MATHEMATICS FOR MECHANICAL ENGINEERING STREAM-III

Semester: III **Year: 2022-23**

Course	Code	Credits	Total Hours - 40 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Mathematic for MES - III	22MATM31	03	03	00	50	50	03

COURSE OBJECTIVES:

The goal of the course Mathematics for Mechanical Engineering Stream-III (22MATM31) is to

1. Familiarize the importance of Random variable and Probability distribution essential for Mechanical engineering.
2. Analyze Civil engineering problems applying Statistical methods to fit a curve and understand co-variance of two variables and its correlation coefficient.
3. Develop the knowledge of complex variable and find the Analyticity of a function.
4. Apply LPP in real life example.
5. To develop the knowledge of functionals and variational problems.
6. Develop the knowledge of solving Mechanical engineering problems numerically.

MODULE-1

Probability Distribution: Random variables (discrete and continuous) probability mass/density functions. Binomial distribution, Poisson distribution. Exponential and Normal distributions. Problems.

Self Study : Definition of probability , addition and multiplication rule, Bay's theorem.

08 Hours

MODULE-2

Basic Statistics: Measures of central tendency, measures of dispersion, range quartile deviation, mean deviation, standard deviation, coefficient of variation, Skewness and Kurtosis, problems.

Statistical Methods: Correlation-karl Pearson's co-efficient of correlation problems. Regression analysis lines of regression, Rank correlation (without proof)-problems.

Curve Fitting: Curve fitting by the method of least square. Fitting of the curves of the form .

Self-study: Center and circle of curvature, evolutes and involutes. **08 Hours**

MODULE-3

Complex variable-1: Complex valued function, limit, continuity, differentiability, analytic functions. Cauchy-Riemann Equation in Cartesian, Polar form. Harmonic and orthogonal property and problems on construction of Analytic function.

Self Study : Complex Trigonometry. **08 Hours**

MODULE-4

Calculus of variation : Functional; Variation of a functional and its properties; Variational problems with fixed boundaries; Euler's equation, Extremals; Functional dependent on several unknown functions and their first order derivatives; Functionals dependent on higher order

derivatives; Functionals dependent on the function of more than one independent variable; Variational problems in parametric form;

Self Study : Differential equation with more than variable. **08 Hours**

MODULE-5

Operation Research: Simplex method, Canonical and Standard form of LP problem, slack, surplus and artificial variables, Solutions to LPP by Simplex method, Big-M Method and Two Phase Simplex Method, Degeneracy in LPP. Concept of Duality, writing Dual of given LPP. Solutions to L.P.P by Dual Simplex Method.

Self Study : Formulation of LPP **08 Hours**

COURSE OUTCOMES:

	Course Outcomes	**RBT LEVEL**
C01	Knowing the random variable both discrete and continuous and their probability distribution, Mass density function and solving the problems on various engineering problems.	L3
C02	Apply the concept of correlation and regression lines for solving the problems and numerical techniques to solve engineering problems and fit a least squares curve to the given data.	L3
C03	Apply the knowledge of Fourier transform to solve engineering problems. Understand the analyticity, potential fields, residues and poles of complex potentials in field theory, electromagnetic theory and studying Bilinear transformation.	L3
C04	Understand what functionals are, and have some appreciation of their applications	L3
C05	Solve linear programming problems using appropriate techniques and optimization solvers, interpret the results obtained.	L3
	Total number of lecture hours	**42**

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2		1				1			1
CO2	3	2	2		1				1			1
CO3	3	2	2		1				1			1
CO4	3	2	2		1				1			1
CO5	3	2	2		1				1			1

TEXT BOOKS:

1. B.S.Grewal:"Higher Engineering Mathematics", Khanna publishers, 44th Ed.,2021.
2. E. Kreyszig: "Advanced Engineering Mathematics", John Wiley & Sons, 10thEd., 2018.

REFERENCE BOOKS:

1. **V. Ramana:**"Higher Engineering Mathematics" McGraw-Hill Education, 11th Ed.,2017
2. **Srimanta Pal & Subodh C. Bhunia**: "Engineering Mathematics" Oxford University Press, 3rdEd., 2016.
3. **N.P Bali and Manish Goyal**: "A textbook of Engineering Mathematics" Laxmi Publications,10th Ed.,2022.
4. **C. Ray Wylie, LouisC. Barrett:**"Advanced Engineering Mathematics" McGraw–Hill Book Co., Newyork, 6thEd., 2017.
5. **Gupta C. B, Sing S .Rand Mukesh Kumar:** "Engineering Mathematic for Semester I and II" ,Mc-Graw Hill Education(India)Pvt. Ltd 2015.
6. **H.K. Dass and Er.RajnishVerma:**"Higher Engineering Mathematics" S.Chand Publication, 3rdEd. ,2014
7. **James Stewart:"**Calculus"CengagePublications,7thEd.,2019.
8. **David CLay:**"Linear Algebra and its Applications", Pearson Publishers,4th Ed.,2018
9. **Gareth Williams:** "Linear Algebra with applications", Jones Bartlett Publishers Inc., 6thEd., 2017.

SCHEME OF EXAMINATION:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question carries 20 marks.
4. There will be two full questions (with a maximum of four sub questions) from each module.
5. Each full question will have sub questions covering all the topics under a module.
6. The students will have to answer five full questions, selecting one full question from each module.

CIE + Assignments: 15+35=50 Marks

There will be a 3 CIE's, the average of best of 2 CIE's will be considered and there will be 35 marks for Assignments

THERMODYNAMICS AND ENERGY CONVERSIONS

Semester: III **Year: 2022-23**

Course	Code	Credits	Total Hours - 48 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Thermodynamics and Energy Conversions	22EG32	04	03	01	50	50	03

COURSE OBJECTIVES:

1) To introduce about basic concepts of Zeroth law, temperature scales and work and heat interaction.
2) To explicate the First and Second law of thermodynamics.
3) To illuminate the concepts of Entropy and Pure substances.
4) To elucidate the concepts of Gas power cycles and Vapour power cycles.
5) To study the basics of Refrigeration and Compressors.

MODULE-1

Basic concepts, Zeroth law and temperature:

Thermodynamic definition and scope, Microscopic and Macroscopic approaches. Some practical applications of engineering thermodynamic Systems, Characteristics of system boundary and control surface, examples. Thermodynamic properties; definition and units, intensive, extensive properties, specific properties, pressure, specific volume Thermodynamic state, state point, state diagram, path and process, quasi-static process, cyclic and non-cyclic; processes; Thermodynamic equilibrium; definition, mechanical equilibrium; diathermic wall, thermal equilibrium, chemical equilibrium, Zeroth law of thermodynamics, Temperature; concepts, scales, international fixed points and measurement of temperature. Constant volume gas thermometer, constant pressure gas thermometer, mercury in glass thermometer.

Energy Interaction:

Mechanics, definition of work and its limitations. Thermodynamic definition of work; examples, sign convention. Displacement work; as a part of a system boundary, as a whole of a system boundary, expressions for displacement work in various processes through p-v diagrams. Shaft work; Electrical work. Other types of work. Heat; definition, units and sign convention. Problems. **10 Hours**

MODULE-2

First Law of Thermodynamics:

Joules experiments, equivalence of heat and work. Statement of the First law of thermodynamics, extension of the First law to non - cyclic processes, energy, energy as a property, modes of energy, Extension of the First law to control volume; steady flow energy equation (SFEE), important applications.

Second Law of Thermodynamics:

limitations of first law of thermodynamics, Devices converting heat to work (Heat engine); Devices converting work to heat (Reversed Heat engine). Second law thermodynamics statements Kelvin - Planck statement and Clausius statement, Equivalence of the two statements; perpetual motion machine of second kind, Carnot cycle, Carnot principles. Numerical. **10 Hours**

MODULE-3

Entropy:

Introduction, Clausius theorem, entropy a property of system, Clausius inequality, two reversible adiabatic path cannot intersect each other, Carnot's cycle on temperature-entropy diagram, change in entropy in an irreversible process, principle of increase of entropy, numerical.

Pure Substances:

P-V-T surface for a pure substance, P-T and P-V diagrams, triple point and critical points. Sub-cooled liquid, saturated liquid, mixture of saturated liquid and vapor, saturated vapor and superheated vapor states of pure substance with water as example. Enthalpy of change of phase, Dryness fraction, T-S and H-S diagrams of various processes. Steam tables and its use. Throttling calorimeter, separating and throttling calorimeter. **09 Hours**

MODULE-4

Gas Power cycles:

Carnot, Stirling, Brayton, Otto, Diesel and Dual cycles, Numerical.

Vapour power cycles:

Simple steam cycle, Rankine cycle, actual vapour cycle processes, comparison of Carnot and Rankine cycle, reheat and regeneration cycle and numerical. **10 Hours**

MODULE-5

Refrigeration:

Definition, refrigeration effect, co-efficient of performance, ton of refrigeration, applications, desirable properties of good refrigerants, Reversed heat engine cycle, vapour compression refrigeration system, vapour absorption refrigeration system, change in operating conditions on the performance of vapour compression and simple numerical.

Compressors:

Introduction, working of reciprocating air compressor, air compressor terminology, work done by compressor with and without clearance, isothermal efficiency, volumetric efficiency, multi stage compressor, condition for minimum work, numerical problems. **09 Hours**

COURSE OUTCOMES

At the end of this course, student will be able to

	COURSE OUTCOMES	**RBT LEVEL**
CO1	Know the basic concepts of Zeroth law, temperature scales and work and heat interaction.	L3
CO2	Practice the examples on First and Second law of thermodynamics and their applications.	L3
CO3	Concepts of Entropy and Pure substances	L3
CO4	Analyse the Gas power cycles and Vapour power cycles.	L3
CO5	Apply and analyse the basics of Refrigeration and Compressors.	L3
	Total Number Lecture Hours	**48**
	NOTE: All levels mentioned are as per Revised Bloom's Taxonomy	

CO-PO Mapping

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	03	02		02	01			01				01
CO2	03	02		02	01			01				01
CO3	03	02		02	01			01				01
CO4	03	02		01	01			01				01
CO5	03	02		01	01			01				01

TEXT BOOKS:

1) Rajput. R. K., "Thermal Engineering" S.Chand Publishers, 2000
2) Kothandaraman.C.P, Domkundwar. S,Domkundwar. A.V., "A course in thermal Engineering", Fifth Edition," Dhanpat Rai & sons, 2002

REFERENCES:

1) Basic and Applied Thermodynamics by P.K. Nag, MCGRAW HILL INDIA
2) Steam & Gas Turbine by R. Yadav, CPH Allahabad
3) Thermal Engg. By PL Ballaney, Khanna Publisher
4) Ganesan V." Internal Combustion Engines", Third Edition, Tata McGraw-Hill 2007
5) Thermodynamics: An Engineering Approach (SIE) By Yunus A. Cengel, Michael A. Boles, Mehmet Kanoglu , 2019 Publisher MCGRAW HILL INDIA.

SCHEME OF EXAMINATION:

Two questions to be set from each module. Students have to answer five full questions choosing at least one full question from each module.

MECHANICS OF MATERIALS

Semester: III **Year: 2022-23**

Course	Code	Credits	Total Hours - 40 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Mechanics of Materials	22EG33	03	03	00	50	50	03

COURSE OBJECTIVES:

1) To understand the basic concepts of the stresses and strains for different materials and strength of structural elements.
2) To know the development of internal forces and resistance mechanism for one dimensional and two-dimensional structural elements.
3) To analyses and understand different internal forces and stresses induced due to representative loads on structural elements.
4) To analyses and understand principal stresses due to the combination of two-dimensional stresses on an element and failure mechanisms in materials.
5) To evaluate the behavior of torsional members, columns and struts.

MODULE-1

Stresses and Strains:

Introduction, Properties of materials, Stress, Strain and Hooke's law, Stress strain diagram for brittle and ductile materials, True stress and strain, Calculation of stresses in straight, Stepped and tapered sections.

Composite sections, Stresses due to temperature change, Shear stress and strain, Lateral strain and Poisson's ratio, Elastic constants and relations between them, numerical.

08 hours

MODULE-2

Analysis of Stress and Strain:

Introduction to three-dimensional state of stress, Stresses on inclined planes, Principal stresses and maximum shear stress.

Principal angles, Shear stresses on principal planes, Maximum shear stress, Mohr circle for plane stress conditions. **08 hours**

MODULE-3

Shear Force and Bending Moment in Beams:

Introduction to types of beams, supports and loadings. Definition of bending moment and shear force, Sign conventions, relationship between load intensity, bending moment and shear force. Shear force and bending moment diagrams for statically determinate beams subjected to points load, uniformly distributed loads, uniformly varying loads, couple and their combinations.

08 hours

MODULE-4

Bending and Shear Stresses in Beams:

Introduction, pure bending theory, Assumptions, derivation of bending equation, modulus of rupture, section modulus, flexural rigidity. Expression for transverse shear stress in beams, Bending and shear stress distribution diagrams for circular, rectangular, 'I', and 'T' sections. Shear

Centre (only concept).

Thin and Thick Cylinders:

Introduction, Thin cylinders subjected to internal pressure; Hoop stresses, Longitudinal stress and change in volume. Thick cylinders subjected to both internal and external pressure; Lame's equation, radial and hoop stress distribution.

08 hours

MODULE-5

Torsion in Circular Shaft:

Introduction, pure torsion, Assumptions, derivation of torsion equation for circular shafts, torsional rigidity and polar modulus Power transmitted by a shaft, combined bending and torsion.

Theories of Failure:

Introduction, maximum principal stress theory (Rankine's theory), Maximum shearing stress theory (Tresca's theory), Strain energy theory (Beltrami and Haigh), and maximum strain theory (St. Venant's theory). **08 hours**

COURSE OUTCOMES

At the end of this course, student should be able to

	COURSE OUTCOMES	**RBT LEVEL**
CO1	Study simple, compound, thermal stresses and strains their relations and strain energy.	L3
CO2	Analyse structural members for stresses, strains and deformations.	L3
CO3	Analyse the structural members subjected to bending and shear loads.	L3
CO4	Comprehend the basic concept of analysis and design of members Subjected to bending and understand the concept of cylinders.	L3
CO5	Comprehend the basic concept of analysis and design of members subjected to torsion and thus understand failure concepts	L3
	Total Number Lecture Hours	**40**
	NOTE: All levels mentioned are as per Revised Bloom's Taxonomy	

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	03	02				02		01				02
CO2	03	02				02		01				02
CO3	03	02				02		01				02
CO4	03	02				02		01				02
CO5	03	02				02		01				02

TEXT BOOKS:

1. B.S. Basavarajaiah, P.Mahadevappa "Strength of Materials" in SI Units, University Press (India) Pvt. Ltd., 3rd Edition, 2010
2. Ferdinand P. Beer, E. Russell Johnston and Jr.John T. DeWolf "Mechanics of Materials", Tata McGraw-Hill, Third Edition, SI Units.

REFERENCES:

1) D.H. Young, S.P. Timoshenko "Elements of Strength of Materials" East West Press Pvt. Ltd., 5th Edition (Reprint 2014)
2) R K Bansal, "A Textbook of Strength of Materials", 4th Edition, Laxmi Publications, 2010
3) S.S. Rattan "Strength of Materials" McGraw Hill Education (India) Pvt. Ltd., 2nd Edition (Sixth reprint 2013)
4) Fundamentals of Strength of Materials P N Chandramouli PHI Learning Pvt. Ltd 2013
5) Strength of Materials R K Rajput S. Chand and Company Pvt. Ltd 2014
6) Strength of Materials R. Subramanian Oxford 2005

SCHEME OF EXAMINATION:

Two questions to be set from each module. Students have to answer five full questions choosing at least one full question from each module.

MATERIALS SCIENCE FOR ENERGY ENGINEERING

Semester: III **Year: 2022-23**

Course	Code	Credits	Total Hours - 40 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Material Science for Energy Engineering	22EG34	03	03	00	50	50	03

COURSE OBJECTIVES:

Upon successful completion of the course the students will be familiar with

1. Provide basic background to systematically approach for selection of materials for a wide range of products in engineering applications.
2. Introduce the concept of crystal structure, atomic planes and directions.
3. Introduce the concept of atomic packing, coordination, and symmetry elements.
4. Introduce imperfections in solids.
5. Introduce phase stabilities and phase diagrams.
6. Teach mechanism of phase transformations.
7. Introduce various heat treatment methods.

MODULE-1

Structure of Materials:

Introduction: Classification of materials, crystalline and non-crystalline solids, atomic bonding

Geometrical Crystallography: Symmetry elements: the operation of rotation, Proper and Improper rotation axes, Screw axes, Glide planes.

Crystal Structure: Crystal Lattice, Unit Cell, Planes and directions in a lattice, Planar Atomic Density, packing of atoms and packing fraction, Classification and Coordination of voids, Bragg's Law

Imperfections in Solids: Types of imperfections, Point defects: vacancies, interstitials, line defects, 2-D and 3D-defects, Concept of free volume in amorphous solids. 8 Hours

MODULE-2

Physical Metallurgy:

Alloy Systems: Classification of Solid solutions, Hume- Rothery Rules

Phase Diagrams: Gibbs Phase Rule, Solubility limit, phase equilibria and Phase Diagrams: Isomorphous systems, Invariant Binary Reactions, Lever Rule; important phase- diagrams, Iron-Carbon Diagram.

Diffusion: Diffusion-Fick's Laws, Role of imperfections in diffusion 8 Hours

MODULE-3

Nucleation and growth: Introduction to homogeneous and heterogeneous nucleation, critical radius for nucleation.

Plastic Deformation: Slip, Twinning; Recovery- Recrystallization-Grain Growth, Introduction to Strengthening mechanisms. Lever rule and phase diagram.

Heat treatment: Annealing, Normalizing, hardening, Tempering, Nitriding, Cyaniding, Induction Hardening and Flame Hardening, Recent advances in heat treat technology. TTT diagram, microstructural effects brought about by these processes and their influence on mechanical properties 08 Hours

MODULE-4

Surface coating technologies: Introduction, coating materials, coating technologies, types of coating, advantages and disadvantages of surface coating.

Powder metallurgy: Introduction, Powder Production Techniques: Different Mechanical and Chemical methods, Characterization of powders (Particle Size & Shape Distribution), Powder Shaping: Particle Packing Modifications, Lubricants & Binders, Powder Compaction & Process, Sintering and Application of Powder Metallurgy. 08 Hours

MODULE-5

Nanomaterials Applied in Solar Cells: Nano, micro, and poly crystalline and amorphous Si for solar cells, Nano-micro-Si-composite structure, various techniques of Si deposition. Nanostructured Materials for High Efficiency Perovskite Solar Cells, Dielectric Nanomaterials for Silicon Solar Cells, Nanostructured Cathode Buffer Layers for Inverted Polymer Solar Cells - Discotic Liquid Crystals for Self-organizing Photovoltaics. 08 Hours

COURSE OUTCOMES

At the end of this course, student should be able to

	COURSE OUTCOMES	**RBT LEVEL**
CO1	Understand the atomic arrangement in crystalline materials and describe the periodic arrangement of atoms in terms of unit cell parameters.	L3
CO2	Understand the importance of phase diagrams and the phase transformations.	L3
CO3	Know various heat treatment methods for controlling the microstructure.	L3
CO4	Correlate between material properties with component design and identify various kinds of defects.	L3
CO5	Apply the method of materials selection, material data and knowledge sources for computer-aided selection of material	L3
	Total Number Lecture Hours	**40**
	NOTE: All levels mentioned are as per Revised Bloom's Taxonomy	

CO-PO Mapping

CO / PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2			2	1						1
CO2	3	2			2	1						1
CO3	3	2			2	1						1
CO4	3	2			2	1						1
CO5	3	2			2	1						1

TEXT BOOKS:

1. Ashby, M.F. (2010), Materials Selection in Mechanical Design, 4th Edition, Butterworth-Heinemann.
2. Azaroff, L.V., (2001) Introduction to solids, 1st Edition, McGraw Hill Book Company.

3. Avner, S.H., (2017), Introduction to Physical Metallurgy, 2nd Edition, McGraw Hill Education.
4. Powder Metallurgy Technology, Cambridge International Science Publishing,2002.

REFERENCES:

1. Jones, D.R.H., and Ashby,M.F., (2011), Engineering Materials 1: An Introduction to Properties, Application and Design, 4th Edition, Butterworth-Heinemann.
2. Jones, D.R.H., and Ashby,M.F., (2012), Engineering Materials 2: An Introduction to Microstructure and Processing, 4th Edition, Butterworth-Heinemann.
3. Callister Jr, W.D., Rethwisch, D.G., (2018), Materials Science and Engineering: An Introduction, 10th Edition, Hoboken, NJ: Wiley.
4. Abbaschian, R., Abbaschian, L., Reed-Hill, R. E., (2009), Physical Metallurgy Principles, 4t Edition, Cengate Learning.
5. P. C. Angelo and R. Subramanian: Powder Metallurgy- Science, Technology and Applications, PHI, New Delhi,2008

SCHEME OF EXAMINATION:

Two questions to be set from each module. Students have to answer five full questions choosing at least one full question from each module.

POWER ELECTRONICS

Semester: III **Year: 2022-23**

Course	Code	Credits	Total Hours - 40 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Power Electronics	**22EG35**	**03**	**03**	**00**	**50**	**50**	**03**

COURSE OBJECTIVES:

Upon successful completion of the course the students will be familiar with

1. To understand the applications power electronics, different types of power semiconductor devices, their switching characteristics, power diode characteristics, types, their operation and the effects of power diodes on RL circuits.
2. To comprehend the techniques for design and analysis of single phase diode rectifier circuits.
3. To analyse the different power transistors, their steady state and switching characteristics and limitations.
4. To know the different power transistors, their steady state and switching characteristics and limitations.
5. To understand and analyse the design, analysis techniques, performance parameters and characteristics of controlled rectifiers, DC- DC, DC -AC converters and Voltage controllers.

MODULE-1

Introduction: Applications of Power Electronics, Types of Power Electronic Circuits, Peripheral Effects, Characteristics and Specifications of Switches.

Power Diodes: Introduction, Diode Characteristics, Reverse Recovery Characteristics, Power Diode Types, Silicon Carbide Diodes, Silicon Carbide Schottky Diodes, Freewheeling diodes, Free wheeling diodes with RL load.

Diode Rectifiers: Introduction, Diode Circuits with DC Source connected to R and RL load, Single-Phase Full-Wave Rectifiers with R load , Single-Phase Full-Wave Rectifier with RL Load.

08 Hours

MODULE-2

Power Transistors: Introduction, Power MOSFETs – Steady State Characteristics, Switching Characteristics Bipolar Junction Transistors – Steady State Characteristics, Switching Characteristics, Switching Limits, IGBTs, MOSFET Gate Drive, BJT Base Drive, Isolation of Gate and Base Drives, Pulse transformers and Opto-couplers. 08 Hours

MODULE-3

Thyristors: Introduction, Thyristor Characteristics, Two-Transistor Model of Thyristor, Thyristor Turn- On, Thyristor Turn-Off, A brief study on Thyristor Types, Series Operation of Thyristors, Parallel Operation of Thyristors, di/dtProtection, dv/dtProtection, DIACs, Thyristor Firing Circuits, Unijunction Transistor. 08 Hours

MODULE-4

Controlled Rectifiers: Introduction, Single phase half wave circuit with RL Load, Single phase half wave circuit with RL Load and Freewheeling Diode, Single phase half wave circuit with RLE Load, Single-Phase Full Converters with RLE Load, Single-Phase Dual Converters, Principle of operation of Three- Phase duel Converters.

