ENGINEERING MATHEMATIC -III

Semester: III **Year: 2021-22**

Course	Code	Credits	Total Hours - 40 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Engineering Mathematic -III	21MAT31	03	03	00	50	50	03

Course Objectives:

1) Introduce most commonly used analytical and numerical methods in the different engineering
2) fields.
3) Learn Laplace transform and Z-transforms to solve ODE and PDE's.
4) Understanding the statistical methods, numerical methods.
5) Solve the problem related to Interpolation.
6) To discuss the random variable and associated probability distributions.
7) Understand the vector space and associated results.
8) Understand the basic concepts of set theory, relations, functions and mathematical logic

Course outcomes:

	Course Outcomes	RBT LEVEL
C01	Apply the knowledge of Laplace transform from time domain to frequency domain. Knowing the property of Laplace transform and solving the problems on Signal and image processing which transforms differential equation into algebraic equation form and solving the problems also in inverse Laplace transform.	L1, L2, L3
C02	Knowing the random variable both discrete and continuous and their probability distribution, Mass density function and solving the problems on various engineering problems.	L1, L2, L3
C03	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.	L1, L2, L3
C04	Studying the Forward and Backward Finite differences and solve the problems on interpolation and finding the numerical integration by different methods.	L1, L2, L3
C05	Apply the knowledge of Z-transforms in solving the difference equation arising in the continuous and discrete time signals and digital processing, Apply the knowledge of vector space in digital communication/ Apply sampling distribution to solve engineering problems. / Apply the operations like union and intersection on discrete structures such as sets, relations and functions and construct mathematical arguments using logical connectives	L1, L2, L3
	Total number of lecture hours	40

Module-1

Laplace Transforms: Definition, Laplace transforms of Elementary functions, properties (without proof) periodic function, Unit step function, Unit impulse function.
Inverse Laplace Transforms: Definition, Convolution Theorem (without proof) and Finding Inverse Laplace transform by convolution Theorem. Solution of Linear Differential equations using Laplace Transforms and Applications (5 Assignment Problem).
Self-Study: Solution of first order simultaneous differential equation 08 Hours

Module-2

Probability Distribution: Random variables (discrete and continuous) probability mass/density functions. Binomial distribution, Poisson distribution. Exponential and Normal distributions. Problems. (5 Assignment Problem).

Self-Study: Definition of probability, addition and multiplication rule, Bay's theorem. 08 Hours

Module-3

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 formy=ax+b,y=ax^2+bx+c & y=ae^bx.
Numerical Methods: Numerical solution of algebraic and transcendental equations by Regula-Falsi Method and Newton-Raphson method. (5 Assignment Problem).
Self-Study: Secent method, mean, mode, median, variance and standard deviation. 08 Hours

Module-4

Finite Difference: Forward and Backward differences, Newton's forward and backward interpolation formulae. Divided difference-Newton's divided difference formulae. Lagrange's-interpolation formula and inverse interpolation formula (all formula without proof) problems.
Numerical Integration: Simpsons(1/3)^rd,(3/8)^thrules, Weddle's rule (without proof) problems. (5 Assignment Problem).
Self-Study: Numerical differentiation, Trapezoidal rule 08 Hours

Module-5

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
08 Hours

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, 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,
2. 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.

Web links and Video Lectures:

1. http://nptel.ac.in/courses.php?disciplineID=111
2. http://www.class-central.com/subject/math
3. http://academicearth.org.

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.

THERMODYNAMICS AND ENERGY CONVERSIONS

Semester: III **Year: 2021-22**

Course	Code	Credits	Total Hours - 48 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Thermodynamics and Energy Conversions	21EG32	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	Comprehend basic concepts of Zeroth law, temperature scales and work and heat interaction.	**L1, L2, L3**
CO2	Practice the examples on First and Second law of thermodynamics and their applications.	**L1, L2, L3**
CO3	Comprehend the concepts of Entropy and Pure substances	**L1, L2, L3**

CO4	Analyse the Gas power cycles and Vapour power cycles.	**L1, L2, L3, L4**
CO5	Apply and analyse the basics of Refrigeration and Compressors.	**L1, L2, L3**
	Total Number Lecture Hours	**48**
	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	02	01						01				01
CO2	02	01		02				01				01
CO3	02	01		02		01		01				01
CO4	02	02		01		01		01				01
CO5	02	02		01		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: 2021-22**

Course	Code	Credits	Total Hours - 48 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Mechanics of Materials	21EG33	03	03		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.k
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.

10 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. 10 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.

10 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.

09 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). 09 hours

COURSE OUTCOMES

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

	COURSE OUTCOMES	**RBT LEVEL**
CO1	Understand simple, compound, thermal stresses and strains their relations and strain energy.	**L1, L2, L5**
CO2	Analyse structural members for stresses, strains and deformations.	**L1, L3**
CO3	Analyse the structural members subjected to bending and shear loads.	**L1, L5**
CO4	Comprehend the basic concept of analysis and design of members subjected to bending and understand the concept of cylinders.	**L2, L4**
CO5	Comprehend the basic concept of analysis and design of members subjected to torsion and thus understand failure concepts	**L2, L4**
	Total Number Lecture Hours	**48**
	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: 2021-22**

Course	Code	Credits	Total Hours - 48 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Material Science for Energy Engineering	21EG34	03	03		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. 9 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 9 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 10 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. 10 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. 10 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.	**L1**
CO2	Understand the importance of phase diagrams and the phase transformations.	**L1, L3**
CO3	Know various heat treatment methods for controlling the microstructure.	**L1, L2, 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	**L1, 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	2				2	1	1	1				1
CO2	2				2	1	1	1				1
CO3	2				2	1	1	1				1
CO4	2				2	1	1	1				1
CO5	2				2	1	1	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.

FLUID MECHANICS

Semester: III **Year: 2021-22**

Course	Code	Credits	Total Hours - 48 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Fluid Mechanics	**21EG35**	**02**	**02**		**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. 10 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. 10 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. 10 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. 09 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. 09 Hours

COURSE OUTCOMES

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

	COURSE OUTCOMES	RBT LEVEL
CO1	To analyse a variety of practical fluid flow and measuring devices and utilize fluid mechanics principles in design.	**L1, L2**
CO2	To understand the concept of measurements of fluid, and study of fluid at static or rest.	**L1, L2**
CO3	To visualise different types of fluid flow, and compare them based on kinematic flow descriptions.	**L2. L3**
CO4	To understand how mass and momentum is conserved based on Bernoulli's & Newton's laws and its applications.	**L1, L2**
CO5	To understand the concept of dimensional quantities, study of notches, wire and its application	**L2, 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	3	2		1								1
CO2	3	2		1		1						1
CO3	2	1		1		2						1
CO4	2	1		1		2						1
CO5	2	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.
3. Fluid Mechanics, John F. Douglas, Janul and M.Gasiosek and john A.Swaffield, Pearson Education Asia, 5th ed., 2006.
4. Fluid Mechanics and Fluid Power Engineering, Kumar.D.S, Kataria and Sons, 2004
5. 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.

