & Keyboard Event: Action Class in Selenium Webdriver

Module VI: Selenium - File Handling Essentials (8 Hours)

How to Upload & Download a File using Selenium Webdriver, XPath in Selenium WebDriver: Alert & Popup Window Handling in Selenium WebDriver, How to Handle Web Table in Selenium WebDriver, Handling Dynamic Web Tables Using Selenium WebDriver, Desired Capabilities in Selenium WebDriver, How to Verify Tooltip using Selenium WebDriver, How to Find All/Broken links using Selenium Webdriver, Gecko (Marionette) Driver Selenium: Download, Install, Use with Firefox

Module VII: selenium - Testing (10 Hours)

TestNGl: 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

Code	Course Title	(Credit)	T-P-PJ
CUTM2582	**POWER SYSTEM OPERATION & CONTROL**	3	2-1-0

Course Objectives

- To learn the basic control technique involved in power system operation
- To provide a solid foundation in mathematical and engineering fundamentals required to control the governing system in turbine models

Course Outcomes

Cos	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Able to gain knowledge on Economic operation of power system and importance of LFC power plans.	PO1 (3), PO2 (2)
CO2	Able to identify and resolve the problems on Load frequency control of power system.	PO2(3),
CO3	Use of software/design tools for operation of power system and control.	PO3(3)

Module – I [7 Hours]

Fundamentals of Power System:
Introduction, Single Subscript Notation, Double Subscript Notation, Power in Single Phase AC Circuit, Complex Power, The Power Triangle, Direction of Power Flow, Voltage and Current in Balanced Three Phase Circuits, Power in Balanced Three Phase Circuits, PerUnit Quantities, Changing the Base in Per- Unit Quantities, Node Equations, 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, an Equivalent Admittance Network, Modification of Ybus, the Network Incidence Matrix and Ybus.

Module – II [7 Hours]

Power Flow Solutions
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. Power system structure: Power factor correction, three

phase loads, delta to star transformation: advanced topics as decided by the concerned faculty teaching the subject.

Module – III [7 Hours]

Economic Operation of Power System
Distribution of Load between Units within a Plant, Distribution of Load between Plants, The Transmission-Loss Equation, An interpretation of Transformation C, Classical Economic Dispatch with Losses, Automatic Generation Control, Unit Commitment, Solving the Unit Commitment Problems.

Module – IV [7 Hours]

Load Frequency Control, Control Area Concept
Automatic Load-Frequency Control of Single Area Systems: Speed-Governing System, Hydraulic Valve Actuator, Turbine-Generator Response, Static Performance of Speed Governor, Closing the ALFC Loop, Concept of Control Area, Static Response of Primary ALFC Loop, Dynamic Response of ALFC Loop, Physical Interpretation of Results, The Secondary ("Reset") ALFC Loop, Economic Dispatch Control, Load frequency control.

Module – V [6 Hours]

Two Area Systems
ALFC of Multi-Control-Area Systems (Pool Operation): The Two Area Systems, Modelling the Tie-Line, Block Diagram Representation of Two Area System, Mechanical Analog of Two Area System, Dynamic Response of Two Area System, Static System Response, Tie-Line Bias Control of Multi-Area Systems. Tie line bias control

Module- VI [6 Hours]

Power System Stability
The Stability Problem, Rotor Dynamics and the Swing Equation, Further Considerations of the Swing Equations, The Power-Angle Equation, Synchronizing Power Coefficients, Equal Area Criterion for Stability, Further Applications of the Equal-Area Criterion, Multi-machine Stability Studies: Classical Representation, Step-By-Step Solution of the Swing Curve, Computer Programs for Transient Stability Studies, Factors Affecting Transient Stability. Synchronous machine, Steady state stability, Transient Stability:

HARDWARE BASED

1. To determine negative and zero sequence synchronous reactance of an alternator.
2. To determine 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 setting and time setting multipliers and plot its time – current characteristics.
5. To determine the operating characteristics of biased different relay with different % of biasing.

6. To determine location of fault in a cable using cable fault locator.

SIMULATION BASED (USING MATLAB OR ANY OTHER SOFTWARE)

1. To obtain steady-state, transient and sub-transient short-circuit currents in an alternator.
2. To formulate the Y-Bus matrix and perform load flow analysis.
3. To compute voltage, current, power factor, regulation and efficiency at the receiving end of a three phase Transmission line when the voltage and power at the sending end are given. Use Π model.
4. To perform symmetrical fault analysis in a power system.
5. To perform unsymmetrical fault analysis in a power system.
6. Write a program in language to solve economic dispatch problem of a power system with only thermal units. Take production cost function as quadratic and neglect transmission loss.

REFERENCE:

1. Chakrabarti & Haldar, "Power System Analysis: Operation and Control", Prentice Hall of India, 2004 Edition.
2. C.L. Wadhwa, 'Power System Analysis, New Age International- 6th Edition, 2010,
3. Robert Miller, James Malinowski, 'Power System Operation', Tata McGraw Hill Publishing Company Ltd, New Delhi, 3E, JUN-09.
4. P. Kundur, Neal J. Balu, 'Power System Stability & Control', IEEE, 1998. 5. Power System Analysis by Hadi Saadat – TMH Edition.
5. https://ch.mathworks.com/solutions/power-system-analysis-and-design.html
6. https://ch.mathworks.com/solutions/utilities-energy/power-system-studies.html