AC Voltage Controllers: Introduction, Principle of phase control & Integral cycle control, Single-Phase Full-Wave Controllers with Resistive Loads, Single- Phase Full-Wave Controllers with Inductive Loads, Three-Phase Full-Wave Controllers. 08 Hours

MODULE-5

DC-DC Converters: Introduction, principle of step down and step-up chopper with RL load, performance parameters, DC-DC converter classification.

DC-AC Converters: Introduction, principle of operation single phase bridge inverters, three phase bridge inverters, voltage control of single-phase inverters, Harmonic reductions, Current source inverters. 08 Hours

COURSE OUTCOMES:

At the end of this course, student should be able to

	COURSE OUTCOMES	RBT LEVEL
CO1	Overview of applications power electronics, different types of power semiconductor devices, their switching characteristics, power diode characteristics, types, their operation and the effects of power diodes on RL circuits.	L3
CO2	Analyse techniques for design and analysis of single phase diode rectifier circuits.	L3
CO3	Explain different power transistors, their steady state and switching characteristics and limitations.	L3
CO4	Know the types of Thyristors, their gate characteristics and gate control requirements.	L3
CO5	Analysis techniques, performance parameters and characteristics of controlled rectifiers, DC- DC, DC -AC converters and Voltage controllers	L3
	Total Number Lecture Hours	**40**
	NOTE: All levels mentioned are as per Revised Bloom's Taxonomy	

CO-PO Mapping

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1			1						1
CO2	3	2	1			1						2
CO3	3	1	1			1						1
CO4	3	2	1			2						1
CO5	3	2	1			1						1

TEXT BOOKS:

1. Power Electronics: Circuits Devices and Applications Mohammad H Rashid, Pearson 4th Edition, 2014

REFERENCES:

1. Power Electronics P.S. Bimbhra Khanna Publishers 5th Edition, 2012
2. Power Electronics: Converters, Applications and Design Ned Mohan et al Wiley 3rd Edition, 2014

3. Power Electronics Daniel W Hart McGraw Hill 1st Edition, 2011
4. Elements of Power Electronics Philip T Krein Oxford Indian Edition, 2008

SCHEME OF EXAMINATION:

Two questions to be set from each module. Students have to answer five full questions choosing at least one full question from each module.

ENERGY CONVERSION LAB - 1

Semester: III **Year: 2022-23**

Course	Code	Credits	Total Hours - 24 Hours /Week		Assessment		Exam Duration in hrs
			Lecture	Practical	SEE	CIE	
Energy Conversion Lab -1	**22EGL36**	**01**	**00**	**02**	**50**	**50**	**03**

OBJECTIVES:

Upon successful completion of this laboratory, the students should be able to have hands on experience in

1) Determination of Fire and flash point of various fuels.
2) Determination of viscosity of various fuels.
3) Determination of cloud and pour point of various fuels.
4) Determination of carbon residue of various fuels.
5) Determination of density, calorific value of various fuels.
6) Determination of area of irregular shapes.

PART-A

1. Determination of Flash and Fire point of lubricating oil using Abel Pensky and Marten's (closed) Apparatus.
2. Determination of Flash and Fire point of lubricating oil using Cleveland's (Open Cup) Apparatus.
3. Determination of Calorific value of solid and liquid fuels using Bomb Calorimeter.
4. Determination of Calorific value of gaseous fuels using Boy's gas calorimeter.
5. Determination of Viscosity of a lubricating oil using Redwoods Viscometers.

PART-B

1. Determination of Viscosity of a lubricating oil using Say Bolt Viscometers
2. Determine the carbon residue of the given sample of lubricating oil/ fuels.
3. Determination of cloud point and pour point of the given lubricant.
4. Determination of density of given fluid.
5. Determination of dropping point of a grease.

COURSE OUTCOMES

At the end of this course, student should be able to:

	COURSE OUTCOMES	RBT LEVEL
CO1	Perform experiments to determine the flash point, fire point of fuels and oils.	L3
CO2	Perform experiments to determine calorific value of solid, liquid and gaseous fuels.	L3
CO3	Perform experiments to determine viscosity of various oils.	L3
CO4	Perform experiments to determine carbon residue and density of fuels.	L3
CO5	Perform experiments to determine cloud and pour point of lubricants.	L3
CO6	Perform experiments to determine area of irregular surfaces using planimeter	L3

	Total Number Lecture Hours	**24**
	NOTE: All levels mentioned are as per Revised Bloom's Taxonomy	

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1					1	1				1
CO2	1	1					1	1				1
CO3	1	1					1	1				1
CO4	1	1					1	1				1
CO5	1	1					1	1				1
CO6	1	1					1	1				1

Scheme of Examination:

ONE question from par –A: 20 Marks
ONE question from part –B: 20Marks
Viva -Voice: : 10 Marks
Total: : 50 Marks

MATERIAL SCIENCE & TESTING LAB

Semester: III **Year: 2022-23**

Course	Code	Credits	Total Hours - 24 Hours /Week		Assessment		Exam Duration in hrs
			Lecture	Practical	SEE	CIE	
Material Science & Testing Lab-1	22EGL37	01	00	02	50	50	03

OBJECTIVES:

1. To learn the concept of the preparation of samples to perform characterization such as microstructure, volume fraction of phases and grain size.
2. Calculate the various Mechanical properties of material such as tension, flexural, compression strength and hardness.
3. To learn materials failure modes and the differential loads causing failure.
4. To learn the concept of improving the mechanical properties of materials by differential method like heat treatment, surface treatment etc.

PART-A

1. Preparation of specimen for metallographic examination of different engineering materials. To report microstructure of Plain Carbon Steel, Tool steel, Gray CI, SG Iron. Brass, Bronze and Composites.
2. Brinell Hardness test on metals.
3. Rockwell Hardness test on metals.
4. Vickers's Hardness test on metals.

PART-B

1. Tensile, shear and compression tests of metallic and wooden materials specimens using universal testing machine
2. Bending test on wooden specimen
3. Torsion test on steel bar
4. Izod and Charpy test on mild steel specimen
5. Fatigue test

COURSE OUTCOMES:

At the end of this course, student should be able to:

	COURSE OUTCOMES	RBT LEVEL
CO1	Demonstrate the application of metallography and material science.	L1
CO2	Select the standard experiments to determine the mechanical properties of different materials using hardness test by different apparatus.	L3
CO3	Select the standard experiments to determine tensile, shear and compression tests of various material using UTM.	L3
CO4	Determine the mechanical properties of different materials using torsion test on steel bar.	L3
CO5	Determine the mechanical properties of fatigue test.	L3
	Total Number Lecture Hours	**24**
	NOTE: All levels mentioned are as per Revised Bloom's Taxonomy	

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3		2		2		1				2
CO2	3	3		2		2		1				2
CO3	3	3		2		2		1				2
CO4	3	3		2		2		1				2
CO5	3	3		2		2		1				2

Scheme of Examination:

ONE question from par –A: 15 Marks
ONE question from part –B: 25Marks
Viva -Voice: : 10 Marks
Total: : 50 Marks

POWER ELECTRONICS LAB

Semester: III **Year: 2022-23**

Course	Code	Credits	Total Hours - 24 Hours /Week		Assessment		Exam Duration in hrs
			Lecture	Practical	SEE	CIE	
Power Electronic Lab	**22EGL38**	**01**	**00**	**02**	**50**	**50**	**03**

COURSE OBJECTIVES:

Upon successful completion of this laboratory, the students should be able to have hands on experience in

1) Study Characteristics of power electronic devices.
2) Understand the converters with different Loads
3) Control the speed of different motors.

PART-A

1. Study of Characteristics of SCR,
2. Study of Characteristics of MOSFET
3. Study of Characteristics of IGBT
4. Study of Characteristics of Triac
5. Single Phase Half controlled converter with R load

PART-B

1. Single Phase fully controlled bridge converter with R and RL loads
2. Single Phase AC Voltage Controller with R and RL Loads
3. Speed control of DC motor using single semi converter.
4. Speed control of stepper motor.
5. Speed control of universal motor using ac voltage regulator.

COURSE OUTCOMES:

At the end of this course, student will be able to

	COURSE OUTCOMES	RBT LEVEL
CO1	Study characteristics of different power electronic devices.	L3
CO2	Verify the performance of single phase controlled full wave rectifier with different Loads	L3
CO3	Verify AC voltage controller with R and RL loads.	L3
CO4	Control the speed of a DC motor, universal motor and stepper motors.	L3
	Total Number Lecture Hours	**24**
	NOTE: All levels mentioned are as per Revised Bloom's Taxonomy	

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	-					1		1

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

Scheme of Examination:

ONE question from par –A: 15 Marks

ONE question from part –B: 25Marks

Viva -Voice: : 10 Marks

Total: : 50 Marks

PROJECT-3

Semester: III **Year: 2022-23**

Course	Code	Credits	Total Hours - 32 Hours /Week		Assessment		Exam Duration in hrs
			Lecture	Project	SEE	CIE	
Project-3	22PRJ39	01	00	02	50	50	03

OBJECTIVES:

To Introduce fundamental concepts and analysis techniques in engineering to students across all disciplines.

Mini-Project Work:

Based on the ability/abilities of the students and recommendations of the mentor, a single discipline or a multidisciplinary Mini-Project can be assigned to an individual student or to a group having not more than 4 students.

COURSE OUTCOMES:

At the end of this course, student should be able to:

	COURSE OUTCOMES	RBT LEVEL
CO1	Comprehend how to identify issues related to environment, society and industry.	L3
CO2	Able to prepare the model and report on society, environment and industry related projects.	L3
	Total Number Lecture Hours	**32**
	NOTE: All levels mentioned are as per Revised Bloom's Taxonomy	

CO-PO Mapping

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2		1	2	2	1	2	1	1	1
CO2	2	2	2		1	2	2	1	2	1	1	1

Scheme of Examination:

Write-up : 15 Marks
Demonstration : 25Marks
Viva -Voice: : 10 Marks
Total: : 50 Marks

SOCIAL CONNECT RESPONSIBILITY

Semester: III **Year: 2022-23**

Course	Code	Credits	Total Hours - 24 Hours /Week		Assessment		Exam Duration in hrs
			Lecture	Tutorial	SEE	CIE	
Social Connect Responsibility	**22HSM310**	**01**	**01**	**00**	**50**	**50**	**03**

COURSE OBJECTIVES:

1. Enable the student to do a deep drive into societal challenges being addressed by NGO(s), social enterprises & The government and build solutions to alleviate these complex social problems through immersion, design & technology.
2. Provide a formal platform for students to communicate and connect with their surroundings.
3. Enable to create of a responsible connection with society.

MODULE 1

Plantation and adoption of a tree: Plantation of a tree that will be adopted for four years by a group of B.Tech. students. They will also make an excerpt either as a documentary or a photoblog describing the plant's origin, its usage in daily life, and its appearance in folklore and literature.

MODULE 2

Heritage walk and crafts corner: Heritage tour, knowing the history and culture of the city, connecting to people around through their history, knowing the city and its craftsman, photoblog and documentary on evolution and practice of various craft forms.

MODULE 3

Organic farming and waste management: usefulness of organic farming, wet waste management in neighbouring villages, and implementation in the campus.

MODULE 4

Water Conservation: knowing the present practices in the surrounding villages and implementation in the campus, documentary or photo blog presenting the current practices

MODULE 5

Food Walk City's culinary practices, food lore, and indigenous materials of the region used in cooking.

COURSE OUTCOMES

At the end of this course, student should be able to:

	COURSE OUTCOMES	RBT LEVEL
CO1	Analyse social responsibility	L2
CO2	Practice sustainability and creativity	L2
CO3	Showcase planning and organizational skills	L2
	Total Number Lecture Hours	**24**
	NOTE: All levels mentioned are as per Revised Bloom's Taxonomy	

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2			1	1	1				1	1
CO2	3	2			1	1	1				1	1
CO3	3	2			1	1	1				1	1
CO4	3	2			1	1	1				1	1
CO5	3	2			1	1	1				1	1

Semester End Examination (SEE) This Jamming session will be conducted at the end of the course for 50 marks Jamming session includes -Platform to connect to others. Share the stories with others. Share the experience of Social Connect. Exhibit the talent like playing instruments, singing, one-act play, art painting, and fine art. Faculty mentor has to design the evaluation system for the Jamming session.

WORKSHOP PRACTICE ON REFRIGERATION & AIR CONDITIONING

Semester: III **Year: 2022-23**

Course	Code	Credits	Total Hours - 32 Hours /Week		Assessment		Exam Duration in hrs
			Lecture	Practical	SEE	CIE	
Workshop Practice on Refrigeration & Air Conditioning	22AEG311	01	00	01	50	50	03

OBJECTIVES:

The main objectives are to

1) Identify hazards and safety procedures following safety precautions.
2) Identify RAC tools and equipment and recognise different parts of RAC system.
3) Perform copper tube cutting, flaring, swaging and brazing.
4) Test mechanical & electrical components.
5) Perform leak test, vacuuming, gas charging, wiring & installation of refrigerator.
6) Understand the function of compressor, condenser, expansion valve and evaporator.

RAC Work:

Identify the RAC tools and equipment, Identify the condensing and cooling unit, Copper pipe cutting, bending, swaging, flaring and brazing as per requirements and test pressure, Leak testing of RAC unit use dry nitrogen, Evacuation the unit and test vacuum level, Gas charging unit, Wirings, Install, run and check the performance, Trace and test compressor / motor terminals, Start the compressor Direct / without relay, Start the compressor with relay, Flushing, cleaning of condenser, Evaporator coils, Joining of condensers, Evaporator capillary fitter drier by brazing, Braze the major mechanical components, Test Pressure, Test electrical components and safety cut outs, Make wiring, run the machine and check performance, Assembly and Dis-assembly of Air-Conditioner.

COURSE OUTCOMES

At the end of this course, student should be able to:

	COURSE OUTCOMES	RBT LEVEL
CO1	Study the safety hazards, precautions, RAC Tools, Copper tube cutting and Brazing.	L1
CO2	Analyse the mechanical, electrical, leak test, charging and installation of refrigerator.	L3
	Total Number Lecture Hours	**32**
	NOTE: All levels mentioned are as per Revised Bloom's Taxonomy	

CO-PO Mapping

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2		1	2	2	1	2	1	1	1

CO2	2	2	2		1	2	2	1	2	1	1	1

Scheme of Examination:

Write-up : 15 Marks
Demonstration : 25Marks
Viva -Voice: : 10 Marks
Total: : 50 Marks

ADDITIONAL MATHEMATICS-1

Semester: III **Year: 2022-23**

Course	Code	Credits	Total Hours - 25 Hours /Week		Assessment		Exam Duration in hrs
			Lecture	Practical	SEE	CIE	
Additional Mathematics-1	22MATDIP31	00	02	00		50	03

OBJECTIVE:

1. Acquire basic concepts of complex trigonometry, vector algebra, differential and integr calculus and vector differentiation.
2. know the basic concepts of derivatives and representation of different types of polar curves Evaluation of double and triple integrals.
3. know the basic concepts of partial differential equations.
4. To develop the knowledge of matrices and linear algebra in compressive manner.
5. To understand the essential concept of linear algebra.

MODULE 1 : COMPLEX TRIGONOMETRY

Complex Numbers: Definition and Properties . Modulus and Amplitude of complex number, Argand's diagram , De-Moivre's theorem (without proof)

Vector Analysis : Scalar and Vectors. Vector addition and subtraction. Multiplication of vectors (Dot and Cross products) Scalar and vector triple products- simple problems, Vector Differentiation : Gradient, Divergence and Curl. 05 Hours

MODULE 2: DIFFERENTIAL CALCULUS

Review of successive differentiation. Formulae of nth derivatives of standard functions- Leibnitz's theorem (without proof).

Polar Curves: Expression for Angle between radius vector and tangent, length of perpendicular from pole to the tangent, angle between two polar curves, Pedal Equation of polar curves and problems. Taylor' and Maclaurin's series expansions. 05 Hours

MODULE 3: PARTIAL DIFFERENTIAL

Definitions of Partial Differentiation, Direct and Indirect partial derivatives, Symmetric functions, Homogeneous function and Euler's theorem on homogeneous function. Total Derivative of composite and implicit function. Jacobians. 05 Hours

MODULE-4: INTEGRAL CALCULUS

Reduction Formulae of $\int_0^{\pi/2} Sin^n x\, dx, \int_0^{\pi/2} Cos^n x\, dx$, *and* Statement of Reduction formulae $\int_0^{\pi/2} sin^m x\, cos^n x\, dx$ and Problems. Double and Triple integral- simple problems. 05 Hours

MODULE-5: LINEAR ALGEBRA

Basic concepts of matrices- Rank of matrix by elementary row transformations- Echelon form. Consistency of system of Linear equations. Solution of system linear equations by Gauss

Elimination method, Linear Transformation, Cayley- Hamilton theorem to compute inverse of matrix. Eigen values and Eigen vector, Largest Eigen value and corresponding Eigen vector by Reyleigh's Power method. 05 Hours

COURSE OUTCOMES

At the end of this course, student should be able to

	COURSE OUTCOMES	RBT LEVEL
CO1	Learn the representation of complex numbers in Argand diagram and understanding the vector dot product and cross product and use in finding the area, projection, etc. Also understanding the gradient, divergence and curl operators.	L3
CO2	Apply the knowledge of calculus to find the nth derivative and solve the problems related to polar curves and its applications in determining the bendness of a curve.	L3
CO3	Learn the notion of partial differentiation to calculate rates of change of multivariate functions and solve problems related to composite functions and solve first order linear/nonlinear differential equation analytically using standard methods.	L3
CO4	Apply the concept of change of order of integration and variables to evaluate multiple integrals and their usage in computing the area and volumes.	L3
CO5	Make use of matrix theory for solving system of linear equations and compute Eigen values and Eigen vectors.	L3
	Total Number Lecture Hours	**25**
	NOTE: All levels mentioned are as per Revised Bloom's Taxonomy	

CO-PO Mapping

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2		1				1			1
CO2	3	2	2		1				1			1
CO3	3	2	2		1				1			1
CO4	3	2	2		1				1			1
CO5	3	2	2		1				1			1

TEACHING LEARNING PROCESS:

CIE + Assignments: 15+35=50 Marks

There will be a 2 CIE's, the best one among 2 CIE's will be considered and there will be a 35 marks for Assignments

TEXT BOOKS:

1. B.S. Grewal : Higher Engineering Mathematics, Khanna Publishers, 43rd Ed., 2015.
2. E. Kreyszig : Advanced Engineering Mathematics, John Wiley & Sons, 10th Ed.(Reprint), 2016.

REFERENCE BOOKS:

1. C.Ray Wylie, Louis C.Barrett : “Advanced Engineering Mathematics", 6th Edition, McGraw-Hill Book Co., New York, 1995.
2. James Stewart : “Calculus –Early Transcendentals”, Cengage Learning India Private Ltd., 2017.
3. B.V.Ramana : "Higher Engineering Mathematics" 11th Edition, Tata McGraw-Hill, 2010.
4. Srimanta Pal & Subobh C Bhunia:“Engineering Mathematics”, Oxford University Press,3rd Reprint,2016.
5. Gupta C.B., Singh S.R. and Mukesh Kumar : “Engineering Mathematics for Semester I & II”, Mc-Graw Hill Education (India) Pvt.Ltd., 2015.

Mathematics for Mechanical Engineering Stream-IV

Semester: IV **Year: 2022-23**

Course	Code	Credits	Total Hours - 40 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Mathematics for MES - IV	22MATM41	03	03	00	50	50	03

COURSE OBJECTIVES:

The goal of the course Mathematics for Mechanical Engineering Stream-IV(22MATM41)is to

1. Familiarize the importance of numerical methods to solve First order ODE in Mechanical engineering.
2. Introduce most commonly used analytical and numerical methods in the different engineering fields.
3. Understand Joint probability distribution and stochastic processes arising in science and Mechanical engineering.
4. Develop the knowledge of complex variable and discuss the various properties of it.
5. To develop the knowledge of special functions like Bessel and Legendre.
6. Develop the knowledge of sampling theory in day to day life and trace different types of curves.

MODULE-1: Numerical Methods-1

Numerical Methods: Numerical solution of ordinary differential equations of first order and first degree, Taylor's series method, modified Euler's-method Runge Kutta method of fourth order. Milne's and Adams- Bashforth predictor and corrector methods (No derivations of formulae). (5 Assignment Problem).

Self Study : Picard's method

Applications of Numerical Methods: 08 Hours

MODULE-2 : Numerical Methods-2

Numerical Methods: Numerical solution of second order ordinary differential equations, Runge-Kutta Method and Milne's Method, Numerical solution of P.D.E: Numerical solution of Heat equation, Wave equation, problems. (5 Assignment Problem).

Self-Study : Picard's method, Numerical solution of Laplace's equation

Applications of Numerical Methods: 08 Hours

MODULE-3: Sampling theory and curve tracing

Sampling theory : Sampling, Sampling distributions, standard error, test of hypothesis for means and proportions, Type I and Type II errors, Level of significance, confidence limits for means, one tailed and two tailed tests, student's t-distribution, Chi - square distribution as a test of goodness of fit.

Tracing of curves: Cartesian form - Strophoid, Leminscate, Parametric form - Cycloid, Astroid, Polar form - Cardioid, Leminscate.

Self Study :. Types of samplings, Cartesian equations and their geometrical representation

Applications of Sampling theory and curve tracing: 08 Hours

MODULE-4: Special Functions

Special Functions: Series solution of Bessel's differential equation leading to J_n (x)-Bessel's function of first kind. Basic properties and orthogonality. Series solution of Legendre's differential equation leading to P_n (x)-Legendre polynomials. Rodrigue's formula, problems

Self Study : Condtion for Orthogonality, Differential Equations

Applications of Special Functions: 08 Hours

MODULE-5: Complex variable-2

Complex line Integrals: Cauchy's Integration theorem, Cauchy integral formula, Laurent's Series, types of singularities. Residue, Poles, Cauchy's Residue theorem (without proof) and Problems.

Transformations: Bilinear transformations and problems.

Self Study : Cauchy Riemann Integral, Singularity Defination.

Applications of Special Functions: 08 Hours

COURSE OUTCOMES

At the end of this course, student will be able to

	COURSE OUTCOMES	**RBT LEVEL**
CO1	Solving the first order first degree ordinary differential equations arising in flow problems using single step and multistep numerical methods.	L3
CO2	Use to solve Finite Difference Method and partial differential equations arising in heat , wave and Laplace Equation equations by numerical methods.	L3
CO3	Apply Sampling Distribution to solve Engineering Problems .	L3
CO4	Obtain the series solution of ordinary differential equations and studying special functions.	L3
CO5	Able to Solve complex Integration Problem.	L3
	Total Number Lecture Hours	**40**
	NOTE: All levels mentioned are as per Revised Bloom's Taxonomy	

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2		1				1			1
CO2	3	2	2		1				1			1
CO3	3	2	2		1				1			1
CO4	3	2	2		1				1			1
CO5	3	2	2		1				1			1

TEXT BOOKS:

1. B.S.Grewal:"Higher Engineering Mathematics", Khanna publishers, 44th Ed.,2021.
2. E. Kreyszig: "Advanced Engineering Mathematics", John Wiley & Sons, 10thEd., 2018.