Fluid Mechanics Lab

Semester: III **Year: 2021-22**

Course	Code	Credits	Total Hours - 24 Hours /Week		Assessment		Exam Duration in hrs
			Lecture	Practical	SEE	CIE	
Fluid Mechanics Lab	**21EGL36**	**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	Comprehend the types of valves, taps, pipe fitting and gauges.	**L1, L2**
CO2	Understand the measurement of pressure gauge and to measure metacentric height of floating body.	**L1, L2**
CO3	Understand the concept of Bernoulli's and Reynolds number.	**L2. L3**
CO4	To understand the different flow measurement equipment's and their procedures.	**L1, L2**
CO5	Able to develop the skill of experimentation techniques for the study of flow phenomena in channels/pipes.	**L2, L3**
	Total Number Lecture Hours	**48**
	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	1						1	1			1
CO2	2	1						1	1			1
CO3	2	1						1	1			1
CO4	2	1						1	1			1
CO5	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

ENERGY CONVERSION LAB - 1

Semester: III **Year: 2021-22**

Course	Code	Credits	Total Hours - 24 Hours /Week		Assessment		Exam Duration in hrs
			Lecture	Practical	SEE	CIE	
Energy Conversion Lab -1	**21EGL37**	**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.

LIST OF EXPERIMENTS:

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 - 1

Semester: III **Year: 2021-22**

Course	Code	Credits	Total Hours - 24 Hours /Week		Assessment		Exam Duration in hrs
			Lecture	Practical	SEE	CIE	
Material Science & Testing Lab-1	21EGL38	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

PROJECT-3

Semester: III **Year: 2021-22**

Course	Code	Credits	Total Hours - 32 Hours /Week		Assessment		Exam Duration in hrs
			Lecture	Project	SEE	CIE	
Project-3	21PROJ39	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.	L1, L3
CO2	Able to prepare the model and report on society, environment and industry related projects.	L2
	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 : 25Marks
Viva -Voice: : 10 Marks
Total: : 50 Marks

KANNADA KALI-III/
AYDU KATEGALU

Semester: III **Year: 2021-22**

Course	Code	Credits	Total Hours - 24 Hours /Week		Assessment		Exam Duration in hrs
			Lecture	Tutorial	SEE	CIE	
Kannada kali-III /Aydu Kategalu	21KANKK310/ 20KANAK310	01	01	00	50	50	03

OBJECTIVES:

OUTCOMES:

CO-PO Mapping

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

WORKSHOP PRACTICE ON REFRIGERATION & AIR CONDITIONING

Semester: III **Year: 2021-22**

Course	Code	Credits	Total Hours - 32 Hours /Week		Assessment		Exam Duration in hrs
			Lecture	Practical	SEE	CIE	
Workshop Practice on Refrigeration & Air Conditioning	21AEC301	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	Comprehend safety hazards, precautions, RAC Tools, Copper tube cutting and Brazing.	L1
CO2	Understand mechanical, electrical, leak test, charging and installation of refrigerator.	L1
	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: 2021-22**

Course	Code	Credits	Total Hours - 24 Hours /Week		Assessment		Exam Duration in hrs
			Lecture	Practical	SEE	CIE	
Additional Mathematics-1	21MATDIP31	00	03	00	50	50	03

OBJECTIVES:

OUTCOMES:

CO-PO Mapping

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

ENGINEERING MATHEMATICS-IV

Semester: IV **Year: 2021-22**

Course	Code	Credits	Total Hours - 40 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Engineering Mathematics-IV	21MAT41	03	03	00	50	50	03

COURSE OBJECTIVES:

This course will enable students to:

1. Learn Fourier series and Fourier transforms.
2. Conversant with numerical methods to solve ordinary differential equations.
3. Know then complex combers, Analytic function and associated results and problems.
4. Understand Joint probability distribution and stochastic processes arising in science and engineering.
5. Understand the definition of sequence, series and its importance.
6. Discuss the elementary concepts of graph theory.
7. Know the finite difference method and use in solving partial differential equation.

MODULE-1

Fourier Series: Periodic functions, Dirichlet's condition, Fourier Series of periodic functions with period 2π and with arbitrary period 2c. Fourier series of even and odd functions Half range Fourier Series, practical harmonic analysis (5 Assignment Problem).

Self-Study: Sequence and series of a function, convergent series. 08 Hours

MODULE-2

Joint probability distribution: Joint Probability distribution for two discrete random variables, expectation, covariance, correlation coefficient.

Stochastic process: Stochastic processes, probability vector, stochastic matrices, fixed points, regular stochastic matrices, Markov chains, higher transition probability-simple problems.
(5 Assignment Problem).

Self-Study: Joint probability distribution for continuous random variable 08 Hours

MODULE-3

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: Picards method 08 Hours

MODULE-4

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 08 Hours

MODULE-5

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

Self-Study: Frobenius method 08 Hours

COURSE OUTCOMES

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

	COURSE OUTCOMES	**RBT LEVEL**
CO1	Define the Periodic function and find the Fourier series and half range series expansion of different functions in different intervals and studying Practical Harmonic functions, Know the use of periodic signals and Fourier series to analyze circuits	**L1, L2, L3**
CO2	Learn to solve the problems on Joint probability distribution for two discrete random variables. Knowing the concept of stochastic processes, probability vector, Probability matrix and studying the examples on Markov's chains in discrete time.	**L1, L2, L3**
CO3	Solving the first order first degree ordinary differential equations arising in flow problems using single step and multistep numerical methods.	**L1, L2, L3**
CO4	Use to solve second order ordinary and partial differential equations arising in heat and wave equations by numerical methods.	**L1, L2, L3,**
CO5	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. / Obtain the series solution of ordinary differential equations and studying special functions. / Develop the model using advanced concept of graph for real world applications.	**L1, L2, L3**
	Total Number Lecture Hours	**43**
	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			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, 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,
2. 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.

Web links and Video Lectures:

1. http://nptel.ac.in/courses.php?disciplineID=111
2. http://www.class-central.com/subject/math
3. http://academicearth.org.

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.