REFERENCE BOOKS:

1. **V. Ramana:**"Higher Engineering Mathematics" McGraw-Hill Education, 11th Ed.,2017
2. **Srimanta Pal & Subodh C. Bhunia**: "Engineering Mathematics" Oxford University Press, 3rdEd., 2016.
3. **N.P Bali and Manish Goyal**: "A textbook of Engineering Mathematics" Laxmi Publications,10th Ed.,2022.
4. **C. Ray Wylie, LouisC. Barrett:**"Advanced Engineering Mathematics" McGraw–Hill Book Co., Newyork, 6thEd., 2017.
5. **Gupta C. B, Sing S .Rand Mukesh Kumar:** "Engineering Mathematic for Semester I and II" ,Mc-Graw Hill Education(India)Pvt. Ltd 2015.
6. **H.K. Dass and Er.RajnishVerma:**"Higher Engineering Mathematics" S.Chand Publication, 3rdEd. ,2014
7. **James Stewart:"**Calculus"CengagePublications,7thEd.,2019.
8. **David CLay:**"Linear Algebra and its Applications", Pearson Publishers,4th Ed.,2018
9. **Gareth Williams:** "Linear Algebra with applications", Jones Bartlett Publishers Inc., 6thEd., 2017.

SCHEME OF EXAMINATION:

Two questions to be set from each module. Students have to answer five full questions choosing at least one full question from each module.

ELECTRICAL MECHINES

Semester: IV **Year: 2022-23**

Course	Code	Credits	Total Hours - 40 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Electrical Machines	22EG42	03	03	00	50	50	03

COURSE OBJECTIVES:

This course will enable the students:

1) To understand the concepts of transformers and their analysis and suggest a suitable three phase transformer connections for a particular application.
2) To explain the required conditions for the parallel operation of transformers.
3) To study different tests to be conducted for the assessment of the performance characteristics of DC motors.
4) To understand the different tests on DC motor.
5) To Explain the construction and operation of Synchronous generators and to evaluate their performance.

MODULE-1

Single phase Transformers: Operation of practical transformer under no-load and on-load conditions with Phasor diagrams. Open circuit and short circuit tests, calculation of equivalent circuit parameters and predetermination of efficiency-commercial and all-day efficiency. Voltage regulation and its significance.

Three-phase Transformers: Introduction, Constructional features of three-phase transformers. Choice between single unit three-phase transformer and a bank of three single-phase transformers. Transformer connection for three phase operation– star/star, delta/delta, star/delta, zigzag/star and V/V, comparative features. Phase conversion-Scott connection for three-phase to two-phase conversion. Labelling of three-phase transformer terminals, vector groups. 08 Hours

MODULE-2

Transformers (Continuation): Polarity test, Sumpner's test, separation of hysteresis and eddy current losses.

Parallel Operation of Transformers: Necessity of Parallel operation, conditions for parallel operation – Single phase and three phase transformers. Load sharing in case of similar and dissimilar transformers.

D.C. Machines: Working principle of D.C. Machine as a generator and a motor. Types and constructional features. Types of armature windings, Emf equation of generator, relation between induced emf and terminal voltage with an enumeration of brush contact drop and drop due to armature reaction. Illustrative examples, neglecting armature reaction. 08 Hours

MODULE-3

D.C. Machines (Continuation): Operation of D.C. motor, Back emf and its significance, torque equation. Types of D.C. motors, characteristics and applications. Necessity of a starter for D.C. motor. Illustrative examples on back emf and torque.

Testing of dc motors: Direct & indirect methods of testing of DC motors-Brake test, Swinburne's test, Retardation test, Hopkinson's test, Field's test, merits and demerits of tests. 08 Hours

MODULE-4

Three Phase Synchronous Generators: Principle of operation, Types and constructional features, Advantages of rotating field type alternator, Synchronous speed, Frequency of generated voltage, Emf equation. Concept of winding factor (excluding the derivation of distribution and pitch factors). Illustrative examples on emf equation. 08 Hours

MODULE-5

Three Phase Induction Motors: Principle of operation, Concept and production of rotating magnetic field, Synchronous speed, rotor speed, Slip, Frequency of the rotor induced emf, Types and Constructional features. Slip and its significance. Applications of squirrel - cage and slip – ring motors. Illustrative examples on slip calculations..

Starting and speed Control of Three-phase Induction Motors: Need for starter. Direct on line, Star-Delta and autotransformer starting. Rotor resistance starting. Speed control by voltage, frequency, and rotor resistance methods. 08 Hours

COURSE OUTCOMES

At the end of this course, student will be able to

	COURSE OUTCOMES	RBT LEVEL
CO1	Explain the construction, operation and performance of single phase and three phase transformers.	L3
CO2	Explain the use of auto transformer, tap changing and tertiary winding transformer and need of operating transformers in parallel and explain the working principle of D.C. Machine as a generator	L3
CO3	Analyze and assess the performance characteristics of DC motors by conducting suitable tests and control the speed by suitable method.	L3
CO4	Explain the construction and operation of Synchronous generators.	L3
CO5	Explain the constructional features of Three Phase induction Motors and assess their performance. And control the speed of three-phase Induction Motor by a suitable method.	L3
	Total Number Lecture Hours	**40**
	NOTE: All levels mentioned are as per Revised Bloom's Taxonomy	

CO-PO Mapping

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	2								2
CO2	2	1	1									2
CO3	2	1	1									1
CO4	2	1	2		2	2	2					2
CO5	2	1	2	2	2	2	2					3

TEXT BOOKS:

1. Electrical Technology AC & DC Machines, B.L. Thereja and A. K. Thereja S. CHAND Publications Reprint 2014.
2. Electric Machines D. P. Kothari, et al McGraw Hill 4th Edition, 2011
3. Performance and Design of A.C. Machines M. G. Say CBS Publishers 3rd Edition, 2002

4. Electrical machinery, P.S Bhimbra, Khanna Publishers

REFERENCES:

1) Principles of Electric Machines P.C.Sen Wiley 2nd Edition, 2013
2) Electric Machines MulukuntlaS.Sarma,at el Cengage 1st Edition, 2009
3) Performance & Design of Alternating Current machines, M. G. Say, CBS publishers,3rd Edition,2002.
4) The Performance & Design of DC machines A.E Clayton &N.N.Hancock CBS Publication,3rd Edition,2004.
5) Electrical Machines,Ashfaq Hussain, Dhanpat Rai Publications.

SCHEME OF EXAMINATION:

Two questions to be set from each module. Students have to answer five full questions choosing at least one full question from each module.

RENEWABLE ENERGY TECHNOLOGIES

Semester: IV **Year: 2022-23**

Course	Code	Credits	Total Hours - 40 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Renewable Energy Technologies	**22EG43**	**03**	**03**	**00**	**50**	**50**	**03**

COURSE OBJECTIVES:

1) To discuss causes of energy scarcity and its solution, energy resources and availability of renewable energy.
2) To explain solar geometry and solar thermal applications.
3) To discuss benefits of hydrogen energy, production of hydrogen energy.
4) To discuss wind turbines, wind resources, site selection for wind turbine.
5) To discuss geothermal systems, and geothermal based electric power generation
6) To discuss waste recovery management systems.
7) To discuss biogas, its composition, production, benefits.
8) To discuss tidal energy and wave energy resources.

MODULE-1

Introduction: Causes of Energy Scarcity, Solution to Energy Scarcity, Factors Affecting Energy Resource Development, Energy Resources and Classification, Renewable Energy – Worldwide Renewable Energy Availability, Renewable Energy in India.

Energy from Sun: Sun- earth Geometric Relationship, Layer of the Sun, Earth – Sun Angles and their relationships, Solar Energy Reaching the Earth's Surface, Solar Thermal Energy Applications. 08 Hours

MODULE-2

Solar Thermal Energy Collectors: Types of Solar Collectors, Configurations of Certain Practical Solar Thermal Collectors, Material Aspects of Solar Collectors, Concentrating Collectors, Parabolic Dish – Stirling Engine System, Working of Stirling or Brayton Heat Engine.

Solar Collector Systems into Building Services, Solar Water Heating Systems, Passive Solar Water Heating Systems, Applications of Solar Water Heating Systems, Active Solar Space Cooling, Solar Air Heating, Solar Dryers, Crop Drying, Space Cooing, Solar Cookers, Solar Pond. 08 Hours

MODULE-3

Hydrogen Energy: Benefits of Hydrogen Energy, Hydrogen Production Technologies, Hydrogen Energy Storage, Use of Hydrogen Energy, Advantages and Disadvantages of Hydrogen Energy, Problems Associated with Hydrogen Energy. Wind Energy: Windmills, Wind Turbines, Wind Resources, Wind Turbine Site Selection.

Geothermal Energy: Geothermal Systems, Classifications, Geothermal Resource Utilization, Resource Exploration, Geothermal Based Electric Power Generation, Associated Problems, environmental Effects. 08 Hours

MODULE-4

Biogas Energy: Introduction, Biogas and its Composition, Anaerobic Digestion, Biogas Production, Benefits of Biogas, Factors Affecting the Selection of a Particular Model of a Biogas Plant, Biogas Plant Feeds and their Characteristics.

Tidal Energy: Introduction, Tidal Energy Resource, Tidal Energy Availability, Tidal Power Generation in India, Leading Country in Tidal Power Plant Installation, Energy Availability in Tides, Tidal Power Basin, Turbines for Tidal Power, Advantages and Disadvantages of Tidal Power, Problems Faced in Exploiting Tidal Energy. 08 Hours

MODULE-5

Ocean Thermal Energy: Introduction, Principles of Ocean Thermal Energy Conversion (OTEC), Ocean Thermal Energy Conversion plants, Basic Rankine Cycle and its Working, Closed Cycle, Open Cycle and Hybrid Cycle, Carnot Cycle, Application of OTEC in Addition to Produce Electricity, Advantages, Disadvantages and Benefits of OTEC.

Wave Energy: Introduction, Motion in the sea Waves, Power Associated with Sea Waves, Wave Energy Availability, Devices for Harnessing Wave Energy, Advantages and Disadvantages of Wave Power. 08 Hours

COURSE OUTCOMES

At the end of this course, student should be able to

	COURSE OUTCOMES	RBT LEVEL
CO1	Discuss scenario of renewable energy sources and solar geometry.	L3
CO2	Analyse the solar thermal energy conversion.	L3
CO3	Explain generation of energy from hydrogen, wind and geothermal system.	L3
CO4	Discuss production of energy from biogas and tidal energy resources.	L3
CO5	Summarize ocean thermal energy and wave energy.	L3
	Total Number Lecture Hours	**40**
	NOTE: All levels mentioned are as per Revised Bloom's Taxonomy	

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1		2	1	2	1				1
CO2	3	2	1		2	1	2	1				1
CO3	3	2	1		2	1	2	1				1
CO4	3	2	1		2	1	2	1				1
CO5	3	2	1		2	1	2	1				1

TEXT BOOKS:

1. Nonconventional Energy Resources by G D Rai, Khanna Publication.

REFERENCES:

1. Nonconventional Energy Resources B.H. Khan McGraw Hill 3rd Edition
2. Renewable Energy; Power for a sustainable Future Godfrey Boyle Oxford 3rd Edition, 2012

SCHEME OF EXAMINATION:

Two questions to be set from each module. Students have to answer five full questions choosing at least one full question from each module

FLUID MECHANICS

Semester: IV **Year: 2022-23**

Course	Code	Credits	Total Hours - 40 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Fluid Mechanics	**22EG44**	**03**	**03**	**00**	**50**	**50**	**03**

COURSE OBJECTIVES:

1. To understand the basic principles and fundamental concepts of fluid mechanics.
2. To make the students to understand the concept and apply the various laws solving the fluid engineering problems.
3. To make the students familiar with measurements and visualisation of fluid flow types, kinematics, dynamics and its analysis.
4. To understand the concept flow of liquids through pipes and different sections and the dimensional quantities.

MODULE-1

Basics concepts and definitions: Introduction, Properties of fluids-mass density, weight density, specific volume, specific gravity, viscosity, surface tension, capillarity, compressibility and bulk modulus**.**

Fluid pressure at a point, Pascal's Law, Pressure Variation in Fluid at rest, Types of fluids, Absolute, Gauge, Atmosphere and Vacuum Pressure, simple numerical. 08 Hours

MODULE-2

Pressure measurement: Simple Manometers (Piezometers, U-tube Manometers and Single Column Manometers), differential manometers (U-tube and Inverted U-Tube differential manometers)

Fluid Statics: Introduction, Hydrostatic forces on submerged horizontal plane, vertical plane and inclined plane to determine total pressure and centre of pressure in static fluid, Definition of Buoyance, Centre of Buoyance, Meta Centre, Meta centric Height and simple numerical. 08 Hours

MODULE-3

Fluid Kinematics: Introduction, Method of describing fluid motion, Types of flows - steady, unsteady, uniform, non-uniform, laminar, turbulent, one, two and three dimensional, compressible, incompressible, rotational, irrational flow, Continuity Equation, Continuity Equation in Three Dimensions.

Velocity and Acceleration, velocity components, convective and local acceleration, velocity potential and stream function and types of motion. 08 Hours

MODULE-4

Fluid Dynamics; Introduction, Forces acting on fluid in motion. Euler's equation of motion along a streamline, Integration of Euler's equation to obtain Bernoulli's equation, Assumptions and limitations of Bernoulli's equation, simple numerical

Fluid Flow Measurements: Introduction to Navier-Stokes equation, Application of Bernoulli's theorem such as venturi-meter, orifice meter and pitot tube, Simple numerical. 08 Hours

MODULE-5

Notches and weirs: Introduction, classification, rectangular notch, triangular Notch, Trapezoidal notch (Simple Numerical).

Dimensional Analysis: Introduction, dimensions of physical quantities, dimensional homogeneity, Rayleigh's method, Buckingham Pi-theorem, similitudes- Types of similarities, Forces acting in moving fluid, dimensionless numbers, Simple Numerical. 08 Hours

COURSE OUTCOMES

At the end of this course, student should be able to

	COURSE OUTCOMES	RBT LEVEL
CO1	Analyse a variety of practical fluid flow and measuring devices and utilize fluid mechanics principles in design.	L3
CO2	Study the concept of measurements of fluid, and study of fluid at static or rest.	L3
CO3	Visualise different types of fluid flow, and compare them based on kinematic flow descriptions.	L3
CO4	Know the mass and momentum is conserved based on Bernoulli's & Newton's laws and its applications.	L3
CO5	Know concept of dimensional quantities, study of notches, wire and its application	L3
	Total Number Lecture Hours	**40**
	NOTE: All levels mentioned are as per Revised Bloom's Taxonomy	

CO-PO Mapping

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2		1	1	1						1
CO2	3	2		1	1	1						1
CO3	2	2		1	1	1						1
CO4	3	2		1	1	1						1
CO5	3	2		1	1	1						1

TEXTBOOKS:

1. A Text Book of Fluid Mechanis And Hydraulic Machines Dr R.K Bansal Laxmi Publishers
2. Fluid Mechanics F M White McGraw Hill Publications Eighth edition. 2016
3. Fluid Mechanics (SI Units) Yunus A. Cengel John M.Cimbala TataMcGraw Hill 3rd Ed.,2014.

REFERENCE:

1. Fluid Mechanics, Oijush.K.Kundu, IRAM COCHEN, ELSEVIER, 3rd Ed. 2005.
2. Fluid Mechanics and hydraulics, Dr.Jagadishlal: Metropolitan Book Co-Ltd., 1997.Fluid Mechanics, John F. Douglas, Janul and M.Gasiosek and john A.Swaffield, Pearson Education Asia, 5th ed., 2006.
3. Fluid Mechanics and Fluid Power Engineering, Kumar.D.S, Kataria and Sons, 2004
4. Fluid Mechanics -. Merle C. Potter, Elaine P.Scott. Cengage learning.

SCHEME OF EXAMINATION:

Two questions to be set from each module. Students have to answer five full questions choosing at least one full question from each module.

HEAT TRANSFER

Semester: IV **Year: 2022-23**

Course	Code	Credits	Total Hours - 40 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Heat Transfer	22EG45	03	03	00	50	50	03

COURSE OBJECTIVES:

Upon successful completion of the course the students will be familiar with

1. To explain the basic modes of heat transfer, applications, fundamental rule and one-dimensional steady state heat transfer with boundary condition.
2. To understand the concept of fins and its application for various engineering field.
3. Learn how to formulate and solve 1-D steady heat conduction problems
4. To comprehend the heat transfer due to free and forced convective heat transfer.
5. Understand the principles of radiation heat transfer related engineering problems.
6. Study the basic principles of heat exchanger analysis, LMTD and thermal design.

MODULE-1

Introductory Concepts and Definitions: Modes of heat transfer: Basic laws of governing conduction, convection and radiation heat transfer, Thermal conductivity, convective heat transfer coefficient, radiation heat transfer and combined heat transfer mechanism, Types of boundary condition, general heat conduction equation: derivation of the equation in cartesian and polar co-ordinate system, Simple numerical.

One Dimensional Steady State Heat Conduction: steady state one dimensional heat conduction problems without heat generation for slab, composite wall, and cylinder wall in cartesian system with various possible boundary condition. 08 Hours

MODULE-2

Critical Thickness of insulation: introduction, Critical Thickness of insulation for Cylinder surface and spherical surface, simple numerical.

Fins: Fins, Necessity of fins, types of fins, application, steady state heat conduction in fins of uniform cross section Rectangular and circular fins, case1: Infinitely long fin, case 2: fin with insulated end, efficiency and effectiveness of fin. 08 Hours

MODULE-3

Forced convection: introduction, dimensional analysis of forced convection, significance, correlation for forced convection, simple numerical

Natural convection: introduction, dimensional analysis of free convection, significance, correlation for free convection, simple numerical. 08 Hours

MODULE-4

Radiation: introduction, characteristics, absorptivity, reflectivity and transmissivity of black, Gray and white body, Stefan Boltzman law, total emissive power, Planck's law, Rayleigh jeans law, Wein's displacement law, Kirchhoff's law, concept of gray body, emissivity.

Heat exchange between black bodies, heat exchange between gray bodies, Radiation shield, electrical network for radiation heat exchanger, simple numerical. 08 Hours

MODULE-5

Heat Exchanger: Introduction, Classification, over all heat transfer coefficient, fouling, analysis of heat exchanger: LMTD Parallel flow and counter flow.

Capacity rates, Analysis of heat exchanger by NTU-Effective method: parallel and counter flow heat exchanger, heat pipe and simple numerical. 08 Hours

COURSE OUTCOMES

At the end of this course, student should be able to

	COURSE OUTCOMES	RBT LEVEL
CO1	Know the modes of heat transfer and apply the basic laws to formulate engineering systems.	L3
CO2	Apply the basic laws of heat transfer to extended surface, fins and problems	L3
CO3	Analyze heat transfer due to free and forced convective heat transfer.	L3
CO4	Analyze heat conduction through numerical methods and apply the fundamental principle to solve radiation heat transfer problems.	L3
CO5	Design and performance analysis of heat exchangers and their practical applications.	L3
	Total Number Lecture Hours	**40**
	NOTE: All levels mentioned are as per Revised Bloom's Taxonomy	

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2			2	1		1				1
CO2	3	2			2	1		1				1
CO3	3	2			2	1		1				1
CO4	3	2			2	1		1				1
CO5	3	2			2	1		1				1

TEXT BOOKS:

1. Principals of heat transfer,FrankKreith, Raj M. Manglik, Mark S. Bohn, Seventh Edition, Cengage learning, 2011.
2. Yunus A. Cengel - Heat transfer, a practical approach, Fifth edition,Tata Mc Graw Hill.
3. J P Holman, Souvik Bhattacharyya, 10th Edition, McGraw Hill Education Private Ltd.,

REFERENCE BOOKS

1. Heat and mass transfer, Kurt C, Rolle, second edition, Cengage learning.
2. Heat Transfer, M. NecatiOzisik, A Basic Approach, McGraw Hill, New York, 2005.
3. Fundamentals of Heat and Mass Transfer, Incropera, F. P. and De Witt, D. P., 5th Edition, John Wiley and Sons, New York, 2006.
4. Heat Transfer, Holman, J. P., 9th Edition, Tata McGraw Hill, New York, 2008.

SCHEME OF EXAMINATION:

Two questions to be set from each module. Students have to answer five full questions choosing at least one full question from each module

ELECTRICAL MACHINES LAB-1

Semester: IV **Year: 2022-23**

Course	Code	Credits	Total Hours - 24 Hours /Week		Assessment		Exam Duration in hrs
			Lecture	Practical	SEE	CIE	
Electrical Machine Lab-1	22EGL46	01	00	02	50	50	03

COURSE OBJECTIVES:

This course will enable the students:

1. Conducting different tests on transformers and Induction machines and evaluating their Performance.
2. Verify the parallel operation of two single phase transformers.
3. Study the connection of single-phase transformers for three phase operation and phase conversion.
4. To conduct load test on single phase and three phase induction motors.
5. To conduct test on induction motor to determine the performance characteristics.

LIST OF EXPERIMENTS:

PART-A

1. (a)Predetermination of efficiency and regulation by Open Circuit and Short circuit tests on single - phase transformer. (b)Calculation of parameters of equivalent circuit from the readings of the tests and determination of efficiency and regulation from the equivalent circuit to correlate results obtained earlier.
2. Sumner's test on similar transformers and determination of combined and individual transformer efficiency.
3. Parallel operation of two dissimilar (different kVA) single-phase transformers and determination of load sharing and analytical verification-given the Open Circuit and Short circuit tests details.
4. Polarity test and connection of 3 single-phase transformers in star – delta and determination of efficiency and regulation under balanced resistive load.
5. Scott connection with balanced and unbalanced resistive loads.

PART-B

1. Load test on 3-phase induction motor- and plot of Torque versus speed, output hp versus efficiency, power factor and slip.
2. (a)Determination of parameters of the equivalent circuit of a 3-phase Induction Motor by conducting NO load and Blocked rotor tests. (b)Determination of performance parameters of the induction motor from the equivalent circuit to correlate the results obtained from the load test or circle diagram.
3. Speed control of 3-phase induction motor by varying rotor resistance.
4. Load test on- induction generator.
5. Load test on single- phase induction motor.

COURSE OUTCOMES:

At the end of this course, student will be able to

	COURSE OUTCOMES	**RBT LEVEL**
CO1	Evaluate the performance of transformers from the test data obtained.	L3
CO2	Connect and operate two single phase transformers of different KVA rating in parallel.	L3
CO3	Connect single phase transformers for three phase operation and phase conversion.	L3
CO4	Perform load test on single phase and three phase induction motors to assess the performance.	L3
CO5	Conduct test on induction motor to pre-determine the performance characteristics	L3
	Total Number Lecture Hours	**24**
	NOTE: All levels mentioned are as per Revised Bloom's Taxonomy	

CO-PO Mapping

CO \ **PO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	1	1		2		1		2			2
CO2	2	1	2	1	2		2		2			2
CO3	3	1	2	1	2				2			2
CO4	2	2	1	1		2			2			2
CO5	2	1	1	1		2			2			2

Conduct of Practical Examination:

1) All laboratory experiments are to be included for practical examination.
2) Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3) Students can pick one experiment from the questions lot prepared by the examiners.
4) Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero

Scheme of Examination:

ONE question from par –A: 15 Marks
ONE question from part –B: 25Marks
Viva -Voice : 10 Marks
Total : 50 Marks

FLUID MECHANICS LAB

Semester: IV **Year: 2022-23**

Course	Code	Credits	Total Hours - 24 Hours /Week		Assessment		Exam Duration in hrs
			Lecture	Practical	SEE	CIE	
Fluid Mechanics Lab	**22EGL47**	**01**	**00**	**02**	**50**	**50**	**03**

COURSE OBJECTIVES:

Upon Completion of this subject, the students can able to have hands on experience in flow measurements using different devices and also perform calculation related to losses in pipes and also perform characteristic study of pumps, turbines etc.

LIST OF EXPERIMENTS:

PART-A

1) Study of taps, valves, pipe fittings, gauges, pitot tubes, water meters and current meters.
2) Calibration of Pressure gauges
3) Determination of metacentric height and radius of gyration of floating bodies.
4) Verification of Bernoulli's theorem
5) Reynolds experiment

PART-B

6) Determination of the Coefficient of discharge of given Venturi meter
7) Determination of the Coefficient of discharge of given Orifice meter.
8) Determination of the Coefficient of discharge of given V-Notch 600, and 900.
9) Determination of the Coefficient of discharge of given V-Notch rectangular notch
10) Determination of friction factor for a given set of pipes.
    a) Major loss.
    b) Minor loss.

COURES OUTCOMES:

At the end of the course the student will be able to:

	COURSE OUTCOMES	**RBT LEVEL**
CO1	Study the types of valves, taps, pipe fitting and gauges.	L3
CO2	Know the measurement of pressure gauge and to measure metacentric height of floating body.	L3
CO3	Apply the concept of Bernoulli's and Reynolds number.	L3
CO4	Analyse the different flow measurement equipment's and their procedures.	L3
CO5	Able to develop the skill of experimentation techniques for the study of flow phenomena in channels/pipes.	L3
	Total Number Lecture Hours	**24**
	NOTE: All levels mentioned are as per Revised Bloom's Taxonomy	

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2						1	1			1
CO2	3	2						1	1			1
CO3	3	2						1	1			1
CO4	3	2						1	1			1
CO5	3	2						1	1			1

Conduct of Practical Examination:

1) All laboratory experiments are to be included for practical examination.
2) Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3) Students can pick one experiment from the questions lot prepared by the examiners.
4) Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Scheme of Examination:

ONE question from par –A: 20 Marks
ONE question from part –B: 20Marks
Viva -Voice : 10 Marks
Total : 50 Marks

HEAT TRANSFER LAB

Semester: IV **Year: 2022-23**

Course	Code	Credits	Total Hours - 24 Hours /Week		Assessment		Exam Duration in hrs
			Lecture	Practical	SEE	CIE	
Heat Transfer Lab	22EGL48	01	00	02	50	50	03

COURSE OBJECTIVES:

Upon successful completion of this laboratory, the students should be able to have hands on experience in

1. The primary objective of this course is to provide the fundamental knowledge necessary to understand the behavior of thermal systems.
2. This course provides a detailed experimental analysis, including the application and heat transfer through solids, fluids, and vacuum.
3. Convection, conduction, and radiation heat transfer in one and two dimensional steady and unsteady systems are examined.

PART-A

1. Determination of Thermal Conductivity of a Metal Rod
2. Determination of Overall Heat Transfer Coefficient of a Composite wall.
3. Determination of Effectiveness on a Metallic fin.
4. Determination of Heat Transfer Coefficient in free Convection
5. Determination of Heat Transfer Coefficient in a Forced Convention
6. Determination of Emissivity of a Surface.

PART-B

1. Determination of Stefan Boltzmann Constant.
2. Determination of LMDT and Effectiveness in Parallel Flow Heat Exchangers.
3. Determination of LMDT and Effectiveness in Counter Flow Heat Exchangers.
4. Performance Test on a Vapour Compression Refrigeration.
5. Performance Test on a Vapour Compression Air – Conditioner.

COURSE OUTCOMES

At the end of this course, student should be able to:

	COURSE OUTCOMES	RBT LEVEL
CO1	Determine the thermal conductivity of a metal rod and overall heat transfer coefficient of composite slabs.	L3
CO2	Determine convective heat transfer coefficient for free and forced convection and correlate with theoretical values.	L3
CO3	Comprehend the surface emissivity of a given test plate.	L3
CO4	Determine surface emissivity of Stefan Boltzmann constant.	L3
CO5	Estimate performance of a refrigerator and effectiveness of a fin and Double pipe heat exchange.	L3
	Total Number Lecture Hours	**24**
	NOTE: All levels mentioned are as per Revised Bloom's Taxonomy	

CO-PO Mapping:

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1					1	1				1
CO2	1	1					1	1				1
CO3	1	1					1	1				1
CO4	1	1					1	1				1
CO5	1	1					1	1				1
CO6	1	1					1	1				1

Scheme of Examination:

ONE question from part –A: 15 Marks
ONE question from part –B: 25Marks
Viva -Voice: : 10 Marks
Total: : 50 Marks

PROJECT-IV

Semester: IV **Year: 2022-23**

Course	Code	Credits	Total Hours - 32 Hours /Week		Assessment		Exam Duration in hrs
			Lecture	Project	SEE	CIE	
Project-4	22PRJ49	01	00	02	50	50	03

OBJECTIVES:

To Introduce fundamental concepts and analysis techniques in engineering to students across all disciplines.

Mini-Project Work:

Based on the ability/abilities of the students and recommendations of the mentor, a single discipline or a multidisciplinary Mini-Project can be assigned to an individual student or to a group having not more than 4 students.

COURSE OUTCOMES

At the end of this course, student should be able to:

	COURSE OUTCOMES	RBT LEVEL
CO1	Comprehend how to identify issues related to environment, society and industry.	L3
CO2	Able to prepare the model and report on society, environment and industry related projects.	L3
	Total Number Lecture Hours	**32**
	NOTE: All levels mentioned are as per Revised Bloom's Taxonomy	

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2		1	2	2	1	2	1	1	1
CO2	2	2	2		1	2	2	1	2	1	1	1

Scheme of Examination:

Write up : 15 Marks
Demonstration : 25 Marks
Viva -Voice: : 10 Marks
Total: : 50 Marks

UNIVERSAL HUMAN VALUES

Semester: IV **Year: 2022-23**

Course	Code	Credits	Total Hours - 40 Hours /Week		Assessment		Exam Duration in hrs
			Lecture	Tutorial	SEE	CIE	
Universal Human Values	22UHV410	03	02	01	50	50	03

COURSE OBJECTIVES: Upon successful completion of the course the students will be familiar with

1. To help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
2. To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
3. To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature.

MODULE 1:

Introduction to Value Education

Introduction to Value Education: Lecture 1: Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education)

Lecture 2: Understanding Value Education

Tutorial 1: Practice Session PS1 Sharing about Oneself

Lecture 3: Self-exploration as the Process for Value Education

Lecture 4: Continuous Happiness and Prosperity – the Basic Human Aspirations

Tutorial 2: Practice Session PS2 Exploring Human Consciousness

Lecture 5: Happiness and Prosperity – Current Scenario

Lecture 6: Method to Fulfill the Basic Human Aspirations

Tutorial 3: Practice Session PS3 Exploring Natural Acceptance. 08 Hours

MODULE 2:

Module 2 – Harmony in the Human Being (6 lectures and 3 tutorials for practice session)

Lecture 7: Understanding Human being as the Co-existence of the Self and the Body

Lecture 8: Distinguishing between the Needs of the Self and the Body

Tutorial 4: Practice Session PS4 Exploring the difference of Needs of Self and Body

Lecture 9: The Body as an Instrument of the Self

Lecture 10: Understanding Harmony in the Self

Tutorial 5: Practice Session PS5 Exploring Sources of Imagination in the **Self**

Lecture 11: Harmony of the Self with the Body

Lecture 12: Programme to ensure self-regulation and Health

Tutorial 6: Practice Session PS6 Exploring Harmony of Self with the Body 08 Hours

MODULE 3:

Harmony in the Family and Society (6 lectures and 3 tutorials for practice session)

Lecture 13: Harmony in the Family – the Basic Unit of Human Interaction

Lecture 14: 'Trust' – the Foundational Value in Relationship

Tutorial 7: Practice Session PS7 Exploring the Feeling of Trust

Lecture 15: 'Respect' – as the Right Evaluation

Tutorial 8: Practice Session PS8 Exploring the Feeling of Respect

Lecture 16: Other Feelings, Justice in Human-to-Human Relationship

Lecture 17: Understanding Harmony in the Society

Lecture 18: Vision for the Universal Human Order 08 Hours

MODULE 4:

Harmony in the Nature/Existence (4 lectures and 2 tutorials for practice session)

Lecture 19: Understanding Harmony in the Nature

Lecture 20: Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature

Tutorial 10: Practice Session PS10 Exploring the Four Orders of Nature

Lecture 21: Realizing Existence as Co-existence at All Levels

Lecture 22: The Holistic Perception of Harmony in Existence

Tutorial 11: Practice Session PS11 Exploring Co-existence in Existence 08 Hours

MODULE 5:

Implications of the Holistic Understanding – a Look at Professional Ethics (6 lectures and 3 tutorials for practice session)

Lecture 23: Natural Acceptance of Human Values

Lecture 24: Definitiveness of (Ethical) Human Conduct

Tutorial 12: Practice Session PS12 Exploring Ethical Human Conduct

Lecture 25: A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order

Lecture 26: Competence in Professional Ethics

Tutorial 13: Practice Session PS13 Exploring Humanistic Models in Education

Lecture 27: Holistic Technologies, Production Systems and Management Models-Typical Case Studies

Lecture 28: Strategies for Transition towards Value-based Life and Profession

Tutorial 14: Practice Session PS14 Exploring Steps of Transition towards Universal Human Order

08 Hours

OUTCOMES: After studying this course, students will be able to:

CO-1-Present sustainable solutions to the problems in society and nature

CO-2-See that these solutions are practicable and draw roadmaps to achieve them.

CO-3-Grasp the right utilization of their knowledge in their streams of Technology/Engineering/Management/any other area of study to ensure mutual fulfilment. E.g. mutually enriching production system with rest of nature.

CO-4-Sincerely evaluate the course and share with their friends. They are also able to suggest measures to make the course more effective and relevant.

CO-5-Make use of their understanding in the course for the happy and prosperous family and society.

CO-PO Mapping

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

TEST BOOKS:

1. The Textbook - A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1
2. The Teacher's Manual- Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, RR Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53

REFERENCE BOOKS:

1. JeevanVidya: EkParichaya, A Nagaraj, JeevanVidyaPrakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj – Pandit Sunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)

COMPUTATIONAL LAB

Semester: IV **Year: 2022-23**

Course	Code	Credits	Total Hours - 24 Hours /Week		Assessment		Exam Duration in hrs
			Lecture	Practical	SEE	CIE	
Computational Lab	22AEG411	01	01	00	50	50	03

OBJECTIVES:

1. Understand the basics of Solid Edge 2D and its applications in engineering.
2. Acquire proficiency in creating and editing 2D drawings using Solid Edge.
3. Develop skills in dimensioning and annotating drawings for clear communication.
4. Explore methods for creating accurate geometric constraints and relationships.
5. Familiarize yourself with advanced tools and features for enhancing 2D drawings.
6. Apply acquired knowledge to solve real-world engineering problems using Solid Edge.

COURSE DETAILS:

Introduction to Solid Edge 2D, Introduction to Solid Edge 2D interface and workspace Understanding files management and project organization, Sketching and Drawing Tools, Creating and modifying 2D sketches, Exploring different sketching techniques and tools, Using geometric constraints to control sketch behaviour, Dimensioning and Annotations, Adding accurate dimensions to sketches and drawings, Understanding different dimensioning systems (metric, imperial), Annotating drawings with text, symbols, and callouts, Creating and managing parts in Solid Edge and simple line diagrams (i.e Simple Rankine Cycle, Open cycle OTEC, Closed cycle OTEC , steam power plant, Diesel power plant, Energy conversion wind power plant, Reheat cycle ,Regenerative cycle, Vapour dominated or dry steam system and Indian digester.

COURSE OUTCOMES

At the end of this course, student should be able to:

	COURSE OUTCOMES	RBT LEVEL
CO1	Comprehend different tools, dimensions and constraints to sketches for accurate design representation.	L2
CO2	Understand layout of vapour power cycle, OTEC, Diesel cycle, steam power plant and vapour dominated.	L2
	Total Number Lecture Hours	**24**
	NOTE: All levels mentioned are as per Revised Bloom's Taxonomy	

CO-PO Mapping:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1		1					2		2
CO2	3	2	1		1					2		2

Scheme of Examination:

Write-up : 25 Marks
Demonstration : 25 Marks
Total : 50 Marks

ADDITIONAL MATHEMATICS-II

Semester: IV **Year: 2022-23**

Course	Code	Credits	Total Hours - 25 Hours /Week		Assessment		Exam Duration in hrs
			Lecture	Practical	SEE	CIE	
Additional Mathematics-II	22MATDIP41	00	03	01		50	03

COURSE OBJECTIVES:

1. Solve first order differential equations. .
2. Solve second and higher order differential equations.
3. Understand and solve the partial differential equation.
4. To acquire the knowledge of elementary probability theory.
5. Know the basic concepts of evaluation of double and triple integrals.

MODULE 1: DIFFERENTIAL EQUATIONS - 1

Differential Equation-1: Solution of first order and first degree differential equations: Variable separable, Homogeneous, Exact and Reducible to exact differential equation, Linear differential equation. Applications of first order first degree differential equations: Newton's law of cooling.

05 Hours

MODULE 2: DIFFERENTIAL EQUATIONS - 2

Differential Equations-2: Solution of second & higher order Ordinary linear differential equation with constant co-efficients. Method of variation of parameters. Solution of homogeneous LDE by Power series solution Method. 05 Hours

MODULE 3: PARTIAL DIFFERENTIAL EQUATIONS (PDE's)

Partial Differential Equations(PDE's): Formation of PDE by eliminating arbitrary constant & functions, Solution of Non-homogeneous PDE by direct integration, solution of homogeneous PDE with respect to one independent variable only. Derivation of one dimensional wave equation and heat equation and Various possible solution of wave & heat equations by methods of separation of variables. 05 Hours

MODULE 4: IMPROPER INTEGRALS

Improper Integrals: Beta and gamma functions and its properties and examples. Evaluation of double integral over a specific region, changing the order of integration, changing into polar form.

05 Hours

MODULE 5: PROBABILITY

Probability: Introduction , Sample space and Events. Axioms of Probability, Addition & Multiplication theorems. Conditional probability- illustrative examples. Baye's theorem-examples. 05 Hours

COURSE OUTCOMES

At the end of this course, student should be able to

	COURSE OUTCOMES	RBT LEVEL
CO1	Apply the knowledge of differential equation of first order to solve examples based on Newton's law of cooling.	L5

CO2	Solve second and higher order differential equations occurring in of electrical circuits , damped/un-damped vibrations. Explain the applications of Power series and obtain series solution of ordinary differential equations.	L5
CO3	Construct a variety of partial differential equations and solution by exact Methods / method of separation of variables.	L5
CO4	Apply the concept of change of order of integration and variables to evaluate multiple integrals and their usage in computing the area and volumes.	L5
CO5	Apply the knowledge of Probability to solve the simple real life problems	L5
	Total Number Lecture Hours	**25**
	NOTE: All levels mentioned are as per Revised Bloom's Taxonomy	

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1		1				1			1
CO2	3	2	1		1				1			1
CO3	3	2	1		1				1			1
CO4	3	2	1		1				1			1
CO5	3	2	1		1				1			1

TEACHING LEARNING PROCESS:

CIE + Assignments: 15+35=50 Marks

There will be a 2 CIE's, the best one among 2 CIE's will be considered and there will be a 35 marks for Assignments

TEXT BOOKS:

1. B.S. Grewal : Higher Engineering Mathematics, Khanna Publishers, 43rd Ed., 2015.
2. E. Kreyszig : Advanced Engineering Mathematics, John Wiley & Sons, 10th Ed.(Reprint), 2016.

REFERENCE BOOKS:

1. C.Ray Wylie, Louis C.Barrett : "Advanced Engineering Mathematics", 6th Edition, McGraw-Hill Book Co., New York, 1995.
2. James Stewart : "Calculus –Early Transcendentals", Cengage Learning India Private Ltd., 2017.
3. B.V.Ramana : "Higher Engineering Mathematics" 11th Edition, Tata McGraw-Hill, 2010.
4. Srimanta Pal & Subobh C Bhunia:"Engineering Mathematics", Oxford University Press,3rd Reprint,2016.
5. Gupta C.B., Singh S.R. and Mukesh Kumar : "Engineering Mathematics for Semester I & II", Mc-Graw Hill Education (India) Pvt.Ltd., 2015.

Continuous Internal Evaluation (CIE)
Record Details
2022 Scheme (2022-2026 Batch)

Each Course/Subject has five modules:

- **Module 1**
- **Module 2**
- **Module 3**
- **Module 4**
- **Module 5**

- **50% of the syllabus must be covered before IA – I, and the remaining 50% must be covered before IA – II.**
- **IA – I and IA – II are compulsory for all students. IA – III will be conducted as an improvement test for the syllabus of IA – I or IA – II, as required. If needed, students can attend the improvement tests for both IA – I and IA – II.**

Continuous Internal Evaluation Marks Break-Up

Sl. No.	Particulars	Max. Marks
1.	Internal Assessment (IA) (IA – I and IA – II)	15
2.	Assignment	25
3.	Library and Seminar (02+03)	05
4.	Attendance	05
	Total	**50**

Table 01: Internal Assessment Marks

Sl. No.	Particulars	Max. Marks
1.	Internal Assessment – I	30
2.	Internal Assessment – II	30
3.	Internal Assessment – III (Improvement IA – I)	30
4.	Internal Assessment – III (Improvement IA– II)	30
	Average Marks (IA – I and IA – II)	**30**
Note: Final Average Marks should be reduced to 15		

Table 02: Other Component

Sl. No.	Particulars	Max. Marks
1.	Assignment	25
2.	Library and Seminar (02+03)	05
3.	Attendance	05
	Average Marks (IA – I and IA – II)	**35**
Note: Final Average Marks should be reduced to 25		

Final Marks = Table 1 + Table 2
Example: Final Marks = 14+35
= 49/5

Sharnbasva University, Kalaburagi
Faculty of Engineering & Technology (Co-Edu.)
Scheme of Teaching and Examination 2022-23
[As Per NEP, Outcome Based Education (OBE) and Choice Based Credit System (CBCS) Scheme]
(Effective from the academic year 2022-23)

Programme: B.Tech: Energy Engineering

V SEMESTER

Sl. No.	Course Code		Course Title	Teaching Department	Teaching Hours/week			Examination				Credits
					Theory/Lecture	Tutorial	Practical/ Drawing	Duration in Hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	HSS	22HSM51	Engineering Economics	EEG	3	0	0	3	50	50	100	03
2	PCC	22EG52	Fluid Machinery	EEG	4	0	0	3	50	50	100	04
3	PCC	22EG53	Python for Energy Engineering	EEG	3	0	0	3	50	50	100	03
4	PEC	22EG54X	Professional Elective Course-I	EEG	3	0	0	3	50	50	100	03
5	OEC	22EG55X	Open Elective Course-I	EEG	4	0	0	3	50	50	100	04
6	PCC	22EGL56	Fluid Machinery Lab	EEG	0	0	2	3	50	50	100	01
7	PCC	22EGL57	Python Lab for Energy Engineering	EEG	0	0	2	3	50	50	100	01
8	PEC	22EGL58	Electrical Machines Lab -2	EEG	0	0	2	3	50	50	100	01
9	PW	22PRJ59	Project-V	EEG	0	0	2	3	50	50	100	01
10	AEC	22AEG510	Ability Enhancement Course-V	EEG	0	0	2	3	50	50	100	01
Total					**17**	**0**	**10**	**30**	**500**	**500**	**1000**	**22**

Note: PCC- Programme Core Course, PEC- Professional Elective Course, PW-Project Work, HSS-Humanity and Social Science, OEC- Open Elective Course, AEC- Ability Enhancement Course.

Project (PRJ): A Batch of 4 students (Same Branch or Different Branches with a Guide, May undertake one project.

Professional Elective Course-I (For EG Students)	
Course Code	**Course Title**
22EG541	Reaction Engineering and Combustion
22EG542	MEMS - Micro Electro Mechanical System

Open Elective Course-I (For NON EG Students)	
Course Code	**Course Title**
22EG551	Energy and Environment
22EG552	Non-Conventional Energy Resources

Ability Enhancement Course-V	
Course Code	**Course Title**
22AEC510	Entrepreneurship and Development
AICTE Activity Points: In case students fail to earn the prescribed activity points, eighth semester Grade Card shall be issued only after earning the required activity points. Student shall be admitted for the award of the degree only after the release of the Eighth semester Grade Card.	

ENGINEERING ECONOMICS

Semester: V

Course	Code	Credits	Total Hours - 45 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Engineering Economics	**22HSM51**	**03**	**03**	**00**	**50**	**50**	**03**

COURSE OBJECTIVES:

1. To provide the students with knowledge of basic economic problems and the relationship between engineering technology and economics.
2. To alert the students to understand the demand determinates and the methods of demand forecasting of a product.
3. To give knowledge to the students about various costs for determining the manufacturing of a product.
4. To guide the students for accounting the depreciation and providing the funds for replacement of necessary and depreciated machinery and equipment.
5. To sensitize the students to the changing environment of banking scenario and to understand the functions of RBI.

MODULE-1

Introduction to Economics- Economics-Flow in an Economy, Law of Supply and Demand, Concept of Engineering Economics- Types of Efficiency, Definition and Scope of Engineering Economics, Elements of Costs, Other Costs/Revenues-Marginal Cost, Marginal Revenue, Sunk Cost, Opportunity Cost, Break-Even Analysis, Profit/Volume Ratio (P/V Ratio).

Elementary Economic Analysis – Introduction, Examples for Simple Economic Analysis-Material Selection for a Product/Substitution of Raw Material, Design Selection for a Product, Building Material Selection, Process Planning/Process Modification. **09 Hours**

MODULE-2

Interest Formulas and Their Applications- Introduction, Time Value of Money, Interest Formulas-Single-Payment Compound Amount, Single-Payment Present Worth Amount, Equal-Payment Series Compound Amount, Equal-Payment Series Sinking Fund, Equal-Payment Series Present Worth Amount, Equal-Payment Series Capital Recovery Amount, Uniform Gradient Series Annual Equivalent Amount, Effective Interest Rate.

Present worth Method of Comparison- Introduction, Revenue-dominated Cash Flow Diagram, Cost-dominated Cash Flow Diagram, Examples. **09 Hours**

MODULE-3

Future worth Method- Introduction, Revenue-dominated Cash Flow Diagram, Cost-dominated Cash Flow Diagram, Examples.

Annual Equivalent Method- Introduction, Revenue-dominated Cash Flow Diagram, Cost dominated Cash Flow Diagram, Alternate Approach, Examples. Rate of Return Method-Introduction, Examples. **09 Hours**

MODULE-4

Replacement and Maintenance Analysis – Introduction, Types of Maintenance, Types of Replacement Problem, Determination of Economic Life of an Asset, Replacement of Existing Asset with a New Asset- Capital Recovery with Return, Concept of Challenger and Defender, Simple Probabilistic Model for Items Which Fail Completely.

Deprecation- Introduction, Methods of Depreciation-Straight Line Method of Depreciation, Declining Balance Method of Depreciation, Sum-of-the-Years-Digits Method of Depreciation, Sinking Fund Method of Depreciation, service Output Method of Depreciation. **09 Hours**

MODULE-5

Make or Buy Decision- Introduction, Criteria for Make or Buy, Approaches for Make or Buy Decision -Simple Cost Analysis, Economic Analysis, Break-even Analysis.