ELECTRICAL MECHINES

Semester: IV **Year: 2021-22**

Course	Code	Credits	Total Hours - 48 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Electrical Machines	21EG42	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.
6) To study the constructional features of Motors and select a suitable drive for specific application.
7) To study the constructional features and speed control of Three Phase induction Motors.

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. 10 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. 10 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. 10 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. 09 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. 09 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.	**L1, L2, 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	**L1, L2, L3**
CO3	Analyze and assess the performance characteristics of DC motors by conducting suitable tests and control the speed by suitable method.	**L1, L2, L3, L4**
CO4	Explain the construction and operation of Synchronous generators.	**L1, L2, L3, L4**
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.	**L1, L2, L3**
	Total Number Lecture Hours	**48**
	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	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: 2021-22**

Course	Code	Credits	Total Hours - 48 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Renewable Energy Technologies	**21EG43**	**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. 10 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. 10 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. 10 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. 10 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. 10 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.	**L1, L2, L3**
CO2	Comprehend solar thermal energy conversion.	**L1, L2, L3**
CO3	Explain generation of energy from hydrogen, wind and geothermal system.	**L1, L2, L3**
CO4	Discuss production of energy from biogas and tidal energy resources.	**L1, L2, L3, L4**
CO5	Summarize ocean thermal energy and wave energy.	**L1, L2, L3**
	Total Number Lecture Hours	**48**
	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	1		2	1	2	1				1
CO2	2	2	1		2	1	2	1				1
CO3	2	2	1		2	1	2	1				1
CO4	2	2	1		2	1	2	1				1
CO5	2	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

POWER ELECTRONICS

Semester: IV **Year: 2021-22**

Course	Code	Credits	Total Hours - 48 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Power Electronics	**21EG44**	**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.

10 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. 10 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. 10 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. 09 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. 09 Hours

COURSE OUTCOMES

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

	COURSE OUTCOMES	RBT LEVEL
CO1	To give an 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.	**L1**
CO2	To explain the techniques for design and analysis of single phase diode rectifier circuits.	**L1, L3**
CO3	To explain different power transistors, their steady state and switching characteristics and limitations.	**L1, L2, L3**
CO4	To explain different types of Thyristors, their gate characteristics and gate control requirements.	**L3**
CO5	To explain the design, analysis techniques, performance parameters and characteristics of controlled rectifiers, DC- DC, DC -AC converters and Voltage controllers	**L1, 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	3	2	1			1						1
CO2	3	2	1			1						2
CO3	3	1	1			1						1
CO4	3	2	1			2						1
CO5	2	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

INTRODUCTION TO HEAT TRANSFER

Semester: IV **Year: 2021-22**

Course	Code	Credits	Total Hours - 48 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Introduction to Heat Transfer	**21EG45**	**03**	**02**	**01**	**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. 10 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. 10 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. 09 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. 09 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. 10 Hours

COURSE OUTCOMES

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

	COURSE OUTCOMES	RBT LEVEL
CO1	Understand the modes of heat transfer and apply the basic laws to formulate engineering systems.	**L1**
CO2	Understand and apply the basic laws of heat transfer to extended surface, fins and problems	**L1, L3**
CO3	Analyze heat transfer due to free and forced convective heat transfer.	**L1, L2, L3**
CO4	Analyze heat conduction through numerical methods and apply the fundamental principle to solve radiation heat transfer problems.	**L3**
CO5	Understand the design and performance analysis of heat exchangers and their practical applications	**L1, L3**
	Total Number Lecture Hours	**48**
	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	1	1	1				1
CO2	2				2	1	1	1				1
CO3	2				2	1	1	1				1
CO4	2				2	1	1	1				1
CO5	2				2	1	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

HEAT TRANSFER LAB

Semester: IV **Year: 2021-22**

Course	Code	Credits	Total Hours - 24 Hours /Week		Assessment		Exam Duration in hrs
			Lecture	Practical	SEE	CIE	
Heat Transfer Lab	21EGL46	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.	L1, 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.	L1
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 par –A: 15 Marks
ONE question from part –B: 25Marks
Viva -Voice: : 10 Marks
Total: : 50 Marks

ELECTRICAL MACHINES LAB-1

Semester: IV **Year: 2021-22**

Course	Code	Credits	Total Hours - 24 Hours /Week		Assessment		Exam Duration in hrs
			Lecture	Practical	SEE	CIE	
Electrical Machine Lab-1	21EGL47	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.	**L1, L2, L3**
CO2	Connect and operate two single phase transformers of different KVA rating in parallel.	**L1, L2, L3**
CO3	Connect single phase transformers for three phase operation and phase conversion.	**L1, L2, L3**
CO4	Perform load test on single phase and three phase induction motors to assess the performance.	**L1, L2, L3, L4**
CO5	Conduct test on induction motor to pre-determine the performance characteristics	**L1, L2, L3**
	Total Number Lecture Hours	**48**
	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	1	1		2		1		2			2
CO2	2		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

POWER ELECTRONICS LAB

Semester: IV **Year: 2021-22**

Course	Code	Credits	Total Hours - 24 Hours /Week		Assessment		Exam Duration in hrs
			Lecture	Practical	SEE	CIE	
Power Electronic Lab	**21EGL48**	**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.

LIST OF EXPERIMENTS:

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	Understand Characteristics of different power electronic devices.	**L1, L2, L3**
CO2	Verify the performance of single phase controlled full wave rectifier with different Loads	**L1, L2, L3**
CO3	Verify AC voltage controller with R and RL loads.	**L1, L2, L3**
CO4	Control the speed of a DC motor, universal motor and stepper motors.	**L1, L2, L3**
	Total Number Lecture Hours	**48**
	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	1	1	1	-					1		
CO2	1	2	1	1		1	1					1
CO3		2	1					1				1
CO4	1	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-IV

Semester: IV **Year: 2021-22**

Course	Code	Credits	Total Hours - 32 Hours /Week		Assessment		Exam Duration in hrs
			Lecture	Project	SEE	CIE	
Project-4	21PROJ49	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.	L1, L3
CO2	Able to prepare the model and report on society, environment and industry related projects.	L2
	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

KANNADA KALI-IV/
MAHADASOHIGALU

Semester: IV **Year: 2021-22**

Course	Code	Credits	Total Hours - 24 Hours /Week		Assessment		Exam Duration in hrs
			Lecture	Tutorial	SEE	CIE	
Kannada Kali-IV/ Mahadasohigalu	21KANKK410/ 20KANMD410	01	01	00	50	50	03

OBJECTIVES:

OUTCOMES:

CO-PO Mapping

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

COMPUTATIONAL LAB

Semester: IV **Year: 2021-22**

Course	Code	Credits	Total Hours - 24 Hours /Week		Assessment		Exam Duration in hrs
			Lecture	Practical	SEE	CIE	
Computational Lab	21AEC401	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: 2021-22**