Value Analysis/Value Engineering- Introduction, When to Apply Value Analysis -Value Analysis vs. Value Engineering, Function, Aims, Value Engineering Procedure, Advantages and Application Areas. **09 Hours**

COURSE OUTCOMES:

At the end of this course, student will be able to

CO#	COURSE OUTCOMES
CO1	Understand concept of economics, and analyses the material selection, design selection for product.
CO2	Understand the time value of money, methods, and evaluate, compare engineering projects.
CO3	Understand future worth methods, Annual Equivalent method and rate of return method.
CO4	Comprehend the concept of replacement, maintenance and Depreciation.
CO5	Understand the concept of make and buy, criteria and factors, functions of value engineering.

CO-PO Mapping

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	-	-	1	-	1	-	-	-	2
CO2	-	1	1	1	1	-	-	2	1	-	2	1
CO3	2	1	1	-	-	1	-	1	-	-	1	-
CO4	1	1	1	-	-	-	-	1	-	-	-	-
CO5	2	-	-	1	1	2	-	2	1	-	-	1

TEXT BOOKS:

1. Engineering Economics, Panneer Selvam, R, Prentice Hall of India Ltd, New Delhi, 2001.
2. Engineering Economy, Riggs J.L., 4TH ed., McGraw Hill, 2002 2.
3. Engineering Economy, Thuesen H.G. PHI, 2002

REFERENCES:

1. Engineering Economy, Tarachand, 2000.
2. Industrial Engineering and Management, OP Khanna, Dhanpat Rai & Sons. 2000

3. Financial Mangement, Prasanna Chandra, 7th Ed., TMH, 2004
4. Finacial Management, IM PANDEY, Vikas Pub. House, 2002

SCHEME OF EXAMINATION:

Two questions to be set from each module. Students have to answer five full questions choosing at least one full question from each module.

FLUID MACHINERY

Semester: V

Course	Code	Credits	Total Hours - 45 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Fluid Machinery	22EG52	03	03	00	50	50	03

COURSE OBJECTIVES:

1. Understand typical design of Turbo machine, their working principle, application and thermodynamics process involved.
2. Study the conversion of fluid energy to mechanical energy in Turbo machine with utilization factor and degree of reaction.
3. Analyse various designs of steam turbine and their working principle
4. Study the various designs of hydraulic turbine based on the working principle.
5. Understand the various aspects in design of power absorbing machine

MODULE-1

Introduction: Definition of turbo machine, parts of turbo machines, Comparison with positive displacement machines, Classification, Dimensionless parameters and their significance, Unit and specific quantities, model studies and its numerical.

(Note: Since dimensional analysis is covered in Fluid Mechanics subject, questions on dimensional analysis may not be given. However, dimensional parameters and model studies may be given more weightage.)

Thermodynamics of fluid flow: Application of first and second law of thermodynamics to turbo machines, Efficiencies of turbo machines, Static and Stagnation states, overall isentropic efficiency, stage efficiency (their comparison) and polytropic efficiency for both compression and expansion processes. Reheat factor for expansion process. Simple Numerical on-stage efficiency and polytropic efficiency. **09 Hours**

MODULE-2

Energy exchange in Turbo machines: Euler's turbine equation, Alternate form of Euler's turbine equation, Components of energy transfer, General Analysis of Turbine, Degree of Reaction, utilization factor, Relation between degree of reaction and Utilization factor, Axial Flow Turbine, Velocity triangles for different values of degree of reaction, Problems.

General Analysis of Turbo machines: General analysis of axial flow pumps and compressors, Energy Exchange, degree of reaction, velocity triangles, **Radial flow compressors and pumps – general analysis,** Expression for degree of reaction, velocity triangles, Effect of blade discharge angle on energy transfer and degree of reaction, Numerical Problems. **09 Hours**

MODULE-3

Steam Turbines: Classification, Single stage impulse turbine, condition for maximum blade efficiency, stage efficiency, Need and methods of compounding, multi-stage impulse turbine, expression for maximum utilization factor, Numerical Problems.

Reaction turbine – Parsons's turbine, condition for maximum utilization factor, reaction staging. Numerical Problems. **09 Hours**

MODULE-4

Hydraulic Turbines: Classification, various efficiencies. Pelton Wheel – Principle of working, velocity triangles, design parameters, maximum efficiency, and numerical problems.

Francis turbine – Principle of working, velocity triangles, design parameters, and numerical problems.

Kaplan and Propeller turbines - Principle of working, velocity triangles, design parameters and Numerical Problems. Theory and types of Draft tubes. **09 Hours**

MODULE-5

Centrifugal Pumps: Classification and parts of centrifugal pump, different heads and efficiencies of centrifugal pump, Theoretical head – capacity relationship, Minimum speed for starting the flow, Maximum suction lift, Net positive suction head, Cavitation, Need for priming, Pumps in series and parallel problems.

Centrifugal Compressors: Stage velocity triangles, slip factor, power input factor, Stage work, Pressure developed, stage efficiency and surging and problems. **09 Hours**

COURSE OUTCOMES:

At the end of this course, student should be able to

CO#	COURSE OUTCOMES
CO1	Model studies and thermodynamics analysis of turbo machines.
CO2	Analyse the energy transfer in Turbo machine with degree of reaction and utilisation factor.
CO3	Classify, analyse and understand various type of steam turbine.
CO4	Classify, analyse and understand various type of hydraulic turbine.
CO5	Understand the concept of radial power absorbing machine and the problems involved during its operation.

CO-PO Mapping

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	2	-	-	2	-	-	-	2
CO2	2	2	3	2	2	-	2	2	-	-	-	3
CO3	3	3	3	3	2	2	1	2	-	-	-	2
CO4	3	3	2	3	1	2	2	2	-	-	-	2
CO5	2	3	2	2	1	1	1	2	-	-	-	3

TEXT BOOKS:

1. An Introduction to Energy Conversion, Volume III, Turbo machinery, V. Kadambi and Manohar Prasad, New Age InternationalPublishers, reprint 2008
2. Turbo machines, M. S. Govindegowda and A. M. Nagaraj, M. M. Publications, 7Th Ed, 2012
3. Fundamentals of Turbo Machinery, B.K Venkanna, PHI Publishers

REFERENCE:

1. Turbines, Compressors & Fans, S. M. Yahya, Tata McGraw Hill Co. Ltd, 2nd edition, 2002
2. Principals of Turbo machines, D. G. Shepherd, The MacmillanCompany, 1964

3. Fluid Mechanics & Thermodynamics of Turbo machines, S. L. Dixon, Elsevier, 2005

SCHEME OF EXAMINATION:

Two questions to be set from each module. Students have to answer five full questions choosing at least one full question from each module.

PYTHON FOR ENERGY ENGINEERING

Semester: V

Course	Code	Credits	Total Hours - 45 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Python for Energy Engineering	22EG53	03	03	00	50	50	03

COURSE OBJECTIVES:

1. Develop Python programming skills, including syntax, data structures, and functions.
2. Master data handling, manipulation, and visualization using libraries like pandas and numpy.
3. Apply energy systems modeling and simulation techniques, including optimization and forecasting.
4. Implement machine learning algorithms for energy analytics and predictive modeling.
5. Analyze real-world energy data through case studies and develop predictive models for renewable energy.

MODULE-1

Introduction to Python Programming: Python Basics: Syntax, data types, and variables, Basic operators and expression, Control flow: loops and conditionals. **Functions and Modules**: Defining and calling functions, Function arguments and return values, Importing and using standard libraries and modules. **Data Structures**: Lists, tuples, dictionaries, and sets, Comprehensions for lists and dictionaries. **09 Hours**

MODULE-2

Data Handling and Analysis: Working with Data: Reading and writing data files (CSV, Excel, JSON) Introduction to libraries: pandas and numpy, Data manipulation and cleaning with pandas. **Data Visualization**: Basic plotting with matplotlib, Advanced visualization with seaborn, Interactive plots with plotly or bokeh. **Statistical Analysis**: Descriptive statistics Data correlation and regression analysis. **09 Hours**

MODULE-3

Energy Data Modeling and Simulation: Energy Systems Modeling: Introduction to energy systems and their components, Mathematical modeling of energy systems. Simulation Techniques: Time series analysis and forecasting. Monte Carlo simulations for energy predictions. Optimization: Basic optimization techniques (e.g., linear programming). Using scipy for optimization problems in energy systems. **09 Hours**

MODULE-4

Energy Analytics and Machine Learning: Introduction to Machine Learning: Supervised vs. unsupervised learning, Overview of common algorithms (e.g., regression, classification, clustering). **Machine Learning Libraries**: Using scikit-learn for building models. Data pre-processing and feature selection. **Energy-specific Applications**: Predictive maintenance and anomaly detection. Demand forecasting and load prediction. **09 Hours**

MODULE-5

Real-World Applications and Case Studies: Case Studies in Energy Engineering: Analysis of real-world energy data sets. Case studies on renewable energy sources, energy efficiency, and smart grids. **Predictive Models:** Solar energy, wind energy, tidal energy, geothermal energy and biomass energy. **09 Hours**

COURSE OUTCOMES:

At the end of this course, student should be able to

CO#	COURSE OUTCOMES
CO1	Write and debug Python code effectively using fundamental constructs and libraries.
CO2	Read, clean, and visualize data, performing analysis with pandas, numpy, and visualization tools.
CO3	Conduct simulations and solve optimization problems for energy systems using appropriate techniques.
CO4	Build and evaluate machine learning models for energy applications using scikit-learn.
CO5	Analyze and solve energy engineering problems using case studies and predictive modeling for various energy sources.

CO-PO Mapping

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	0	2	1	3	1	0	1	0	0	0	1
CO2	2	2	3	1	3	1	0	1	0	1	0	1
CO3	3	3	2	2	3	1	0	2	0	2	0	1
CO4	3	3	2	1	2	1	0	2	0	1	0	1
CO5	3	3	2	1	1	1	0	2	1	1	0	1

TEXT BOOKS:

1. Python Programming: Using Problem Solving Approach: Reema Thareja
2. R. Nageswara Rao, "Core Python Programming", dreamtech
3. Allen B. Downey, ``Think Python: How to Think Like a Computer Scientist,2nd edition, Updated for Python 3, Shroff/O,,Reilly Publishers, 2016.
4. Python Programming: A Modern Approach, Vamsi Kurama, Pearson.
5. Python for Renewable Energy Applications: Abdellatif M. Sadeq 1st edition February 2024.

REFERENCE BOOKS:

1. Core Python Programming, W.Chun, Pearson.
2. Introduction to Python, Kenneth A. Lambert, Cengage.
3. Learning Python, Mark Lutz, Orielly.
4. Fundamentals and Applications of Renewable Energy, 1st Edition, Mehmet Kanoğlu, 2020 McGraw-Hill Education.

Websites/E-Sources/Video Lectures:

1. https://www.youtube.com/watch?v=ERCMXc8x7mc
2. https://www.w3schools.com/python/

3. https://www.geeksforgeeks.org/python-programming-language/
4. https://www.youtube.com/watch?v=yNiEJzFrqjE&list=PLmJzSa3IrL46RzXP2Ka0YUrH4vJ9UyRXM
5. https://education.nationalgeographic.org/resource/renewable-energy/

SCHEME OF EXAMINATION:

Two questions to be set from each module. Students have to answer five full questions choosing at least one full question from each module.

REACTION ENGINEERING AND COMBUSTION

Semester: V

Course	Code	Credits	Total Hours - 45 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Reaction Engineering and Combustion	**22EG541**	**03**	**03**	**00**	**50**	**50**	**03**

COURSE OBJECTIVES:

1) To understand basic concepts of Reaction, Rate equation & its theories, Energies involved.
2) To understand Chemical Catalysis and analysis of fuel properties.
3) To know different types of fuels available, their composition and handling.
4) To analyze stoichiometry & kinetics of combustion process.
5) To study in detail about flame and Combustion appliances.

MODULE-1

Introduction to Reaction Engineering: Scope of Reaction Engineering, Typical Chemical Process, Classification of reactions. Applications in Energy Engineering, Rate of a chemical reaction, Factors affecting rate of reaction, Rate equation, Concertation-dependent term of rate equation, Rate constants & its units, Reaction Mechanism (Elementary & Non elementary reactions and its comparison).

Molecularity of a reaction, Orders of reaction, Activation Energy and its significance, Temperature-dependent term of Rate Equation (Temperature dependency of rate constant from Arrhenius Law, Collision theory and Transition state theory. **09 Hours**

MODULE-2

Chemical Catalysis & Fuels: Chemical Catalysis: Nature of Catalytic Reactions, Classification, Preparation, Properties, Catalytic Promoters, Accelerators and Inhibitors & poisons, Steps in a Catalytic Reaction, Industrial Catalysts, Catalysis applications.

Fuels: Characteristics and Properties, Types of fuels - solid, liquid and gaseous, Determination of fuel composition, Testing of Fuels: viscosity, flash point, pour point, aniline point, carbon residue, Diesel index, octane and cetane number, moisture content. Higher and lower heating values of fuels. **09 Hours**

MODULE-3

Types of Fuels: Solid fuels: Coal: Types, Composition, Analysis & properties, Processing (Preparation, Carbonation, Liquefaction, Gasification). Liquid Fuels: Origin, composition, classification, Processing, Important petroleum products, storage and handling.

Gaseous Fuels: Different types of gaseous fuels – Natural and Manufactured fuel gases, Cleaning & Purification, applications. Manufactured fuels: Bio-Fuels - types, production processes, properties related to combustion, handling and storage, importance and applications. **09 Hours**

MODULE-4

Combustion Process: Stoichiometry and Thermodynamics: Stoichiometry - Theoretical and actual combustion process, Flue gas analysis, Numerical Problems. Combustion thermodynamics - Heat

of Combustion, Enthalpy of formation and enthalpy of combustion, Estimation of minimum amount of air required, Air fuel ratio, Numerical Problems,
Combustion Kinetics: Chemical kinetics in combustion processes (Significance, Principles and Applications), Types, Oxy-rich combustion, Dew point of products. Pollutant formation and Control in Combustion - CO, Soot, NOX and SOX. Formation of Ash. **09 Hours**

MODULE-5

Combustion Technology: Combustion Technology: Flame, flame properties, Types (Laminar Diffusion & Turbulent Flames) - Physical description, Factors influencing flame velocity and thickness, flame stabilization, Flame temperature calculations.
Combustion appliances: Gas burner & types, Oil Burner (Vaporising, atomizing, drip feed system,), Coal burning equipment (Hand firing, Mechanical stroker, Pulverised coal firing, Cyclone firing, Fluidised bed combustion). Combustion control and Modelling**.** **09 Hours**

COURSE OUTCOMES

At the end of this course, student should be able to

CO#	COURSE OUTCOMES
CO1	Understand and apply the theories of chemical reactions, equilibrium and energy involved.
CO2	Summaries importance of Catalysis and Fuel properties.
CO3	Understand different types of fuels, its combustion and handling
CO4	Apply stoichiometry to evaluate combustion performance and its exhaust.
CO5	Comprehend types of flames and combustion appliances.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	1	-	1	-	2	-	-	-	2
CO2	3	2	2	2	-	2	-	2	-	-	-	2
CO3	3	3	3	2	-	2	-	2	-	-	-	3
CO4	3	2	2	2	2	2	2	2	-	-	-	2
CO5	2	2	2	2	2	2	2	2	-	-	-	2

TEXT BOOKS:

1. "Chemical Reaction Engineering", Octove Levelspil, Wiley Eastern Ltd.
2. "Chemical Kinetics", Keith Laidler, Harper and Row
3. "Fuels & Combustion", Dr. Samir Sarkar, 3rd ed., Universities Press.
4. "Fuels & Combustion", S.P. Sharma & Chander Mohan, Tata McGraw Hill Publishing Co. Ltd

REFERENCES BOOKS:

1. "Elements of Chemical Reaction Engineering", H. S. Fogler; 3rd Edition; Prentice-Hall of India
2. Irvin Glassman, "Combustion" 2nd ed., Academic Press.

SCHEME OF EXAMINATION:

Two questions to be set from each module. Students have to answer five full questions choosing at least one full question from each module.

MEMS- MICRO ELECTRO MECHANICAL SYSTEM

Semester: V

Course	Code	Credits	Total Hours - 45 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
MEMS- Micro Electro Mechanical System	22EG542	03	03	00	50	50	03

COURSE OBJECTIVES:

1. Students are exposed to the MEMS technology & Miniaturization.
2. Students will understand the Process of Micro fabrication Techniques.
3. Students are made to understand the principles of system modelling.
4. Students are made to understand the working principles of Mechanical sensors and actuators.
5. Students are made to understand the working principles of Micro-Opto-Electro Mechanical Systems.

MODULE-1

MEMS: Introduction, Production Engineering, Precision Engineering and Ultra- Precision Engineering, Integrated circuits, Micro Electro Mechanical Systems. **09 Hours**

MODULE-2

Micromachining: Introduction, Photo Lithography, Structural and Sacrificial Materials, Etching, Surface Micromachining, Bulk versus Surface Micromachining, Wafer Bonding, LIGA. **09 Hours**

MODULE-3

System Modelling: Introduction, Need for Modelling, System types, Basic Modelling Elements In Mechanical System, Basic Modelling Elements In Electrical Systems, Basic Modelling Elements In Fluid Systems and Thermal Systems. **09 Hours**

MODULE-4

Mechanical sensors and actuators: Introduction, Principles of Sensing and Actuation, Beam and Cantilever, Micro Plates, Capacitive Effects, Piezo Electric Material as Sensing and Actuating Elements. **09 Hours**

MODULE-5

Micro-opto-Electro Mechanical Systems: Introduction, Fundamental Principles of MOEMS Technology, Review on Properties of Light, Light Modulators, Micro mirrors, Digital Micro mirror Device. **09 Hours**

COURSE OUTCOMES:

At the end of this course, student should be able to

CO#	COURSE OUTCOMES
CO1	Understand the working of MEMS technology & Miniaturization.
CO2	Explain the Process of Micro fabrication Techniques.

CO3	Explain the principles of system modelling.
CO4	Understand the working principles of Mechanical sensors and actuators.
CO5	Describe the working principles of Micro-Opto-Electro Mechanical systems.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	1	-	1	-	2	-	-	-	2
CO2	2	3	2	1	-	2	-	2	-	-	-	3
CO3	3	2	2	1	-	2	-	2	-	-	-	2
CO4	3	2	2	1	-	2	-	2	-	-	-	2
CO5	3	2	2	1	-	2	-	2	-	-	-	2

TEXTBOOKS:

1. MEMS- Nitaigour Premchand Mahalik, TMH 2007.
2. Micro and Smart Systems: G.K.Ananthasuresh, K.J.Vinoy, S.Gopalakrishnan,
3. K.N.Bhat,V.K.Aatre,Wiley India 2010.

REFERENCE:

1. Design and Development Methodogies, Smart Material Systems and MEMS: V. Varadan, K. J. Vinoy, S. Goplakrishnan, Wiley.
2. MEMS & Microsystems: Design and Manufacture, Tai-Ran Hsu, Tata Mc-Graw-Hill.

SCHEME OF EXAMINATION:

Two questions to be set from each module. Students have to answer five full questions choosing at least one full question from each module.

ENERGY AND ENVIRONMENT

Semester: V

Course	Code	Credits	Total Hours - 50 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Energy and Environment	22EG551	04	04	00	50	50	03

COURSE OBJECTIVES:

1. To understand the fundamentals of energy sources, energy use, energy efficiency, and resulting environmental implications of various energy supplies.
2. To introduce various aspects of environmental pollution and its control.
3. To understand the causes and remedies related to social issues like global warming, ozone layer depletion, climate change etc.
4. To introduce various acts related to prevention and control of pollution of water and air, forest protection act, wild life protection act etc.

MODULE-1

Basic Introduction to Energy: Energy and power, forms of energy, primary energy sources, energy flows, world energy production and consumption, Key energy trends in India: Demand, Electricity, Access to modern energy, Energy production and trade, Factors affecting India's energy development: Economy and demographics Policy and institutional framework, Energy prices and affordability, Social and environmental aspects, Investment. **10 Hours**

MODULE-2

Energy storage systems: Thermal energy storage methods, Energy saving, Thermal energy storage systems Energy Management: Principles of Energy Management, Energy demand estimation, **Energy pricing Energy Audit:** Purpose, Methodology with respect to process Industries, Characteristic method employed in Certain Energy Intensive Industries. **10 Hours**

MODULE-3

Environment: Introduction, Multidisciplinary nature of environmental studies- Definition, scope and importance, Need for public awareness.

Ecosystem: Concept, Energy flow, Structure and function of an ecosystem. Food chains, food webs and ecological pyramids, Forest ecosystem, Grassland ecosystem, Desert ecosystem and Aquatic ecosystems, Ecological succession. **10 Hours**

MODULE-4

Environmental Pollution: Definition, Cause, effects and control measures of - Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution and nuclear hazards, Solid waste Management, Disaster management Role of an individual in prevention of pollution, Pollution case studies. **10 Hours**

MODULE-5

Social Issues and the Environment: Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies. Wasteland reclamation, Consumerism

and waste products, Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation. **10 Hours**

COURSE OUTCOMES:

At the end of this course, student should be able to

CO#	COURSE OUTCOMES
CO1	Summarize the basic concepts of energy, its distribution and general Scenario.
CO2	Explain different energy storage systems, energy management, audit and economic analysis.
CO3	Summarize the environment eco system and its need for awareness.
CO4	Identify the various types of environment pollution and their effects.
CO5	Discuss the social issues of the environment with associated acts
	Total Number Lecture Hours
	NOTE: All levels mentioned are as per Revised Bloom's Taxonomy

CO-PO Mapping

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	1	-	1	1	1	-	-	-	1
CO2	3	2	-	1	-	1	1	2	-	-	-	1
CO3	2	1	-	1	-	2	1	1	-	-	-	2
CO4	2	1	-	1	-	2	1	1	-	-	-	1
CO5	2	1	-	1	-	2	1	1	-	-	-	1

TEXTBOOKS:

1. Textbook for Environmental Studies for Undergraduate Courses of all Branches of Higher Education University grant commission and Bharathi Vidyapeeth Institute of environment education and Research, Pune.
2. Energy Management Audit & Conservation- for Module 2 Barun Kumar De Vrinda Publication 2nd Edition 2010.

REFERENCE:

1. Energy Management Hand book Turner, W. C., Doty, S. and Truner, W. C Fairmont Press 7th Edition 2009.
2. Energy Management Murphy, W. R Elsevier 2007
3. Energy Management Principles Smith, C. B Pergamum 2007
4. Environment pollution control Engineering C S Rao New Age International reprint 2015, 2nd edition
5. Environmental studies Benny Joseph Tata McGraw Hill 2nd edition

SCHEME OF EXAMINATION:

Two questions to be set from each module. Students have to answer five full questions choosing at least one full question from each module.

NON-CONVENTIONAL ENERGY RESOURCES

Semester: V

Course	Code	Credits	Total Hours - 50 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Non-Conventional Energy Resources	22EG552	04	04	00	50	50	03

COURSE OBJECTIVES:

1. To introduce the concepts of solar energy, its radiation, collection, storage and application.
2. To introduce the concepts and applications of Wind energy, Biomass energy, Geothermal energy and Ocean energy as alternative energy sources.
3. To explore society's present needs and future energy demands.
4. To examine energy sources and systems, including fossil fuels and nuclear energy, and then focus on alternate, renewable energy sources such as solar, biomass (conversions), wind power, geothermal, etc.
5. To get exposed to energy conservation methods.

MODULE-1

Introduction to Energy Sources: Energy sources and their availability, non-conventional sources, advantages of renewable energy sources, prospects of renewable energy sources.

Solar Energy: Solar energy collectors – flat plate collectors and concentrating collectors, solar energy storage systems – mechanical, electrical, chemical and electro-magnetic, solar pond, applications of solar energy – solar water heating, solar distillation, solar cooking. **10 Hours**

MODULE-2

Wind Energy: Basic principles of wind energy conversion, site selection considerations, basic components of Wind Energy Conversion System (WECS), classification of WECS, Wind energy collectors – horizontal axis machines and vertical axis machines, generating systems, applications of wind energy.

Geothermal Energy: Geothermal sources, hydrothermal resources – vapor dominated and liquid dominated systems, hybrid plants – geothermal preheat and fossil superheat; applications of geothermal energy, advantages and disadvantages of geothermal energy. **10 Hours**

MODULE-3

Energy from Biomass: Biomass conversion technologies, photosynthesis, biogas generation, factors affecting biogas generation, classification of biogas plants – floating drum plants and fixed dome plants, selection of site for biogas plant, utilization of biogas;

Methods for obtaining energy from biomass, biomass gasification, classification of biomass gasifiers, fixed bed gasifiers and fluidized bed gasifiers, applications of gasifiers, advantages and limitations of gasifiers. **10 Hours**

MODULE-4

Chemical Energy sources: Fuel cells -principle of operation of fuel cell, types of fuel cells – hydrogen-oxygen, solid-oxide, alkaline, polymer electrolyte membrane fuel cells, advantages, disadvantages and conversion efficiency of fuel cells, applications of fuel cells.

Energy from the oceans: Ocean thermal energy conversion-open cycle and closed cycle systems, energy from tides – basic principle of tidal power, components of tidal power plants, single basin and double basin systems, ocean waves – wave energy conversion systems. **10 Hours**

MODULE-5

Magneto Hydro Dynamic (MHD), Thermo-electric and Thermo-ionic Power Generations: Principles of MHD power generation – open cycle and closed cycle – advantages and limitations. Basic principles of thermo-electric and thermo-ionic power generation – advantages and limitations.

Energy Conservation: Economic concept of energy, principles of energy conservation and energy audit, energy conservation technologies, co-generation, waste heat utilization, combined cycle power generation. **10 Hours**

COURSE OUTCOMES:

At the end of this course, student should be able to

	COURSE OUTCOMES
CO1	Describe the environmental aspects of non-conventional energy resources, use of solar energy and the various components used in the energy production.
CO2	Appreciate the need of Wind Energy and Geothermal energy with various components used in energy generation and know the classifications.
CO3	Understand the concept of Biomass energy resources.
CO4	Comprehend the need of chemical and ocean energy with various components used in energy generation.
CO5	Understand the concept of MHD power generation and Energy Conversion concept.

CO-PO Mapping

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	1	1	2	-	-	-	-	3
CO2	3	2	3	2	1	1	1	-	-	-	-	3
CO3	3	3	2	2	1	1	1	-	-	-	-	3
CO4	3	3	2	2	1	1	1	-	-	-	-	3
CO5	3	2	2	2	1	1	1	-	-	-	-	2

TEXTBOOKS:

1. G.D. Rai, Non-Conventional energy sources, 5th Edition, Khanna Publishers, 2011.

REFERENCE BOOKS:

1. D.P. Kothari, R. Rakesh and K.C. Singal, Renewable Energy Resources and Emerging Technologies, 2nd Edition, Prentice India Pvt. Ltd, 2011.
2. G.S. Sawhney, Non-Conventional Energy Sources, 1st Edition, Prentice India Pvt. Ltd, 2012.
3. G.N. Tiwari and M.K. Ghosal, Renewable Energy Resources: Basic Principles and Applications, 1st Edition, Alpha Science International Ltd, 2004.

SCHEME OF EXAMINATION:

Two questions to be set from each module. Students have to answer five full questions choosing at least one full question from each module.

FLUID MACHINERY LAB

Semester: V

Course	Code	Credits	Total Hours		Assessment		Exam Duration in hrs
			Hours /Week				
			Lecture	Practical	SEE	CIE	
Fluid Machinery Lab	**22EGL56**	**01**	**00**	**03**	**50**	**50**	**03**

COURSE OBJECTIVES:

1. To gain knowledge in performance testing of Hydraulic Turbines and Hydraulic Pumps at constant speed and Head.
2. To provide practical knowledge in verification of principles of fluid flow.
3. Enrich the concept of fluid mechanics and hydraulic machines.
4. Demonstrate the classical experiments in fluid mechanics and hydraulic machinery.
5. Discuss the performance characteristics of turbines and pumps.

LIST OF EXPERIMENTS:

PART-A

1) To determine total head, pump output, overall efficiency and pump efficiency of Gear Pump Test Rig.
2) To determine total head, pump output, overall efficiency and pump efficiency of the submersible pump of Submersible Pump Test Rig
3) To find out discharge of useful water and waste water. To find out the efficiency of the Hydraulic ram of Hydraulic Ram Test Rig,
4) To determine total head, pump output, overall efficiency and pump efficiency of the Jet pump
5) To study the pipes in parallel and series.

PART-B

6) Performance on hydraulic Turbines
   a. Pelton wheel
   b. Francis Turbine
7) Performance of Kaplan Turbines.
8) Performance of Single stage and Multi stage centrifugal pumps.
9) Performance of reciprocating pump.
10) Performance test on a two stage Reciprocating Air Compressor

COURES OUTCOMES:

At the end of the course the student will be able to:

CO#	COURSE OUTCOMES
CO1	Understand the performance of hydraulic turbine and pumps under different working conditions.
CO2	Comprehend the knowledge in calculating performance analysis in turbines and pumps and can be used in power plants.

CO-PO Mapping

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	-	-	1	1	1	-	-	2
CO2	3	2	1	1	-	-	1	1	1	-	-	2

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Scheme of Examination:

ONE question from par –A: 20 Marks
ONE question from part –B: 20Marks
Viva -Voice: : 10 Marks
Total: : 50 Marks

PYTHON LAB FOR ENERGY ENGINEERING

Semester: V

Course	Code	Credits	Total Hours		Assessment		Exam Duration in hrs
			Hours /Week				
			Lecture	Practical	SEE	CIE	
Python Lab for Energy Engineering	**22EGL57**	**01**	**00**	**03**	**50**	**50**	**03**

COURSE OBJECTIVES:

1. Understand and Apply Key Renewable Energy Principles
2. Develop Python Programs for Energy Calculations
3. Optimize Energy Systems with Python Programming
4. Simulate and Analyze Phase Changes and Energy Efficiency

LIST OF EXPERIMENTS:

PART-A

1. Python program to calculate solar energy generation based on inputs such as solar panel efficiency, area, solar irradiance and sunlight hour.
2. Python program to calculate wind energy generation based on inputs such as wind speed, air density, and swept area of the turbine blades.
3. Python program to calculate the power generated in a hydroelectric power plant based on inputs such as water flow rate and the height of the water falling.
4. Python program to calculates the energy generated by a nuclear power plant based on inputs such as power output and operating time.
5. Python program to calculate the energy generated from biomass energy based on inputs such as the mass of biomass and its energy content.

PART-B

6. Python program to calculate the Efficiency of a Geothermal Power Plant based on input such as heat input and electrical output.
7. Python program to calculate the Energy Generated by a Combined Heat and Power (CHP) Plant based on input such as electric power output & heat recovery.
8. Python program to calculate the Energy Output from a Fuel Cell based on current and voltage.
9. Python program to calculate the Energy Produced by a Tidal Power System based on input of water flow rate, height of water falling & system efficiency.
10. Python program to calculate the Heat Energy Required for a Phase Change Process based on input such as mass of substance and latent heat of phase change.

COURES OUTCOMES:

At the end of the course the student will be able to:

CO#	COURSE OUTCOMES
CO1	Ability to Develop Python Programs for Renewable Energy Systems
CO2	Proficiency in Simulating and Analyzing Energy Efficiency
CO3	Competence in Calculating Energy Requirements for Phase Change Processes

CO4	Comprehensive Understanding of Integrated Energy Solutions

CO-PO Mapping

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	2	3	0	0	0	0	0	0	3
CO2	2	3	2	2	3	0	0	0	0	0	0	3
CO3	2	3	2	2	3	0	0	0	0	0	0	3
CO4	2	3	2	2	3	0	0	0	0	0	0	3

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Scheme of Examination:

ONE question from par –A: 20 Marks
ONE question from part –B: 20Marks
Viva -Voice: : 10 Marks
Total: : 50 Marks

ELECTRICAL MACHINES LAB -2

Semester: V

Course	Code	Credits	Total Hours		Assessment		Exam Duration in hrs
			Hours /Week				
			Lecture	Practical	SEE	CIE	
Electrical Machine Lab-2	**22EGL58**	**01**	**00**	**03**	**50**	**50**	**03**

COURSE OBJECTIVES:

1. To perform tests on dc machines to determine their characteristics.
2. To control the speed of dc motor.
3. To conduct test for pre-determination of the performance characteristics of dc machines
4. To conduct load test on single phase and three phase induction motor.
5. To conduct test on induction motor to determine the performance characteristics.

LIST OF EXPERIMENTS:

PART-A

1. Load test on DC shunt motor to draw speed–torqnutes and horse power–efficiency characteristics.
2. Load test on DC generator.
3. Field **te**st on DC series motor.
4. Speed control of DC shunt motor by armature and field control.
5. Swinburne's test

PART-B

6. Retardation test- electrical braking method
7. Hopkinson's test
8. Voltage regulation of alternator by EMF and MMF methods
9. Voltage regulation of alternator by ZPF methods
10. Slip test on alternator

COURES OUTCOMES:

At the end of the course the student will be able to:

CO#	COURSE OUTCOMES
CO1	Test DC machines to determine their characteristics and also to control the speed of DC motor.
CO2	Pre-determine the performance characteristics of DC machines by conducting suitable tests.
CO3	Perform load test on single phase and three phase induction motor to assess its performance.
CO4	Conduct test on induction motor to pre-determine the performance characteristics.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1						1	1			1
CO2	2	1						1	1			1

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.

3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Scheme of Examination:

ONE question from par –A: 20 Marks
ONE question from part –B: 20Marks
Viva -Voice: : 10 Marks
Total: : 50 Marks

PROJECT-V

Semester: V

Course	Code	Credits	Total Hours		Assessment		Exam Duration in hrs
			Hours /Week				
			Lecture	Project	SEE	CIE	
Project-V	**22PRJ59**	**01**	**00**	**02**	**50**	**50**	**03**

OBJECTIVES:

To Introduce fundamental concepts and analysis techniques in engineering to students across all disciplines.

Mini-Project Work:

Based on the ability/abilities of the students and recommendations of the mentor, a single discipline or a multidisciplinary Mini-Project can be assigned to an individual student or to a group having not more than 4 students.

COURSE OUTCOMES

At the end of this course, student should be able to:

	COURSE OUTCOMES
CO1	Comprehend how to identify issues related to environment, society and industry.
CO2	Able to prepare the model and report on society, environment and industry related projects.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	-	1	2	2	1	2	2	1	2
CO2	2	2	2	-	1	2	2	1	2	2	1	2

Scheme of Examination:

Write-up : 15 Marks
Demonstration : 25Marks
Viva -Voice: : 10 Marks
Total: : 50 Marks

ENTREPRENEURSHIP AND DEVELOPMENT

Semester: V

Course	Code	Credits	Total Hours		Assessment		Exam Duration in hrs
			Hours /Week				
			Lecture	Practical	SEE	CIE	
Entrepreneurship and Development	**22AEC510**	**01**	**00**	**02**	**50**	**50**	**03**

OBJECTIVE: The main objectives are to

1. Develop conceptual understanding of the entrepreneurship among the students.
2. Learn qualities of a "technopreneur" and explore various methods for identifying opportunities.
3. Learn basics of market research and provide evidence for the viability of the business idea.
4. Develop a viable business proposition and learn to pitch your ideas for various audiences.
5. Understand the dynamics of new venture development and team building.
6. Develop the ability to translate a business idea into marketing and financial plans.

COURSE CONTENTS

1. Evolution from Entrepreneurship to 'Technopreneur-ship'.
2. Creativity and entrepreneurship.
3. Entrepreneurial Motivation in the current economic scenario.
4. Innovation and inventions & Legal Protection of innovation.
5. New Ventures - Industrial Parks, Special Economic Zone, Export oriented units.
6. Incentives to Entrepreneurs.
7. Organizational Assistance to an entrepreneur.
8. Financial assistance by different agencies.
9. Rules and Legislations for entrepreneurs.
10. Basics of Project Report & Detailed Project Report.

COURSE OUTCOMES

At the end of this course, student should be able to:

CO#	COURSE OUTCOMES
CO1	Develop conceptual understanding of the entrepreneurship, learn qualities of a "technopreneur" and learn basics of market research and provide evidence for the viability of the business idea.
CO2	Develop a viable business proposition, Understand the dynamics of new venture development and develop the ability to translate a business idea into marketing and financial plans.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	-	1	2	2	1	2	1	1	2
CO2	3	2	2	-	1	2	2	1	2	1	1	2

Scheme of Examination:

Write-up	: 15 Marks
Demonstration	: 25Marks
Viva -Voice:	: 10 Marks
Total:	: 50 Marks

Sharnbasva University, Kalaburagi
Faculty of Engineering & Technology (Co-Edu.)
Scheme of Teaching and Examination 2022-23
[As Per NEP, Outcome Based Education (OBE) and Choice Based Credit System (CBCS) Scheme]
(Effective from the academic year 2022-23)

Programme: B.Tech: Energy Engineering

VI SEMESTER

Sl. No.	Course Code		Course Title	Teaching Department	Teaching Hours/week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in Hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	PCC	22EG61	Electrochemistry	EEG	3	0	0	3	50	50	100	03
2	PCC	22EG62	Artificial Intelligence and Data Science for Energy Engineering	EEG	3	0	0	3	50	50	100	03
3	PEC	22EG63X	Professional Elective Course-II	EEG	3	0	0	3	50	50	100	03
4	PEC	22EG64X	Professional Elective Course-III	EEG	3	0	0	3	50	50	100	03
5	OEC	22EG65X	Open Elective Course-II	EEG	4	0	0	3	50	50	100	04
6	PCC	22EGL66	Artificial Intelligence and Data Science for Energy Engineering Lab	EEG	0	0	2	3	50	50	100	01
7	PCC	22EGL67	Solar Energy Lab	EEG	0	0	2	3	50	50	100	01
8	PEC	22EGL68	Virtual Lab	EEG	0	0	2	3	50	50	100	01
9	PW	22PRJ69	Project-VI	EEG	0	0	2	3	50	50	100	01
10	HSS	22HSM610	Professional Ethics	EEG	1	0	0	3	50	50	100	01
11	AEC	22AEG611	Ability Enhancement Course-VI	EEG	0	0	2	3	50	50	100	01
Total					**17**	**0**	**10**	**33**	**550**	**550**	**1100**	**22**

Note: PCC-Professional Core Course, PEC-Professional Elective Course, OEC-Open Elective Course, PW-Project Work, HSS-Humanity and Social Science, AEC- Ability Enhancement Course. Internship- To be carried out during the vacation/s of VI and VII semesters or VII and VIII semesters

Project (PRJ): A Batch of 4 students (Same Branch or Different Branches with a Guide, May undertake one project.

Professional Elective Course-II (For EG Students)	
Course Code	**Course Title**
22EG631	Operations Research
22EG632	Solar Energy Utilization
Professional Elective Course-III (For EG Students)	
Course Code	**Course Title**
22EG641	Power Generation and System Planning
22EG642	Cryogenics
Open Elective Course (For Non EG Students)	
Course Code	**Course Title**
22EG651	Optimization Techniques in Engineering
22EG652	Power Plant Engineering
Ability Enhancement Course-V	
Course Code	**Course Title**
22AEC611	Information and Communication Technology (ICT)
AICTE Activity Points: In case students fail to earn the prescribed activity points, eighth semester Grade Card shall be issued only after earning the required activity points. Student shall be admitted for the award of the degree only after the release of the Eighth semester Grade Card.	

ELECTROCHEMISTRY

Semester: VI

Course	Code	Credits	Total Hours - 45 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Electrochemistry	22EG61	03	03	00	50	50	03

COURSE OBJECTIVES:

1. To understand the basic concepts of electrochemistry and Laws of Chemical thermodynamics.
2. To import knowledge on types of catalysis.
3. To understand the mechanism of chemical kinetics
4. To understand the principles and working of electrochemical techniques.
5. To understand concepts of types of Electroactive Layers and Electrodes.

MODULE-1

Introduction to Electrochemistry: Scope & applications of Electrochemistry in Energy Engineering, the nature of electrode reactions, Methods for studying electrode reactions, Electrolytes and Electrolysis, Application of electrolysis electrolytic conduction, factors affecting conductivity.

First law of thermodynamics, work, heat, and energy, standard enthalpy changes, temperature dependence of enthalpy changes, The second law of thermodynamics, concept of entropy, Helmholtz and Gibbs energies, chemical potential and fugacity **09 Hours**

MODULE-2

Electrochemical Cell & Electrolysis: Electrochemical cell - redox reaction, electrode potential, measurement and applications, Galvanic and electrolytic cells – electrochemical series and its significance - Nernst equation (derivation and Numerical problems).

Electrolysis: fundamentals, Faraday's laws of electrolysis, Features of Electro-catalysts, Comparison with Chemical catalysis, Electrolytes, Electrochemical reactors, Discussion on the mechanisms of hydrogen evolution and oxygen reduction reactions**.** **09 Hours**

MODULE-3

Electrode Kinetics: Electrode fundamentals, classification, Reference electrodes, Electrified interface, structure, and thermodynamics of electrified interface, Electrode kinetics, electrochemical systems of technological interest over.

Equilibrium exchange, current density, charge transfer resistance and polarizability of the interface – concepts of rate determining step, Determination of kinetics parameters. Determination of dissolved oxygen. **09 Hours**

MODULE-4

Electrochemical Techniques: Introduction, Ion selective electrodes, Principle and working of Coulometry, Potentiometry, Amperometry, Voltammetry- Linear Sweep Voltammetry and Cyclic Voltammetry.

Concepts of Faradaic impedance – derivation of kinetic parameters from impedance measurements - Principles of scanning probe techniques. **09 Hours**

MODULE-5

Electroactive Layers and Modified Electrodes: Chemically modified electrodes, Types and methods of modification – chemisorption, covalent bond formation, Polymer film coatings, inorganic materials, Langmuir-Blodgett (LB) methods.

Properties of the modified electrodes, electrochemistry at monolayer and multilayer modified electrodes, characterization of modified electrodes. Industrial applications. **09 Hours**

COURSE OUTCOMES

At the end of this course, student should be able to

CO#	COURSE OUTCOMES
CO1	Comprehend the basics of electrochemistry and Laws of thermodynamics
CO2	Acquaint process and mechanisms of chemical catalysis
CO3	Acquire knowledge of Kinetics of reaction
CO4	Determine applications of Electrochemical techniques.
CO5	Evaluate the applications of Electroactive Layers and modified Electrodes

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	-	1	1	1	-	-	-	2
CO2	2	3	2	1	-	1	1	1	-	-	-	2
CO3	3	2	2	1	-	1	1	1	-	-	-	2
CO4	3	2	2	1	-	1	1	1	-	-	-	2
CO5	3	2	2	1	-	1	1	1	-	-	-	2

TEXT BOOKS:

1. Chemical Engineering Kinetics", Smith J.M., Mc Graw Hill.
2. "Chemical Kinetics", Keith Laidler, Harper and Row
3. Elements of Chemical Reaction Engineering; H. S. Fogler; 3rd Edition; Prentice-Hall of Indi

REFERENCES BOOKS:

1. Modern Electrochemistry, 2nd edition, by John O'M, Bockris and Amulaya Reddy.

SCHEME OF EXAMINATION:

Two questions to be set from each module. Students have to answer five full questions choosing at least one full question from each module.

ARTIFICIAL INTELLIGENCE AND DATA SCIENCE FOR ENERGY ENGINEERING

Semester: VI

Course	Code	Credits	Total Hours - 45 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Artificial Intelligence and Data Science for Energy Engineering	**22EG62**	**03**	**03**	**00**	**50**	**50**	**03**

COURSE OBJECTIVES:

1. Understand Core Concepts of AI, Data Science, and Machine Learning.
2. Master Data Handling and Pre-processing Techniques.
3. Develop Skills in Simulation and Optimization of Energy Systems.
4. Explore the Role of Smart Grids, IoT, and Control Systems in Energy Management.
5. Apply AI and IoE Technologies to Real-World Energy Challenges.

MODULE-1

Introduction to AI and Data Science: Definition and scope of AI and Data Science. Key differences between AI, ML, and Data Science. History and evolution of AI. Applications of AI and Data Science in various industries.

Data Fundamentals: Understanding data: types, sources, and formats (structured, unstructured). Data collection, cleaning, and pre-processing basics. Introduction to datasets and how they are used in AI and Data Science. **09 Hours**

MODULE-2

Machine learning: What is Machine Learning? Types of Machine Learning: Supervised, Unsupervised, and Reinforcement Learning. Basic ML workflow: Training and testing models.

Tools and Technologies: Introduction to popular tools: Python, Jupyter Notebook, and basic libraries (NumPy, Pandas, Matplotlib). Overview of AI platforms (TensorFlow, Scikit-learn).

09 Hours

MODULE-3

Simulation of Energy Systems with Python: Introduction to simulation: Monte Carlo methods and probabilistic analysis. Modeling renewable energy systems (solar, wind) using Python. Simulation of power flows in microgrids and smart grids. Case study: Simulating photovoltaic (PV) system performance.

Optimization Techniques in Energy Engineering: Basics of optimization: Objective functions, constraints, and solution methods. Linear and non-linear optimization using Pyomo and SciPy. Applications: Optimal power flow, energy dispatch, and battery management. Practical exercise: Optimizing the operation of a hybrid energy system. **09 Hours**

MODULE-4

Introduction to the Internet of Energy (IoE): Definition and evolution of IoE. Overview of energy systems: generation, transmission, distribution, and consumption. The role of digital transformation in energy. Key drivers and challenges in IoE implementation.

Introduction to Control Systems: Basic concepts of control systems: Open-loop vs. closed-: control. The role of controllers in feedback systems. Common applications of control systems. Understanding Proportional Integral Derivative (PID) Controllers: Definition of PID control and its importance, Components, Applications of PID Controllers, Challenges and Limitations of PID Controllers. **09 Hours**

MODULE-5

Smart Grids and Energy Management Systems: Fundamentals of smart grids. Smart meters and energy management systems. Demand response and grid balancing. Integration of renewable energy sources (solar, wind, etc.).