Course	Code	Credits	Total Hours - 24 Hours /Week		Assessment		Exam Duration in hrs
			Lecture	Practical	SEE	CIE	
Additional Mathematics-II	21MATDIP41	00	03	01	50	50	03

OBJECTIVES:

OUTCOMES:

CO-PO Mapping

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

ENGINEERING ECONOMICS

Semester: V **Year: 2021-22**

Course	Code	Credits	Total Hours - 40 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Engineering Economics	**21HSM51**	**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. **8 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. **8 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. **8 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. **8 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. **8 Hours**

COURSE OUTCOMES:

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

	COURSE OUTCOMES	RBT LEVEL
CO1	Analyze the material selection, design selection for product.	L3
CO2	Know time value of money, methods, and evaluate, compare engineering projects.	L3
CO3	Analyze the future worth methods, Annual Equivalent method and rate of return method.	L3
CO4	Study the concept of replacement, maintenance and depreciation.	L3
CO5	Make and buy criteria and factors, functions of value engineering.	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	2	1	1	-	-	1	-	1	-	-	-	2
CO2	2	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 **Year: 2021-22**

Course	Code	Credits	Total Hours - 40 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Fluid Machinery	**21EG52**	**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. **8 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. **8 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. **8 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. **8 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. **8 Hours**

COURSE OUTCOMES:

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

	COURSE OUTCOMES	**RBT LEVEL**
CO1	Do the model studies and thermodynamics analysis of turbo machines.	L3
CO2	Analyse the energy transfer in Turbo machine with degree of reaction and utilisation factor.	L3
CO3	Analyse and comprehend various type of steam turbine.	L3
CO4	Analyse and understand various type of hydraulic turbine.	L3
CO5	Know concept of radial power absorbing machine and the problems involved during its operation.	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	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

TEXTBOOKS:

1. An Introduction to Energy Conversion, Volume III, Turbo machinery, V. Kadambi and Manohar Prasad, New Age International Publishers, 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.

REACTION ENGINEERING & COMBUSTION

Semester: V **Year: 2021-22**

Course	Code	Credits	Total Hours - 40 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Reaction Engineering & Combustion	21EG53	03	03	00	50	50	03

COURSE OBJECTIVES:

1. To understand and analyse the reaction engineering with emphasis on engineering applications.
2. To know the basics of chemical kinetics and reacting systems.
3. To analyse the different types of fuels, its applications and technologies.
4. To know the combustion and thermochemistry of different fuel.
5. To analyse the combustion technology of fuels.

MODULE-1

Introduction to Reaction Engineering: Scope of Reaction Engineering, Classification of reactions. Rate equation and rate of reaction. Factors affecting rate of reaction. Reaction Mechanism and Pathways, Rate constants, Activation Energy, Temperature dependency of rate constant from Arrhenius, Collision and Transition state theories.

Molecularity and order of reaction, imultaneous interdependent reactions, Chain reactions, Pseudo-first-order reactions, Pressure effect in fractional conversion. **8 Hours**

MODULE-2

Chemical Kinetics: Chemical kinetics and Thermodynamics Equilibrium, Chemical kinetics of large reaction mechanisms – Sensitivity analysis, Rate of production analysis, coupled thermal and chemical reacting systems, Enthalpy of formation and enthalpy of combustion.

First law analysis of Reacting systems, Adiabatic flame temperature, Entropy change of reacting systems, Second law analysis of reacting systems, Calorific value of fuels, Mechanism and kinetics of combustion, Numerical Problems. **8 Hours**

MODULE-3

Fuels: Fuels, Characteristics and Properties – Physical & Chemical, Types of fuels - solid, liquid and gaseous, fundamental properties, Determination of fuel composition, Testing of oils, viscosity, flash point, pour point, aniline point, carbon residue, Diesel index, octane and cetane number, moisture content. Higher and lower heating values of fuels.

Solid fuels: Coal – Composition & Combustion, Coal liquefaction, Coal oxidation and hydrogenation. **Liquid Fuels**: Origin and classification of Petroleum, refining, storage and handling. **Gaseous Fuels**: Different types of gaseous fuels & applications. **Manufactured fuels**: Bio-Fuels: types, production processes, properties related to combustion, technologies, handling, and storage and applications. **8 Hours**

MODULE-4

Combustion and Thermochemistry: Introduction, Free energy and the equilibrium constants, Flame temperature calculations – Analysis & Practical considerations, Sub and supersonic combustion thermodynamics – Comparisons & Stagnation pressure considerations.

Estimation of minimum amount of air required, Air fuel ratio, Estimation of dry flue gases, dew point of products. Ignition temperature- explosive range - flue gas analysis. Pollutant formation and Control in Combustion - CO, Soot, NO_x and SO_x. Formation of Ash. **8 Hours**

MODULE-5

Combustion Technology: Theoretical and actual combustion processes, combustion of oil, coal, and gas, flue gas analysis, flame properties, combustion appliances, stoker firing, pulverized system of firing, fluidized bed combustion process, Oxy-rich combustion.

Introduction to Flame, Types of flames (Laminar Diffusion & Turbulent Flames) - Physical Description, Factors influencing flame velocity and thickness, flame stabilization, ignition. Combustion control and Modelling. **8 Hours**

COURSE OUTCOMES

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

	COURSE OUTCOMES	**RBT LEVEL**
CO1	Know the reaction engineering with its applications.	L3
CO2	Analysis the concept of chemical kinetics and reacting systems.	L3
CO3	Analysis the different types of fuels used for industrial applications and its technologies.	L3
CO4	Know the difference between combustion and thermochemistry of different fuel.	L3
CO5	Study the combustion technology of different fuels for industries and its pollutions.	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	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. "Fuels & Combustion", Dr. Samir Sarkar, 2nd ed., Orient Longman
2. "Chemical Reaction Engineering", Octove Levelspil, Wiley Eastern Ltd.
3. "Chemical Engineering Kinetics", Smith J.M., Mc Graw Hill.
4. "Chemical Kinetics", Keith Laidler, Harper and Row
5. Elements of Chemical Reaction Engineering; H. S. Fogler; 3rd Edition; Prentice-Hall of India
6. S.P. Sharma & Chander Mohan, "Fuels & Combustion", Tata McGraw Hill Publishing Co. Ltd.

REFERENCES BOOKS:

1. 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.

OPERATION RESEARCH

Semester: V **Year: 2021-22**

Course	Code	Credits	Total Hours -40 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Operation Research	21EG541	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). **8 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 **8 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. **8 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. **8 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**.** **8 Hours**

COURSE OUTCOMES

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

	COURSE OUTCOMES	RBT LEVEL
CO1	Know the meaning, definitions, scope, need, phases and techniques of operations research.	L3
CO2	Formulate linear programming problems by graphical method, Simplex method, Big-M method and Dual simplex method.	L3
CO3	Formulate as Transportation and Assignment problems.	L3
CO4	Solve problems on game theory and job sequencing.	L3
CO5	Study and analyse CPM, PERT and queuing models.	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	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.

MEMS- MICRO ELECTRO MECHANICAL SYSTEM

Semester: V **Year: 2021-22**

Course	Code	Credits	Total Hours - 40 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
MEMS- Micro Electro Mechanical System	21EG542	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. **8 Hours**

MODULE-2

Micromachining: Introduction, Photo Lithography, Structural and Sacrificial Materials, Etching, Surface Micromachining, Bulk versus Surface Micromachining, Wafer Bonding, LIGA. **8 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. **8 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. **8 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. **8 Hours**

COURSE OUTCOMES:

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

	COURSE OUTCOMES	RBT LEVEL
CO1	Know the working of MEMS technology & Miniaturization.	L3
CO2	Analysis the Process of Micro fabrication Techniques.	L3
CO3	know the principles of system modelling.	L3
CO4	Study the working principles of Mechanical sensors and actuators.	L3
CO5	Describe the working principles of Micro-Opto-Electro Mechanical systems	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	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 & ENVIRONMENT

Semester: V **Year: 2021-22**

Course	Code	Credits	Total Hours - 50 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Energy & Environment	21EG551	04	03	01	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

	COURSE OUTCOMES	RBT LEVEL
CO1	Summarize the basic concepts of energy, its distribution and general Scenario.	L3
CO2	Explain different energy storage systems, energy management, audit and economic analysis.	L3
CO3	Know the environment eco system and its need for awareness.	L3
CO4	Identify the various types of environment pollution and their effects.	L3
CO5	Discuss the social issues of the environment with associated acts	L3
	Total Number Lecture Hours	**50**
	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	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

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 **Year: 2021-22**

Course	Code	Credits	Total Hours - 50 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Non-Conventional Energy Resources	21EG552	04	03	01	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 and geothermal energy as alternative energy sources.
3. To analyse the process of biogas plant and their types.
4. To know the method of power generation using hydrogen as fuel.
5. To know the concept of power generation using ocean and tidal energy.

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

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.

Introduction to Fuel Cells: Working and types of fuel cell–low, medium and high temperature fuel cell, liquid and methanol types, proton exchange membrane fuel cell solid oxide, hydrogen fuel cells–thermodynamics and electrochemical kinetics of fuel cells. **10 Hours**

MODULE-5

Energy from the oceans: Ocean thermal energy conversion-open cycle and closed cycle systems, advantages and dis-advantages.

Energy from tides – basic principle of tidal power, components of tidal power plants, single basin and double basin systems, ocean waves , advantages and dis-advantages. **10 Hours**

COURSE OUTCOMES:

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

	COURSE OUTCOMES	RBT LEVEL
CO1	Describe the environmental aspects of non-conventional energy resources, use of solar energy and the various components used in the energy production.	L3
CO2	Appreciate the need of Wind Energy and Geothermal energy with various components used in energy generation and know the classifications.	L3
CO3	Analyse the concept of Biomass energy resources.	L3
CO4	Study the concept of hydrogen energy and working of fuel cells.	L3
CO5	Acquaint the need of ocean energy and tidal energy with various components used in energy generation.	L3
	Total Number Lecture Hours	**50**
	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	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.

ENERGY CONVERSION LAB-2

Semester: V **Year: 2021-22**

Course	Code	Credits	Total Hours		Assessment		Exam Duration in hrs
			Hours /Week				
			Lecture	Practical	SEE	CIE	
Energy Conversion Lab-2	**21EGL56**	**01**	**00**	**02**	**50**	**50**	**03**

COURSE OBJECTIVES:

1. To gain knowledge in performance testing of IC engines at Different loads and conditions.
2. To provide practical knowledge of valve and port timing diagram.
3. Enrich the concept of efficiency of IC engine and their calculations.
4. Discuss the performance characteristics of IC engines and curves.

LIST OF EXPERIMENTS:

PART-A

1. Valve Timing Diagram of an IC Engine (4- Stroke).
2. Port Timing Diagram of an IC Engine (2- Stroke).
3. Planimeter for determining irregular shapes.
4. Performance Tests on I.C. Engines, Calculations of IP, BP, Thermal Efficiencies, Volumetric efficiency, Mechanical efficiency, SFC, FP, A:F, Ratio heat balance sheet for Two stroke Petrol Engine.

PART-B

5. Performance Tests on I.C. Engines, Calculations of IP, BP, Thermal Efficiencies, Volumetric efficiency, Mechanical efficiency, SFC, FP, A:F, Ratio heat balance sheet for Varying Load I.C Engine(4 Stroke).
6. Performance Tests on I.C. Engines, Calculations of IP, BP, Thermal Efficiencies, Volumetric efficiency, Mechanical efficiency, SFC, FP, A:F, Ratio heat balance sheet for Four stroke Petrol Engine.
7. Performance Tests on I.C. Engines, Calculations of IP, BP, Thermal Efficiencies, Volumetric efficiency, Mechanical efficiency, SFC, FP, A:F, Ratio heat balance sheet for Multi Cylinder Petrol Engine (Morse test).
8. Performance Tests on I.C. Engines, Calculations of IP, BP, Thermal Efficiencies, Volumetric efficiency, Mechanical efficiency, SFC, FP, A:F, Ratio heat balance sheet for Variable Compression Ratio I.C. Engine (4 Stroke).