IoT in Energy Systems: IoT fundamentals and architecture. Sensors, actuators, and communication protocols. Data acquisition and monitoring. Case studies on IoT applications in energy (e.g., predictive maintenance, fault detection). **09 Hours**

COURSE OUTCOMES

At the end of this course, student should be able to

CO#	COURSE OUTCOMES
CO1	Understand the basics of AI, Data Science, and their industry applications.
CO2	Develop and apply basic Machine Learning models using key tools.
CO3	Simulate and optimize renewable energy systems using Python.
CO4	Explain IoE and PID control systems in energy management
CO5	Analyze smart grids and IoT applications in energy systems

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	1	0	0	0	0	1	0	1
CO2	3	2	1	1	3	0	0	2	0	1	0	1
CO3	3	2	2	1	3	0	0	2	0	1	0	1
CO4	3	2	1	1	3	0	0	2	0	1	0	1
CO5	3	2	2	1	2	0	0	2	0	1	0	1

TEXTBOOKS:

1. Data Science and Artificial Intelligence for Beginners by Dr. D.Venu Gopal, 2022 BlueRose Publishers Pvt. Ltd.
2. Python Programming: Using Problem Solving Approach: Reema Thareja
3. R. Nageswara Rao, "Core Python Programming", dreamtech
4. Python for Renewable Energy Applications: Abdellatif M. Sadeq 1st edition February 2024.
5. Internet of Energy Handbook, by Kumar, Dr. Pawan & Dong, Z & Nikolovski, Srete. (2021).

REFERENCE:

1. Core Python Programming, W.Chun, Pearson.
2. Fundamentals and Applications of Renewable Energy, 1st Edition, Mehmet Kanoğlu, 2020 McGraw-Hill Education.

Websites/E-Sources/Video Lectures:

1. https://www.youtube.com/watch?v=ERCMXc8x7mc
2. https://www.youtube.com/watch?v=MqffbpjhriQ
3. https://www.w3schools.com/python/
4. https://www.geeksforgeeks.org/python-programming-language/
5. https://www.youtube.com/watch?v=pWhLyV2MOf0
6. https://www.youtube.com/watch?v=yNiEJzFrqjE&list=PLmJzSa3IrL46RzXP2Ka0YUrH4vJ9UyRXM
7. https://education.nationalgeographic.org/resource/renewable-energy/

SCHEME OF EXAMINATION:

Two questions to be set from each module. Students have to answer five full questions choosing at least one full question from each module.

OPERATIONS RESEARCH

Semester: VI

Course	Code	Credits	Total Hours -45		Assessment		Exam Duration in Hours
			Hours/Week				
			Lecture	Tutorial	SEE	CIE	
Operations Research	**21EG631**	**03**	**03**	**00**	**50**	**50**	**03**

COURSE OBJECTIVES:

1. To understand the methodology of OR problem solving and formulate linear programming problem.
2. To develop formulation skills in LPP methods and Concept of Duality.
3. To develop formulation skills in transportation and assignment models for solutions.
4. To understand the basics in the field of game theory and sequencing.
5. To know how project management techniques help in planning, scheduling project basics of CPM and Queening Theory.

MODULE-1

Introduction: Evolution of OR, Definitions of OR, Scope of OR, Applications of OR, Phases in OR study. Characteristics and limitations of OR, models used in OR.

Linear Programming Problem (LPP): Generalized LPP- Formulation of problems as L.P.P. Solutions to LPP by graphical method (Two Variables). **09 Hours**

MODULE-2

LPP by Simplex method: Canonical and standard form of LP problem, slack, surplus and artificial variables, Solutions to LPP by Simplex method, Big-M Method and Two-Phase Simplex Method, Degeneracy in LPP.

Concept of Duality: writing Dual of given LPP. Solutions to L.P.P by Dual Simplex Method **09 Hours**

MODULE-3

Transportation Problem: Formulation of transportation problem, types, initial basic feasible solution using North-West Corner rule, Vogel's Approximation method. Optimality in Transportation problem by Modified transportation problems Distribution (MODI) method. Unbalanced T.P. Maximization T.P. Degeneracy in, application of transportation problem.

Assignment Problem: Formulation, Solutions to assignment problems by Hungarian method, Special cases in assignment problems, unbalanced, Maximization assignment problems. Travelling Salesman Problem (TSP). Difference between assignment and T.S.P, Finding best route by Little's method. Numerical Problems. **09 Hours**

MODULE-4

Game Theory: Definition, Pure Strategy problems, Saddle point, Max-Min and Min-Max criteria, Principle of Dominance, Solution of games with Saddle point, Mixed Strategy problems. Solution of 2X2 games by Arithmetic method, Solution of 2Xn m and mX2 games by graphical method. Formulation of games.

Sequencing: Basic assumptions, Johnson's algorithm, sequencing 'n' jobs on single machine using priority rules, sequencing using Johnson's rule-'n' jobs on 2 machines, 'n' jobs on 3 machines, 'n' jobs on 'm' machines. Sequencing of nm2 jobs on 'm' machines using graphical method. **09 Hours**

MODULE-5

Critical path Method: to find the expected completion time of a project, determination of floats in networks, PERT networks, determining the probability of completing a project, predicting the completion time of project; Cost analysis in networks, Crashing of networks- Problems.

Queuing Theory: Queuing systems and their characteristics, Pure-birth and Pure-death models (only equations), Kendall & Lee's notation of Queuing, empirical queuing models – Numerical on M/M/1 and M/M/C Queuing models**.** **09 Hours**

COURSE OUTCOMES

At the end of this course, student should be able to

	COURSE OUTCOMES
CO1	Know the meaning, definitions, scope, need, phases and techniques of operations research.
CO2	Formulate linear programming problems by graphical method, Simplex method, Big-M method and Dual simplex method.
CO3	Formulate as Transportation and Assignment problems.
CO4	Solve problems on game theory and job sequencing.
CO5	Study and analyse CPM, PERT and queuing models.

CO-PO Mapping

PO / CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	2	1	-	-	-	-	2	-	-	-	-
CO2	1	2	1	1	-	-	-	1	-	-	-	-
CO3	1	2	1	1	-	-	-	1	-	-	-	-
CO4	1	2	1	1	-	-	-	1	-	-	-	-
CO5	1	1	-	1	-	-	-	1	-	-	-	-

TEXT BOOKS:

1. Operations Research, P K Gupta and D S Hira,S. Chand and Company LTD. Publications, New Delhi – 2
2. Operations Research, Theory and Applications, Sixth Edition, J K Sharma, Trinity Press, Laxmi Publication.
3. Operations Research, An Introduction, Seventh Edition, Hamdy A. Taha, PHI Private Limited, 2006.

REFERENCES:

1. Operations Research, A M Natarajan, P Balasubramani, PearsonEducation, 2005
2. Operations Research, Hillier and Lieberman,8th Ed., McGraw Hill
3. Operations Research, 4th edition, Kalavathy S, Vikas Publishing House PVT.LTD – New Delhi.
4. Operation Research, P Shankara Iyer, Mc graw Hill Higher Education, 2008. New Delhi.
5. Operations Research An Introduction., P Mariappan. Pearson Education India., 1971

SCHEME OF EXAMINATION:

Two questions to be set from each module. Students have to answer five full questions choosing at least one full question from each module.

SOLAR ENERGY UTILIZATION

Semester: VI

Course	Code	Credits	Total Hours - 45 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Solar Energy Utilization	22EG632	03	03	00	50	50	03

COURSE OBJECTIVES:

1. To provide the sufficient knowledge of concept, applications, importance of solar energy.
2. To enable them to understand the measurement of solar radiation using various instruments.
3. To familiarize the students about the solar energy and its applications inreallifesituations
4. To enable them to know photovoltaic cell operation and economics of solar systems.

MODULE-1

Introduction: energy sources, Renewable energy sources, potential, Achievements in India, energy alternatives, Solar energy option, overview, devices for thermal collection and storage.
Thermal applications, Water and space heating, Power generation, Space cooling and refrigeration, Distillation, Drying, cooking and Grid connected solar pumping system. **09 Hours**

MODULE-2

Solar Radiation: Solar radiation outside atmosphere, Solar radiation at earth's surface, Instruments for measuring solar radiation and sunshine recorder, solar radiation data,
Solar radiation geometry, Empirical equations, prediction of availability of solar radiation, solar radiation on tilted surfaces. **09 Hours**

MODULE-3

Liquid flat plate collectors: Performance analysis, Transmissivity of cover, transmissivity-absorptivity product, Overall loss coefficient, hear transfer correlations, Collector efficiency factor, Collector heat removal factor, Numerical problems, Effect of various parameters on performance, Analysis of collectors, transient analysis, testing procedures, Alternative to conventional collectors. **09 Hours**

MODULE-4

Concentrating Collectors: Introduction, Flat plate collectors with plane reflectors, cylindrical parabolic collector, compound parabolic collectors, parabolic dish collector. Central receiver collector, tracking, numerical problems. Solar air heaters: performance analysis, types, testing procedures. **09 Hours**

MODULE-5

Photo-Voltaic Conversion: Solar cell, working principles, conversion efficiency, commercial solar cells, applications Economics: Principles of Economic Analysis – Discounted cash flow – Solar system – life cycle costs – cost benefit analysis and optimization – cost-based analysis of water heating and photo voltaic applications**.** **09 Hours**

COURSE OUTCOMES

At the end of this course, student should be able to

CO#	COURSE OUTCOMES
CO1	Identify the significance and applications of various solar energy devices and instrument for measuring Solar radiation.
CO2	Understand the concept of solar radiation geometry and empirical equation for solar radiation.
CO3	Analyse the performance by conducting research on flat plate collector, air heater and concentrating type collector
CO4	Analyse the overall loss coefficient, heat transfer correlation, collector efficiency factors in collectors and propose necessary solutions.
CO5	Evaluate the issue related to photovoltaic conversion efficiency and economical aspects.

CO-PO Mapping

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	-	-	1	1	1	-	-	-	2
CO2	3	2	2	-	-	1	1	1	-	-	-	2
CO3	3	2	2	-	-	1	1	1	-	-	-	2
CO4	3	2	2	-	-	1	1	1	-	-	-	2
CO5	3	2	2	-	-	1	1	1	-	-	-	2

TEXTBOOKS:

1. Solar Energy-Principles of energy conversion and storage, S P Sukhatme, Tata McGraw hill co., New Delhi.
2. Solar Energy Utilisation, G. D. Rai, Khanna publishers, New-Delhi
3. Solar energy: Principles of Thermal Collection and Storage/ Sukhatme/TMH/2nd edition
4. Solar energy/Garg/TMH
5. Solar Thermal Engineering Systems /Tiwari and Suneja/ Narosa

REFERENCE:

1. Solar engineering of Thermal processes, Duffy J A and Beckman, W. A. John Wiley & Sons, New York.
2. Solar energy/Magal/McGraw Hill
3. Power plant Technology/ El Wakil/TMH

SCHEME OF EXAMINATION:

Two questions to be set from each module. Students have to answer five full questions choosing at least one full question from each module

POWER GENERATION AND SYSTEM PLANNING

Semester: VI

Course	Code	Credits	Total Hours - 45 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Power Generation and system Planning	22EG641	03	03	00	50	50	03

COURSE OBJECTIVES:

1. To introduce the concepts of steam power plant, coal and ash handling and boiler.
2. To introduce the concepts and applications of Chimneys, Accessories for the Steam Generator, and boiler.
3. To understand the concept and application of hydroelectric plant and advance power cycles.
4. To know the utilization of nuclear power plant and diesel power plant
5. To get exposed to site selection and economic analysis of power plant.

MODULE-1

Steam Power Plant: Different types of fuels used for steam generation, Equipment for burning coal in lump form, strokers, different types and Oil burners.

Pulverised fuel Coal and Ash Handling: Advantages and Disadvantages of using pulverised fuel, Equipment for preparation and burning of pulverised coal, unit system and bin system. Pulverised fuel furnaces, cyclone furnace, Coal and Ash handling. **09 Hours**

MODULE-2

Chimneys and Cooling Towers: Natural, forced, induced and balanced draft, Calculations involving height of chimney to produce a given draft. Study of different types of cooling towers.

Accessories for the Steam Generator and Boilers: Accessories for the Steam Generator such as super-heaters, desuperheater, , Economisers, Air Pre-heaters**,** Generation of steam using forced circulation, high and supercritical pressures, A brief account of LaMount, Benson, Velox, and Schmidt steam generators. **09 Hours**

MODULE-3

Hydro Electric Plant: Storage and pondage, flow duration and mass curves, hydrographs, Low, medium and high head plants, pumped storage plants, Penstock, water hammer, surge tanks, gates and valves, power house, general layout. A brief description of some of the important Hydel Installations in India.

Advanced Power Cycles: Kalina (Cheng) Cycle, Integrated gasification combined cycle (IGCC), Atmospheric Fluidised Bed Combustion Boilers (AFBC), Pressurised Fluidised Bed Combustion (PFBC). **09 Hours**

MODULE-4

Nuclear Power Plant: Principles of release of nuclear energy Fusion and fission reactions. Nuclear fuels used in the reactors. Multiplication and thermal utilization factors. Elements of the Nuclear reactor, Moderator, control rod, fuel rods, coolants. Brief description of reactors of the following types - Pressurized water reactor, boiling water reactor, Sodium graphite reactor, Homogeneous graphite reactor and gas cooled reactor, Radiation hazards, Radioactive waste disposal.

Diesel Engine: Method of starting diesel engines, Cooling and lubrication system for the diesel engine. Filters, centrifuges, Oil heaters, Intake and exhaust system, Layout of a diesel power plant.

09 Hours

MODULE-5

Choice of site: Choice of site for power station, load estimation, load duration curve, load factor, capacity factor, use factor, diversity factor, demand factor, Effect of variable load on power plant, selection of the number and size of units.

Economic Analysis of power plant: Cost of energy production, selection of plant and generating equipment, performance and operating characteristics of power plants, tariffs for electrical energy

09 Hours

COURSE OUTCOMES

At the end of this course, student should be able to

CO#	COURSE OUTCOMES
CO1	Understand the concepts of steam power plant, coal and ash handling and boiler and their practical application.
CO2	Comprehend the concepts and applications of Chimneys and boiler.
CO3	Analyse the concept and application of hydroelectric plant and advance power cycles.
CO4	Know the utilization of nuclear power plant and diesel power plant.
CO5	Understand the site selection and economic analysis of power plant.

CO-PO Mapping

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	-	1	1	1	-	-	-	2
CO2	3	2	2	1	-	1	1	1	-	-	-	2
CO3	3	2	2	1	-	1	1	1	-	-	-	2
CO4	3	2	2	1	-	1	1	1	-	-	-	2
CO5	3	2	2	1	-	1	1	1	-	-	-	2

TEXTBOOKS:

1. Power Plant Engineering, P.K. Nag, McGrawHill, 4th Edition, 2014
2. Generation of Electrical Energy, B.R.Gupta, S. Chand, 2015
3. Electrical power Generation, Transmission and Distribution, S.N. Singh, PHI 2nd Edition, 2009

REFERENCE:

1. A Course in Power Systems, J.B. Gupta, Katson, 2008
2. Electrical Power Distribution Systems, V. Kamaraju McGrawHill, 1Edition, 2009
3. A Text Book on Power System Engineering, A.Chakrabarti, et al, DhanpathRai, 2nd Edition, 2010
4. Electrical Distribution Engineering, Anthony J. Pansini, CRC Press, 3rd Edition, 2006
5. Electrical Distribution Systems, Dale R PatrickEt al, CRC Press, 2nd Edition, 2009

SCHEME OF EXAMINATION:

Two questions to be set from each module. Students have to answer five full questions choosing at least one full question from each module.

CRYOGENICS

Semester: VI

Course	Code	Credits	Total Hours - 45 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Cryogenics	22EG642	03	03	00	50	50	03

COURSE OBJECTIVES:

1. To understand cryogenic system and gas liquefaction system
2. To analyze gas cycle cryogenic refrigeration system
3. To Comprehend gas separation and gas purification system
4. To have detailed knowledge of vacuum technology, insulation, storage of cryogenic liquids
5. To study applications of cryogenics and to embark on cryogenic fluid

MODULE-1

Introduction to Cryogenic Systems: Cryogenic propellants and its applications, liquid hydrogen, liquid nitrogen, and liquid Helium The thermodynamically Ideal system Production of low temperatures – Joule Thompson Effect, Adiabatic expansion.

Gas Liquefaction Systems: Liquefaction systems for Air Simple Linde –Hampson System, Claude System, Heylndt System, Dual pressure, Claude. Liquefaction cycle Kapitza System. Comparison of Liquefaction Cycles Liquefaction cycle for hydrogen, helium and Neon, Critical components of Liquefaction systems. **09 Hours**

MODULE-2

Gas Cycle Cryogenic Refrigeration Systems: Classification of Cryo coolers Stirling cycle Cryo – refrigerators, Ideal cycle – working principle. Schmidt's analysis of Stirling cycle, Various configurations of Stirling cycle refrigerators.

Integral piston Stirling cryo-cooler, Free displacer split type Stirling Cryo coolers, Gifford Mcmahon Cryo- refrigerator, Pulse tube refrigerator, Solvay cycle refrigerator, Vuillimier refrigerator, Cryogenic regenerators. **09 Hours**

MODULE-3

Gas Separation and Gas Purification Systems: Thermodynamic ideal separation system, Properties of mixtures, Principles of gas separation, Linde single column air separation. Linde double column air separation, Argon and Neon separation systems.

Ultra Low Temperature Cryo – Refrigerators: Magneto Caloric Refrigerator 3He-4He Dilution refrigerator. Pomeranchuk cooling. Measurement systems for low temperatures, Temperature measurement at low temperatures, Resistance thermometers, Thermocouples, Thermistors, Gas Thermometry. Liquid level sensors. **09 Hours**

MODULE-4

Vacuum Technology: Vacuum Technology: Fundamental principles. Production of high vacuum, Mechanical vacuum pumps, Diffusion pumps, Cryo-pumping, Measurement of high vacuum level.

Cryogenic Insulation: Heat transfer due to conduction, Evacuated porous insulation Powder & Fibers Opacified powder insulation, Gas filled powders & Fibrous materials Multilayer super-insulation, Composite insulation. **09 Hour**

MODULE-5

Cryogenic Fluid Storage and Transfer Systems: Design of cryogenic fluid storage vessels, Inner vessel, Outer Insulation, Suspension system, Fill and drain lines. Cryogenic fluid transfers, External pressurization, Self pressurization, Transfer pump.

Application of Cryogenic Systems: Cryogenic application for food preservation – Instant Quick-Freezing Techniques Super conductive devices, Cryogenic applications for space technology. Application of cryogenic systems, super conducting devices, space technology, cryogenic in biology and medicine. 09 **Hours**

COURSE OUTCOMES:

At the end of this course, student should be able to

CO#	COURSE OUTCOMES
CO1	To be able to understand the cryogenic system.
CO2	To have complete knowledge of cryogenic refrigeration system.
CO3	To be able to design gas separation and gas purification system.
CO4	To able to solve the problem in, insulation, storage of cryogenic liquids.
CO5	To be able to apply cryogenic in various areas and to be able take up research in cryogenics.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	1	-	1	1	1	-	-	-	2
CO2	3	2	2	1	-	1	1	1	-	-	-	2
CO3	3	2	2	1	-	1	1	1	-	-	-	2
CO4	3	2	2	1	-	1	1	1	-	-	-	2
CO5	3	2	2	1	-	1	1	1	-	-	-	2

TEXTBOOKS:

1. Cryogenic Systems – R.F. Barron
2. Cryogenic Engineering – R.B. Scott – D.Van Nostrand Company, 1959

REFERENCE BOOKS:

1. Cryogenic Process Engineering – K.D. Timmerhaus and T.M. Flynn, Plenum Press, New York,1989
2. High Vacuum Technology – A. Guthree – New Age International Publication
3. Experimental Techniques in Low Temperature Physics – G.K. White – Osford University Press

SCHEME OF EXAMINATION:

Two questions to be set from each module. Students have to answer five full questions choosing at least one full question from each module.

OPTIMIZATION TECHNIQUES IN ENGINEERING

Semester: VI

Course	Code	Credits	Total Hours - 50 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Optimization Techniques in Engineering	**22EG651**	**04**	**04**	**00**	**50**	**50**	**03**

COURSE OBJECTIVES:

1. To understand the methodology of OR problem solving and formulate linear programming problem.
2. To develop formulation skills in LPP methods and Concept of Duality.
3. To develop formulation skills in transportation models and finding solutions
4. To understand the basics in the field of game theory and assignment problems
5. To know how project management techniques help in planning, scheduling a project basics of CPM and Queening Theory.

MODULE-1

Introduction: Evolution of OR, Definitions of OR, Scope of OR, Applications of OR, Phases in OR study. Characteristics and limitations of OR, models used in OR.

Linear Programming Problem (LPP): Generalized LPP- Formulation of problems as L.P.P. Solutions to LPP by graphical method (Two Variables). **10 Hours**

MODULE-2

LPP by Simplex method: Canonical and standard form of LP problem, slack, surplus and artificial variables, Solutions to LPP by Simplex method, Big-M Method and Two Phase Simplex Method, Degeneracy in LPP.

Concept of Duality: writing Dual of given LPP. Solutions to L.P.P by Dual Simplex Method **10 Hours**

MODULE-3

Transportation Problem: Formulation of transportation problem, types, initial basic feasible solution using North-West Corner rule, Vogel's Approximation method. Optimality in Transportation problem by Modified transportation problems Distribution (MODI) method. Unbalanced T.P. Maximization T.P. Degeneracy in, application of transportation problem.

Assignment Problem: Formulation, Solutions to assignment problems by Hungarian method, Special cases in assignment problems, unbalanced, Maximization assignment problems. Travelling Salesman Problem (TSP). Difference between assignment and T.S.P, Finding best route by Little's method. Numerical Problems. **10 Hours**

MODULE-4

Game Theory: Definition, Pure Strategy problems, Saddle point, Max-Min and Min-Max criteria, Principle of Dominance, Solution of games with Saddle point. Mixed Strategy problems. Solution of 2X2 games by Arithmetic method, Solution of 2Xn m and mX2 games by graphical method. Formulation of games.

Sequencing: Basic assumptions, Johnson's algorithm, sequencing 'n' jobs on single machine using priority rules, sequencing using Johnson's rule-'n' jobs on 2 machines, 'n' jobs on 3 machines, 'n' jobs on 'm' machines. Sequencing ofnm2 jobs on 'm' machines using graphical method. **10 Hours**

MODULE-5

Critical path method to find the expected completion time of a project, determination of floats in networks, PERT networks, determining the probability of completing a project, predicting the completion time of project; Cost analysis in networks. Crashing of networks- Problems.

Queuing Theory: Queuing systems and their characteristics, Pure-birth and Pure-death models (only equations), Kendall & Lee's notation of Queuing, empirical queuing models – Numerical on M/M/1 and M/M/C Queuing models. **10 Hours**

COURSE OUTCOMES

At the end of this course, student should be able to

CO#	COURSE OUTCOMES
CO1	Understand the meaning, definitions, scope, need, phases and techniques of operations research.
CO2	Formulate linear programming problems by graphical method, Simplex method, Big-M method and Dual simplex method.
CO3	Formulate as Transportation and Assignment problems.
CO4	Solve problems on game theory and job sequencing.
CO5	Understand CPM, PERT and queuing models.

CO-PO Mapping

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	-	2	-	-	-	1
CO2	2	2	1	1	-	-	-	1	-	-	-	1
CO3	2	2	1	1	-	-	-	1	-	-	-	1
CO4	2	2	1	1	-	-	-	1	-	-	-	1
CO5	2	1	-	1	-	-	-	1	-	-	-	1

TEXT BOOKS:

1. Operations Research, P K Gupta and D S Hira,S. Chand and Company LTD. Publications, New Delhi – 2
2. Operations Research, Theory and Applications, Sixth Edition, J K Sharma, Trinity Press, Laxmi Publication.
3. Operations Research, An Introduction, Seventh Edition, Hamdy A. Taha, PHI Private Limited, 2006.