COURES OUTCOMES:

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

	COURSE OUTCOMES	RBT LEVEL
CO1	Conduct experiments on engines and draw characteristics.	L3
CO2	Test basic performance parameters of I.C. Engine and implement the knowledge in industry.	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	2	1	-	-	-	1	-	1	1	-	-	1
CO2	2	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 part –A: 15 Marks
ONE question from part –B: 25Marks
Viva -Voice: : 10 Marks
Total : 50 Marks

ELECTRICAL MACHINES LAB -2

Semester: V **Year: 2021-22**

Course	Code	Credits	Total Hours		Assessment		Exam Duration in hrs
			Hours /Week				
			Lecture	Practical	SEE	CIE	
Electrical Machine Lab-2	21EGL57	01	00	02	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:

	COURSE OUTCOMES	RBT LEVEL
CO1	Test DC machines to determine their characteristics and also to control the speed of DC motor.	L3
CO2	Pre-determine the performance characteristics of DC machines by conducting suitable tests.	L3
CO3	Perform load test on single phase and three phase induction motor to assess its performance.	L3
CO4	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

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

FLUID MACHINERY LAB

Semester: V **Year: 2021-22**

Course	Code	Credits	Total Hours		Assessment		Exam Duration in hrs
			Hours /Week				
			Lecture	Practical	SEE	CIE	
Fluid Machinery Lab	**21EGL58**	**01**	**00**	**02**	**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:

	COURSE OUTCOMES	RBT LEVEL
CO1	Study the performance of hydraulic turbine and pumps under different working conditions.	L3
CO2	Calculate the performance analysis in turbines and pumps.	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	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

PROJECT-V

Semester: V **Year: 2021-22**

Course	Code	Credits	Total Hours		Assessment		Exam Duration in hrs
			Hours /Week				
			Lecture	Project	SEE	CIE	
Project-V	**21PROJ59**	**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.	L1, L3
CO2	Able to prepare the model and report on society, environment and industry related projects.	L2
	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	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

ABILITY ENCHANCEMENT COURSE

Semester: V **Year: 2021-22**

Course	Code	Credits	Total Hours		Assessment		Exam Duration in hrs
			Hours /Week				
			Lecture	Practical	SEE	CIE	
Entrepreneurship & Development	**21AEC510**	**01**	**00**	**01**	**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:

	COURSE OUTCOMES	RBT LEVEL
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.	L3
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.	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	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

ELECTROCHEMISTRY

Semester: VI **Year: 2021-22**

Course	Code	Credits	Total Hours - 40 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Electrochemistry	21EG61	03	03	00	50	50	03

COURSE OBJECTIVES:

1. To understand the basics of electrochemistry and the laws of thermodynamics.
2. To analyse the electro catalysis and chemical catalysis and its application.
3. To know the electrode kinetics and its reaction order.
4. To analysis the electrochemical technique and its working principles.
5. To study the different Electro active Layers and its Electrodes.

MODULE-1

Introduction to Electrochemistry: 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, Reaction kinetics, rate of reactions, temperature dependence of reaction rates, activated complex theory. **8 Hours**

MODULE-2

Electro-catalysis: Electrochemical cell - redox reaction, electrode potential, potential- reduction potential, measurement and applications – electrochemical series and its significance - Nernst equation (derivation and problems).

Chemical catalysis and electro catalysis – comparison of electro-catalysts – electro catalysis in simple redox reactions– electronic and geometric factors in electro-catalysts -Discussion on the mechanisms of hydrogen evolution and oxygen reduction reactions. **8 Hours**

MODULE-3

Electrode Kinetics: Electrified interface, structure, and thermodynamics of electrified interface, Electro-chemical kinetics, electro-catalysis, and some electrochemical systems of technological interest over.

Equilibrium exchange, current density-derivation of Butler-Volmer equation – charge transfer resistance and polarizability of the interface – concepts of rate determining step, Stoichiometric number, reaction order – Determination of kinetics parameters. **8 Hours**

MODULE-4

Electrochemical Techniques: Ion selective electrodes – Principles of potentiometry and amperometry - determination of dissolved oxygen. Linear sweep voltammetry and cyclic voltammetry, derivation of Randles- Sevciks equation – effect of sweep rate-analysis of cyclic voltammograms.

Working principles of electrochemistry, Concepts of Faradaic impedance – derivation of kinetic parameters from impedance measurements - principles of scanning probe techniques. **8 Hours**

MODULE-5

Electro active 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. **8 Hours**

COURSE OUTCOMES

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

	COURSE OUTCOMES	RBT LEVEL
CO1	Analyse the electrochemistry and the laws of thermodynamics.	L3
CO2	Acquaint process and mechanism of chemical catalysis	L3
CO3	Acquire knowledge reaction kinetics.	L3
CO4	Determine the application of electro chemical techniques.	L3
CO5	Evaluate the application of electro active layers and electrodes.	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	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. "Fuels & Combustion", Dr. Samir Sarkar, 2nd ed., Orient Longman
2. "Chemical Reaction Engineering", Octove Levelspil, Wiley Eastern Ltd.
3. "Chemical Engineering Kinetics", Smith J.M., Mc Graw Hill.
4. "Chemical Kinetics", Keith Laidler, Harper and Row
5. S.P. Sharma & Chander Mohan, "Fuels & Combustion", Tata McGraw Hill Publishing Co. Ltd.

REFERENCES BOOKS:

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

POWER GENERATION & SYSTEM PLANNING

Semester: VI **Year: 2021-22**

Course	Code	Credits	Total Hours - 40 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Power Generation & system Planning	21EG62	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. **8 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. **8 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). **8 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. **8 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

8 Hours

COURSE OUTCOMES

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

	COURSE OUTCOMES	**RBT LEVEL**
CO1	Analyse the concepts of steam power plant, coal and ash handling and boiler and their practical application.	L3
CO2	Acquaint the concepts and applications of Chimneys and boiler.	L3
CO3	Analyse the concept and application of hydroelectric plant and advance power cycles.	L3
CO4	Know the utilization of nuclear power plant and diesel power plant.	L3
CO5	Outline the site selection and economic analysis of power plant.	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	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.

SOLAR ENERGY UTILIZATION

Semester: VI **Year: 2021-22**

Course	Code	Credits	Total Hours - 40 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Solar Energy Utilization	21EG63	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. **8 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. **8 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. **8 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. **8 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. **8 Hours**

COURSE OUTCOMES

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

	COURSE OUTCOMES	RBT LEVEL
CO1	Identify the significance and applications of various solar energy devices and instrument for measuring Solar radiation.	L3
CO2	Understand the concept of solar radiation geometry and empirical equation for solar radiation.	L3
CO3	Analyse the performance by conducting research on flat plate collector, air heater and concentrating type collector	L3
CO4	Analyse the overall loss coefficient, heat transfer correlation, collector efficiency factors in collectors and propose necessary solutions.	L3
CO5	Evaluate the issue related to photovoltaic conversion efficiency and economical aspects.	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	-	-	-	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 engineering of Thermal processes, Duffy J A and Beckman, W. A. John Wiley & Sons, New York.
4. Solar energy: Principles of Thermal Collection and Storage/Sukhatme/TMH/2nd edition

REFERENCE:

1. Solar energy/Garg/TMH
2. Solar energy/Magal/McGraw Hill
3. Solar Thermal Engineering Systems /Tiwari and Suneja/Narosa
4. 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

INSTRUMENTATION AND CONTROL

Semester: VI **Year: 2021-22**

Course	Code	Credits	Total Hours - 40 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Instrumentation & Control	21EG641	03	03	00	50	50	03

COURSE OBJECTIVES: After completion of this course students are able to:

1. Understand types of Transducers and concept of Measurement system.3
2. Understand the working of various types of flow meters.
3. Understand the Measurement of force, Torque, Pressure.
4. Understand working of Strain and Temperature measurement techniques.
5. Understand the basic concept of control system and types of controllers.