REFERENCES:

1. Operations Research, A M Natarajan, P Balasubramani, Pearson Education, 2005
2. Operations Research, Hillier and Lieberman,8th Ed., McGraw Hill
3. Operations Research, 4th edition, Kalavathy S, Vikas Publishing House PVT.LTD – New Delhi.
4. Operation Research, P Shankara Iyer, Mc graw Hill Higher Education, 2008. New Delhi.

5. Operations Research an Introduction., P Mariappan. Pearson Education India., 1971

SCHEME OF EXAMINATION:

Two questions to be set from each module. Students have to answer five full questions choosing at least one full question from each module.

POWER PLANT ENGINEERING

Semester: VI

Course	Code	Credits	Total Hours - 50 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Power Plant Engineering	**22EG652**	**04**	**04**	**00**	**50**	**50**	**03**

COURSE OBJECTIVES:

1. To introduce the concepts of steam power plant, coal and ash handling and boiler.
2. To introduce the concepts and applications of Chimneys, Accessories for the Steam Generator, and boiler.
3. To understand the concept and application of hydroelectric plant and Gas turbine
4. To know the utilization of nuclear power plant and diesel power plant
5. To get exposed to site selection and economic analysis of power plant.

MODULE-1

Steam Power Plant: Different types of fuels used for steam generation, Equipment for burning coal in lump form, strokers, different types and Oil burners.

Pulverised fuel Coal and Ash Handling: Advantages and Disadvantages of using pulverised fuel, Equipment for preparation and burning of pulverised coal, unit system and bin system. Pulverised fuel furnaces, cyclone furnace, Coal and Ash handling. **10 Hours**

MODULE-2

Chimneys and Cooling Towers: Natural, forced, induced and balanced draft, Calculations involving height of chimney to produce a given draft. Study of different types of cooling towers.

Accessories for the Steam Generator and Boilers: Accessories for the Steam Generator such as super-heaters, desuperheater, , Economisers, Air Pre-heaters**,** Generation of steam using forced circulation, high and supercritical pressures, A brief account of LaMount, Benson, Velox, and Schmidt steam generators. **10 Hours**

MODULE-3

Hydro Electric Plant: Storage and pondage, flow duration and mass curves, hydrographs, Low, medium and high head plants, pumped storage plants, Penstock, water hammer, surge tanks, gates and valves, power house, general layout. A brief description of some of the important Hydel Installations in India.

Gas Turbine Power Plant: Rankine Cycle, Advantages and disadvantages of the gas turbine plant, Open and closed cycle turbine plants with the accessories, intercooling and regeneration. **10 Hours**

MODULE-4

Nuclear Power Plant: Principles of release of nuclear energy Fusion and fission reactions. Nuclear fuels used in the reactors. Multiplication and thermal utilization factors. Elements of the Nuclear reactor, Moderator, control rod, fuel rods, coolants. Brief description of reactors of the following types - Pressurized water reactor, Boiling water reactor, Sodium graphite reactor, Homogeneous graphite reactor and gas cooled reactor, Radiation hazards, Radioactive waste disposal.

Diesel Engine: Method of starting diesel engines, Cooling and lubrication system for the diesel engine. Filters, centrifuges, Oil heaters, Intake and exhaust system, Layout of a diesel power plant. **10 Hours**

MODULE-5

Choice of site: Choice of site for power station, load estimation, load duration curve, load factor, capacity factor, use factor, diversity factor, demand factor, Effect of variable load on power plant, selection of the number and size of units.

Economic Analysis of power plant: Cost of energy production, selection of plant and generating equipment, performance and operating characteristics of power plants, tariffs for electrical energy.

10 Hours

COURSE OUTCOMES

At the end of this course, student should be able to

CO#	COURSE OUTCOMES
CO1	Understand the concepts of steam power plant, coal and ash handling and boiler and their practical application.
CO2	Comprehend the concepts and applications of Chimneys and boiler.
CO3	Analyze the concept and application of hydroelectric plant and Gas turbine.
CO4	Know the utilization of nuclear power plant and diesel power plant.
CO5	Understand the site selection and economic analysis of power plant

CO-PO Mapping

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	-	1	1	1	-	-	-	2
CO2	3	2	1	1	-	1	1	1	-	-	-	2
CO3	3	2	1	1	-	1	1	1	-	-	-	2
CO4	3	2	1	1	-	1	1	1	-	-	-	2
CO5	3	2	1	1	-	1	1	1	-	-	-	2

TEXTBOOKS:

1. Power Plant Engineering – P.C.Sharma / S.K.Kataria Pub
2. A Course in Power Plant Engineering: / Arora and S. Domkundwar.

REFERENCE BOOKS:

1. A Text Book of Power Plant Engineering / Rajput / Laxmi Publications
2. Power plant Engineering/ Ramalingam/ Scietech Publishers
3. Power Plant Engineering: P.K.Nag/ II Edition /TMH.
4. An Introduction to Power Plant Technology / G.D. Rai.

SCHEME OF EXAMINATION:

Two questions to be set from each module. Students have to answer five full questions choosing at least one full question from each module.

ARTIFICIAL INTELLIGENCE AND DATA SCIENCE FOR ENERGY ENGINEERING

Semester: VI

Course	Code	Credits	Total Hours		Assessment		Exam Duration in hrs
			Hours /Week				
			Lecture	Practical	SEE	CIE	
Artificial Intelligence and Data Science for Energy Engineering	**22EGL66**	**01**	**00**	**03**	**50**	**50**	**03**

COURSE OBJECTIVES:

1. Learn to model and simulate energy output for various renewable energy systems using Python.
2. Develop proficiency in applying Python for optimization problems in energy generation.
3. Understand the principles of different renewable energy technologies such as biomass, solar, wind, hydroelectric, and geothermal power.
4. Gain hands-on experience with Python libraries for linear and non-linear programming in energy system simulations.

LIST OF EXPERIMENTS:

(Developing Python Models & visualizations for Renewable Energy Systems)

1. BIOMASS POWER PLANT

As a renewable energy engineer, you are tasked with modeling and simulating the daily energy output of a biomass power plant. Your goal is to create a Python model that considers the calorific value of the biomass, the efficiency of the conversion process, and the daily feedstock availability to calculate the expected energy output.

The data is available at: https://files.fm/u/htqfrhg3cf

Perform the following tasks:

1. Familiarize yourself with the principles of biomass energy conversion to thermal and electrical energy.

2. Use the provided dataset that contains daily feedstock availability (in tons), average calorific value of the biomass (in MJ/kg), and the conversion efficiency of the power plant.

3. Build a model in Python to calculate the expected daily energy output, considering the conversion efficiency and calorific value.

4. Simulate the power plant's performance over a 30-day period.

Expected Outcome:

Using the provided data, calculate the total energy output (in MJ) for each day and then convert it to electrical energy (in kWh) considering the power plant's conversion efficiency. Generate a plot that shows the daily electrical energy output over the 30-day simulation period.

2. SOLAR PV SYSTEM

Simulate daily solar PV system output, modeling the impact of irradiance and temperature

on efficiency. The data is available at: https://files.fm/u/qntg35wesf

Perform the following tasks:

1. Understand the principles behind PV energy conversion.
2. Use the provided dataset with irradiance and temperature readings.
3. Build a model to calculate the expected energy output.
4. Simulate the PV system's performance over a day.

3. WIND TURBINE ENERGY

Given the hypothetical data of a wind turbine energy production over a 24-hour period available at the link: https://files.fm/u/pextkz35m5, the objective is to optimize the operational strategy of a wind farm over a 24-hour period. The challenge is to configure the operational schedule of a wind turbine to maximize the total energy production while considering the variability in wind conditions and technical limitations of the turbine.

Constraints and Considerations:

1. Wind Speed Constraints for the Turbine:

- ✓ Cut-in speed: 3.5 m/s (minimum wind speed to commence energy production)
- ✓ Rated speed: 15 m/s (wind speed at which maximum power output is reached)
- ✓ Cut-out speed: 25 m/s (wind speed at which the turbine must be shut down for safety)

2. Turbine Capacity:

- ✓ The turbine has a maximum power output capacity. For this example, it is given as 1500 kW.

3. Operational Flexibility:

- ✓ The turbine can be turned on or off depending on the wind conditions.
- ✓ The maintenance schedules ensure that the turbine will be non-operational during specific hours: 20:00, 21:00, 22:00, and 23:00.

Objective:

The goal is to maximize the cumulative power output of the wind farm over the 24-hour period, while ensuring the operational constraints are satisfied.

4. HYDROELECTRIC POWER PLANT

A hydroelectric power plant has a maximum daily capacity of 1000 MW. The plant operates for 24 hours and must generate power based on the following hourly demand requirements:

- ✓ 12:00 AM - 4:00 AM: 100 MW
- ✓ 4:00 AM - 8:00 AM: 200 MW
- ✓ 8:00 AM - 12:00 PM: 300 MW
- ✓ 12:00 PM - 4:00 PM: 400 MW
- ✓ 4:00 PM - 8:00 PM: 500 MW
- ✓ 8:00 PM - 12:00 AM: 600 MW

Assumptions and Constraints:

- ✓ The cost of generating power is $10 per MW for the first 500 MW and $15 per MW for any additional power generated.
- ✓ The plant must adhere to a minimum generation capacity of 50 MW at all times.
- ✓ The plant cannot exceed 700 MW of generation capacity at any given hour.
- ✓ The amount of power generated cannot increase or decrease by more than 200 MW per hour.
- ✓ The total cost of power generation should be minimized while meeting the hourly demand requirements.
- ✓ The plant must adhere to the minimum and maximum generation capacity constraints at all times.

Requirement:

Utilize Python libraries such as PuLP or Gurobi to formulate and solve the LP problem to determine the optimal generation schedule that satisfies the constraints and minimizes the cost of power generation.

5. GEOTHERMAL POWER PLANT

A geothermal power plant needs to optimize its power generation schedule over a 24-hour period to minimize the cost of power generation while meeting the hourly demand requirements. The plant has a maximum power generation capacity of 300 MW and a cost curve for power generation based on the amount of power generated. The objective is to minimize the total cost of power generation over the 24-hour period.

Specific Information:

Detailed Cost Function: The cost function is non-linear and can be modeled as follows:

$C(P) = 400P + 0.25P2$

Where C is the total cost of power generation, P is the power generated in MW. The cost function is valid for power generation up to 300 MW.

Operational Constraints:

1. The minimum generation capacity is 50 MW in any given hour.
2. Ramp Rate: The plant can increase or decrease the power output by a maximum of 40 MW per hour.
3. Start-up/Shut-down Costs: There are no start-up or shut-down costs.
4. Power Generation Limits: There is no minimum run time or maximum number of starts top cycles.
5. Cost of Deviation: There are no penalties or costs associated with deviating from the planned generation schedule.

Actual Hourly Demand: The demand for power in MW for each hour over the 24-hour period is as follows:

Hour	Power Demand (MW)	Hour	Power Demand (MW)
1	250	13	290
2	275	14	280
3	300	15	280
4	325	16	285

5	315	17	290
6	290	18	300
7	280	19	315
8	290	20	330
9	310	21	340
10	315	22	330
11	310	23	320
12	300	24	300

Requirement

Using a non-linear programming algorithm, formulate the optimization problem to minimize the total cost of power generation while adhering to the constraints mentioned above.

COURES OUTCOMES:

At the end of the course the student will be able to:

	COURSE OUTCOMES
CO1	Ability to model daily energy output of renewable systems using Python.
CO2	Competence in optimizing power generation schedules using Python libraries like PuLP and Gurobi.
CO3	Demonstrate skills in visualizing and analyzing energy production for solar PV and wind systems.
CO4	Ability to apply non-linear programming algorithms to minimize costs in energy systems such as geothermal and hydroelectric plants

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	2	2	0	0	0	0	0	0	2
CO2	2	3	2	2	2	0	0	0	0	0	0	2

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Scheme of Examination:

ONE question from par –A: 20 Marks
ONE question from part –B: 20Marks
Viva -Voice: : 10 Marks
Total: : 50 Marks

SOLAR ENERGY LAB

Semester: V

Course	Code	Credits	Total Hours		Assessment		Exam Duration in hrs
			Hours /Week				
			Lecture	Practical	SEE	CIE	
Solar Energy Lab	**22EGL67**	**01**	**00**	**03**	**50**	**50**	**03**

COURSE OBJECTIVES:

1. To carry out the performance evaluation of solar thermal system.
2. To optimize the performance of solar photovoltaic conversion devices to simulate the system using tools.

LIST OF EXPERIMENTS:

PART-A

1. Performance of solar power meter
2. Performance of Set of charts for sun shine recorder Digital.
3. Performance of Sun Shine Recorder Make: LYNX or Equivalent.
4. Performance to Measure diffused irradiance.
5. Performance of Solar shadow rings for above pyranometer for the item no 2 for diffused irradiance system.

PART-B

6. Performance of Solar Flat Plate Collector Apparatus.
7. Performance of Evacuative Tube Concentrator.
8. Performance of Solar Power Generation Kit.
9. Performance of Solar Concentrator (Parabolic) Training System.

COURES OUTCOMES:

At the end of the course the student will be able to:

CO#	COURSE OUTCOMES
CO1	To evaluate the performance of the solar devices.
CO2	To comprehend and analysis the different solar measuring devices.
	Total Number Lecture Hours
	NOTE: All levels mentioned are as per Revised Bloom's Taxonomy

CO-PO Mapping

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	1	-	1	1	1	1	-	-	1
CO2	2	1	1	1	-	1	1	1	1	-	-	1

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.

3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Scheme of Examination:

ONE question from par –A: 20 Marks
ONE question from part –B: 20Marks
Viva -Voice: : 10 Marks
Total: : 50 Marks

VIRTUAL LAB

Semester: VI

Course	Code	Credits	Total Hours		Assessment		Exam Duration in hrs
			Hours /Week				
			Lecture	Practical	SEE	CIE	
Virtual Lab	22EGL68	01	00	03	50	50	03

COURSE OBJECTIVES:

Upon successful completion of this laboratory, the students should be able to perform simulation on

1) Flow through Orifice and Venturi Meter experiment
2) Determination of pH, Alkalinity, COD, BOD and Dissolved Oxygen in Water.
3) Reaction kinetic studies in batch reactor and mixed flow reactor.
4) Performance Characteristics of Kaplan Turbine and Pelton Turbine.

LIST OF EXPERIMENTS:

PART-A

1. Flow through Orifice meter
2. Flow through Venturi meter
3. Determination of pH
4. Determination of Alkalinity in water
5. Determination of Biological Oxygen Demand
6. Determination of Chemical Oxygen Demand

PART-B

7. Determination of Dissolved Oxygen in water
8. Reaction kinetic studies in a batch reactor
9. Reaction kinetic studies in a mixed flow reactor
10. Reaction kinetic studies in a plug flow reactor
11. Performance Characteristics of Kaplan Turbine
12. Performance Characteristics of Pelton Turbine

COURES OUTCOMES:

At the end of the course the student will be able to:

CO#	COURSE OUTCOMES
CO1	Perform virtual simulation on Flow through Orifice and Venturi Meter experiment
CO2	Perform virtual simulation on Determination of pH, Alkalinity, COD, BOD and Dissolved Oxygen in Water.
CO3	Perform virtual simulation on Reaction kinetic studies in batch reactor and mixed flow reactor.
CO4	Perform virtual simulation on Performance Characteristics of Kaplan Turbine and Pelton Turbine.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1						1	1			1
CO2	2	1						1	1			1
CO3	2	1						1	1			1
CO4	2	1						1	1			1

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Scheme of Examination:

ONE question from par –A	: 20 Marks
ONE question from part –B	: 20Marks
Viva -Voice:	: 10 Marks
Total:	: 50 Marks

PROJECT-VI

Semester: VI

Course	Code	Credits	Total Hours		Assessment		Exam Duration in hrs
			Hours /Week				
			Lecture	Project	SEE	CIE	
Project-VI	22PRJ69	01	00	02	50	50	03

OBJECTIVES:

To Introduce fundamental concepts and analysis techniques in engineering to students across all disciplines.

Mini-Project Work:

Based on the ability/abilities of the students and recommendations of the mentor, a single discipline or a multidisciplinary Mini-Project can be assigned to an individual student or to a group having not more than 4 students.

COURSE OUTCOMES

At the end of this course, student should be able to:

CO#	COURSE OUTCOMES
CO1	Comprehend how to identify issues related to environment, society and industry.
CO2	Able to prepare the model and report on society, environment and industry related projects.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	-	1	2	2	1	2	1	1	1
CO2	2	2	2	-	1	2	2	1	2	1	1	1

Scheme of Examination:

Write-up : 15 Marks
Demonstration : 25Marks
Viva -Voice: : 10 Marks
Total: : 50 Marks

PROFESSIONAL ETHICS

Semester: VI

Course	Code	Credits	Total Hours - 20 Hours /Week		Assessment		Exam Duration in hrs
			Lecture	Tutorial	SEE	CIE	
Professional Ethics	**22HSM610**	**01**	**01**	**00**	**50**	**50**	**03**

OBJECTIVES:

1. To enable the students to create an awareness on Engineering Ethics and Human Values
2. To instill Moral and Social Values and Loyalty and to appreciate the rights of others.,

MODULE-1

HUMAN VALUES: Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment –
Empathy – Self-confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management. **04 Hours**

MODULE-2

ENGINEERING ETHICS: Senses of „Engineering Ethics" – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral
Autonomy – Kohlberg"s theory – Gilligan"s theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories. **04 Hours**

MODULE-3

Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law. **04 Hours**

MODULE-4

SAEFTY, RESPONSIBILITIES AND RIGHTS: Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority –
Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination. **04 Hours**

MODULE-5

GLOBAL ISSUES: Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority –
Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination. **04 Hours**

COURSE OUTCOMES

At the end of this course, student should be able to:

CO#	COURSE OUTCOMES
CO1	Understand the fundamental concepts of morals, values, and ethics, and their applicability in both personal and professional contexts.
CO2	Demonstrate a commitment to integrity, honesty, and courage in their decision-making processes and professional conduct.
CO3	Develop interpersonal skills such as empathy, respect for others, and cooperation, fostering a collaborative and inclusive work environment.
CO4	Apply techniques such as service learning.
CO5	Cultivate a strong personal character, spirituality, and self-confidence, enabling them to navigate challenges with resilience

CO-PO Mapping

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	2	-	2	1	-	-	-
CO2	-	-	-	-	-	2	-	2	1	-	-	-
CO3	-	-	-	-	-	2	-	2	1	-	-	-
CO4	-	-	-	-	-	2	-	2	1	-	-	-
CO5	-	-	-	-	-	2	-	2	1	-	-	-

QUESTION PAPER PATTERN:

1. The question paper will have ten questions.
2. Each full Question consisting of 20 marks
3. There will be 2 full questions (with a maximum of four sub questions) from each module.
4. Each full question will have sub questions covering all the topics under a module.
5. The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

1. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2003
2. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", PrenticeHall of India, New Delhi, 2004.

REFERENCE BOOKS:

1. Charles B. Fleddermann, "Engineering Ethics", Pearson Prentice Hall, New Jersey, 2004.
2. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, "Engineering Ethics –
3. Concepts and Cases", Cengage Learning, 2009
4. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi, 2003

E-RESOURCES:

https://www.coursera.org/courses?query=ethics

INFORMATION AND COMMUNICATION TECHNOLOGY (ICT)

Semester: VI

Course	Code	Credits	Total Hours: 16 Hours /Week		Assessment		Exam Duration in hrs
			Lecture	Practical	SEE	CIE	
Information and Communication Technology (ICT)	22AEC611	01	00	01	50	50	03

OBJECTIVE:

This course aims at acquainting the students with basic ICT tools which help them in their day to day and life as well as in office and research.

MODULE-I

Fundamentals of Internet: What is Internet? Internet applications, Internet Addressing – Entering a Web Site Address, URL–Components of URL, Searching the Internet, Browser–Types of Browsers, Introduction to Social Networking: Twitter, Tumblr, LinkedIn, Facebook, flickr, Skype, yahoo, YouTube, WhatsApp. **05 Hours**

MODULE-II

Definition of E-mail -Advantages and Disadvantages –User Ids, Passwords, Email_Addresses, Domain Names, Mailers, Message Components, Message Composition,_Mail Management. G-Suite: Google drive, Google documents, Google spread sheets,_Google Slides and Google forms. **05 Hours**

MODULE-III

Overview of Internet security, E-mail threats and secure E-mail, Viruses and antivirus software, Firewalls, Cryptography, Digital signatures, Copyright issues. What are GOI digital initiatives in higher education? (SWAYAM, Swayam Prabha, National. Academic Depository, National Digital Library of India, E-Sodh-Sindhu, Virtual labs, e-acharya, e-Yantra and NPTEL). **06 Hours**

REFERENCE BOOKS:

1. In-line/On-line: Fundamentals of the Internet and the World Wide Web, 2/e –By Raymond Green law and Ellen Hepp, Publishers: TMH
2. Internet technology and Web design, ISRD group, TMH.
3. Information Technology – The breaking wave, Dennis P.Curtin, Kim Foley, Kunai Sen and Cathleen Morin, TMH.

COURSE OUTCOMES

At the end of this course, student should be able to:

CO#	COURSE OUTCOMES
CO1	Understand the literature of social networks and their properties.
CO2	Develop skills to use various social networking sites.
CO3	Apply skills to use online forums, docs, spread sheets, etc. for communication, Collaboration and research.

CO-PO Mapping

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	2	1	1	1	2	1	1	2
CO2	2	2	1	1	2	1	1	1	2	1	1	2

Scheme of Examination:

Write-up	: 15 Marks
Demonstration	: 25Marks
Viva -Voice:	: 10 Marks
Total:	: 50 Marks

RECOMMENDED CO-CURRICULAR ACTIVITIES: Co-curricular activities shall not promote copying from textbook or from others work and shall encourage self/ independent and group learning.

1. Assignments (in writing and doing forms on the aspects of syllabus content and outside the syllabus content. Shall be individual and challenging)
2. Student seminars (on topics of the syllabus and related aspects (individual activity))
3. Quiz and Group Discussion
4. Slip Test
5. Try to solve MCQ's available online.
6. Suggested student hands on activities:
   a. Create your accounts for the above social networking sites and explore them, establish a video conference using Skype.
   b. Create an Email account for yourself- Send an email with two attachments to another friend. Group the email addresses use address folder.
   c. Register for one online course through any of the online learning platforms like NPTEL, SWAYAM, Alison, Codecademy, Coursera. Create a registration form for your college campus placement through Google forms.

CIE FOR THE COURSES WITH 01 CREDIT

a) CIE THEORY COMPONENT

The CIE theory component constitutes of CIE IA Test with maximum 15 marks and minimum passing 07 marks

CIE CCAs with maximum 15 marks and minimum passing 07 marks

- There shall be three Continuous Internal Evaluations (CIE) for 1. Credit course
- The CIE Question paper shall be set for a maximum of 30 marks with questions having a maximum of three bits.
- The question needs to be framed covering the entire syllabus (33%) completed before the consecutive CIEs.
- The best of two CIE marks will be considered and reduced to the final CIE marks to a maximum of 15 marks.
- Another 35 marks are dedicated to class assessment with suitable weightage.

b) SEMESTER END EXAMINATIONS:

- The SEE theory exam to be conducted for 50 marks with minimum passing marks 18.
- The SEE question paper with Multiple Choice Question (MCQs) type is set for 50 questions each of the 01 marks.