MODULE-1

Measurement system and basic concepts of measurement methods: Definition, Significance of measurement, Generalized measurement system, Static characteristics- Accuracy, Precision, Calibration, Threshold, Sensitivity, Hysteresis, Repeatability, Linearity, Loading effect, Dynamic characteristics- System response, Time delay. Errors in measurement, Classification of errors.
Transducers: Transfer efficiency, Primary and Secondary transducers, Electrical transducers, Mechanical, Electronic transducers, Relative comparison of each type of transducers. **8 Hours**

MODULE-2

Introduction Flow meters, differential pressure type flow meters, variable area flow meters, positive displacement flow meters for liquids and gas services, Hot wire Anemometers, EM flow meter and turbine flow meter. Ultrasonic flow meter, Vortex flow meter, Cross correlation flow meter, Mass flow meter: Direct and Indirect methods. 8 Hours

MODULE-3

Applied mechanical measurement: Measurement of force, Torque, Pressure, Types of Dynamometers, Absorption dynamometer, Prony brake and Rope brake dynamometer, and Power Measuring Instruments. Use of elastic members, Bridgeman gauge, McLeod gauge, Pirani gauge. 8 Hours

MODULE-4

Measurement of strain and temperature: Theory of strain gauges, Types, Electrical resistance strain gauge, Preparation and mounting of Strain gauges, Gauge factor, Methods of strain measurement, temperature compensation, Resistance thermometers, Thermocouple, Law of thermocouple, Pyrometer, Optical pyrometer. 8 Hours

MODULE-5

Systems and their representation: Terminology and basic structure of control system, Open loop and Closed loop systems, servomechanism, regulatory system, analogous systems, electrical analogy of physical systems, Physical Systems and their models.
Process control: Types of process, Process lag, load disturbance and their effect on processes.
Controller modes: Basic control action, two position. Continuous controller modes: proportional, integral, derivative. Composite controller modes: P-I, PD, P-I-D. 8 Hours

COURSE OUTCOMES

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

	COURSE OUTCOMES	RBT LEVEL
CO1	Explain various types of Transducers and the concept of measurement system.	**L2**
CO2	Explain **the working of various types of flow meters.**	**L2**
CO3	Describe **the Measurement of force, Torque, Pressure.**	**L2**
CO4	Explain **working of Strain and Temperature measurement techniques.**	**L2**
CO5	Describe **the basic concept of control system and types of controllers**.	**L2**
	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	-	-	1	1	1	-	-	-	3
CO2	3	3	2	-	-	1	1	1	-	-	-	3
CO3	3	3	2	-	-	1	1	1	-	-	-	3
CO4	3	3	2	-	-	1	1	1	-	-	-	3
CO5	3	3	2	-	-	2	1	1	-	-	-	3

TEXTBOOKS:

1. Mechanical Measurements, Beckwith Marangoni and Lienhard 6th Ed., 2006
2. Instrumentation, Measurement and Analysis, B C Nakra, K KChaudhry McGraw–Hill 4thEdition
3. Engineering Metrology, R.K. Jain Khanna Publishers 2009.
4. Ogata K, "Modern Control Engineering", 4th Edition, Prentice Hall, New Delhi, 2002.
5. Stephanopoulos, "Chemical Process Control, 2nd edition, Prentice Hall, New Delhi, 2003.

REFERENCE:

1. Engineering Metrology and Measurements, Bentley, Pearson Education
2. Theory and Design for Mechanical Measurements, III edition, Richard S Figliola, Donald E Beasley, WILEY India Publishers
3. Engineering Metrology, Gupta I.C, DhanpatRai Publications
4. Deoblin's Measurement system, Ernest Deoblin, Dhaneshmanick McGraw–Hill
5. Engineering Metrology and Measurements, N.V.Raghavendra and L. Krishnamurthy, Oxford 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.

CRYOGENICS

Semester: VI **Year: 2021-22**

Course	Code	Credits	Total Hours - 40 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Cryogenics	21EG642	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. **8 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. **8 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. **8 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. **8 Hours**

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. **8 Hours**

COURSE OUTCOMES:

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

	COURSE OUTCOMES	RBT LEVEL
CO1	Analyse the cryogenic system.	L3
CO2	Interpret the cryogenic refrigeration system.	L3
CO3	Design gas separation and gas purification system.	L4
CO4	Solve the problem in insulation, storage of cryogenic liquids.	L3
CO5	Apply cryogenic in various areas and take up research in cryogenics.	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	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 **Year: 2021-22**

Course	Code	Credits	Total Hours - 50 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Optimization Techniques in Engineering	21EG651	04	03	01	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

	COURSE OUTCOMES	RBT LEVEL
CO1	Analyse the techniques of operations research.	L3
CO2	Formulate linear programming problems by graphical method, Simplex method, Big-M method and Dual simplex method.	L3
CO3	Formulate as Transportation and Assignment problems.	L3
CO4	Solve problems on game theory and job sequencing.	L3
CO5	Solve the numerical on CPM, PERT and queuing models.	L3
	Total Number Lecture Hours	**50**
	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	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, 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.

POWER PLANT ENGINEERING

Semester: VI **Year: 2021-22**

Course	Code	Credits	Total Hours - 50 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Power Plant Engineering	21EG652	04	03	01	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

	COURSE OUTCOMES	RBT LEVEL
CO1	Analyse the concepts of steam power plant, coal and ash handling and boiler and their practical application.	L3
CO2	Analyse the concepts and applications of Chimneys and boiler.	L3
CO3	Analyse the concept and application of hydroelectric plant and Gas turbine.	L3
CO4	Know the utilization of nuclear power plant and diesel power plant.	L3
CO5	Outline the site selection and economic analysis of power plant.	L3
	Total Number Lecture Hours	**50**
	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	-	-	-	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.

SOLAR ENERGY LAB

Semester: VI **Year: 2021-22**

Course	Code	Credits	Total Hours		Assessment		Exam Duration in hrs
			Hours /Week				
			Lecture	Practical	SEE	CIE	
Solar Energy Lab	21EGL66	01	00	02	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. Determine total solar radiation by using pyrnometer.
2. Find the diffuse solar radiation by using solar shadow ring pyrnometer
3. Ddetermine the sunshine for the day by using strip.
4. Draw the chart for sunshine record curve at various seasonal or day.
5. Determine the solar radiation by using solar power meter.

PART-B

6. Determine hart gain and heat removal factor and instantaneous efficiency of of Solar Flat Plate Collector.
7. Determine the over heat transfer coefficient and instantaneous efficiency of eacuative tube concentrator.
8. Performance of Solar Power Generation Kit with and without battery.
9. Performance of Solar Concentrator (Parabolic) Training System.
10. Performance of Wind Energy Training System with and without battery.

COURES OUTCOMES:

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

	COURSE OUTCOMES	**RBT LEVEL**
CO1	To analysis the different solar measuring devices.	L3
CO2	To evaluate the performance of the solar devices.	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	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

MANUFACTURING LAB

Semester: VI **Year: 2021-22**

Course	Code	Credits	Total Hours		Assessment		Exam Duration in hrs
			Hours /Week				
			Lecture	Practical	SEE	CIE	
Manufacturing Lab	**21EGL67**	**01**	**00**	**02**	**50**	**50**	**03**

COURSE OBJECTIVES:

1. To provide an insight to different machine tools, accessories and attachments.
2. To train students machining operations to enrich their practical skills.
3. To inculcate team qualities and expose students to shop floor activities.
4. To educate students about ethical, environmental and safety standards

PART-A

1. Preparation of a model using sheet metal work.
2. Preparation of three models on lathe involving - Plain turning, Taper turning, Step turning, Thread cutting, Facing, Knurling, Drilling, Boring, Internal Thread cutting and Eccentric turning.
   Exercises should include selection of cutting parameters and cutting time estimation.

PART-B

3. Cutting of V Groove/ dovetail / Rectangular groove using a shaper.
4. Cutting of Gear Teeth using Milling Machine.
   Exercises should include selection of cutting parameters and cutting time estimation.

COURES OUTCOMES:

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

	COURSE OUTCOMES	RBT LEVEL
CO1	Demonstrate the integral parts of lathe, shaping and milling machines and various accessories and attachments used.	L3
CO2	Perform cylindrical turning operations such as plain turning, taper turning, step turning, thread Cutting, facing, knurling, internal thread cutting, eccentric turning and estimate cutting time.	L3
CO3	Perform machining operations such as plain shaping, inclined shaping, keyway cutting, Indexing and Gear cutting and estimate cutting time.	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	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

VIRTUAL LAB

Semester: VI **Year: 2021-22**

Course	Code	Credits	Total Hours		Assessment		Exam Duration in hrs
			Hours /Week				
			Lecture	Practical	SEE	CIE	
Fluid Mechanics & Machinery Lab	**21EGL68**	**01**	**00**	**02**	**50**	**50**	**03**

COURSE OBJECTIVES:

Many of our daily life activity depends on fluid machinery so it is important to understand the functioning principles and characteristics of such machinery from an engineering point of view. This lab focuses on giving the user idea about the practical behavior of such machines before performing operations on a real system.

PART-A

1. Bernoulli's Experiment
2. Venturi Meter Experiment
3. Orifices Experiment
4. Mouthpieces Experiment
5. Weirs Experiment
6. Channels Experiment

PART-B

1. Performance Characteristics of Centrifugal Pump.
2. Performance Characteristics of Hydraulic Ram
3. Double Acting Reciprocating Pump
4. Performance Characteristics of Pelton Turbine
5. Performance Characteristics of Kaplan Turbine
6. Performance Characteristics of Francis Turbine

COURES OUTCOMES:

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

	COURSE OUTCOMES	**RBT LEVEL**
CO1	To understand the different flow measurement equipment's and their procedures.	L3
CO2	Comprehend the knowledge in calculating performance analysis in turbines and pumps and can be used in power plants.	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	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-VI

Semester: VI **Year: 2021-22**

Course	Code	Credits	Total Hours		Assessment		Exam Duration in hrs
			Hours /Week				
			Lecture	Project	SEE	CIE	
Project-VI	**21PROJ69**	**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	Identify issues related to environment, society and industry.	L3
CO2	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 : 25Marks
Viva -Voice : 10 Marks
Total : 50 Marks

ABILITY ENCHANCEMENT COURSE

Semester: VI **Year: 2021-22**

Course	Code	Credits	Total Hours		Assessment		Exam Duration in hrs
			Hours /Week				
			Lecture	Practical	SEE	CIE	
Information & Communication Technology (ICT)	**21AEC610**	**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**.** **09 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. **10 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). **09 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:

	COURSE OUTCOMES	RBT LEVEL
CO1	Study the literature of social networks and their properties.	L1
CO2	Develop skills to use various social networking sites.	L1
CO3	Apply skills to use online forums, docs, spread sheets, etc. for communication, Collaboration and research.	L2
	Total Number Lecture Hours	**28**
	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	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.

Continuous Internal Evaluation (CIE)
Record Details
2021 Scheme (2021-2025 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	35
	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	35
	Total	**35**

Final Marks = Table 1 + Table 2
Example: Final Marks = 14+35
= 49/50

SHARNBASVA UNIVERSITY, KALABURAGI

Faculty of Engineering & Technology (Co-Edu.)

Scheme of Teaching and Examination 2021-22

Outcome Based Education (OBE) and Choice Based Credit System

(CBCS)(Effective from the academic year 2021-22)

Programme: B. Tech, Energy Engineering

VII SEMESTER

Sl. No.	Course category	Course Code	Course Title	Teaching Dept. (TD) Question PaperSetting Board (PSB)	Teaching Hours/week			Examination				Credits
					Theory Lecture	Tutorial	Practical	Duration in Hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	PCC	21EG71	Python for Energy Engineering	TD:EG/ME PSB:EG/ME	3	0	0	03	50	50	100	03
2	PCC	21EG72	Wind Energy Utilization	TD:EG/ME PSB:EG/ME	3	0	0	03	50	50	100	03
3	PEC	21EG73X	Professional Elective-3	TD:EG/ME PSB:EG/ME	3	0	0	03	50	50	100	03
4	PEC	21EG74X	Professional Elective-4	TD:EG/ME PSB:EG/ME	3	0	0	03	50	50	100	03
5	OEC	21EG75X	Open Elective -3	TD:EG/ME PSB:EG/ME	4	0	0	03	50	50	100	04
6	PCC LAB	21EGL76	Python Lab for Energy Engineering	TD:EG/ME PSB:EG/ME	0	0	2	03	50	50	100	01
7	PCC LAB	21EGL77	Environmental Lab	TD:EG/ME PSB:EG/ME	0	0	2	03	50	50	100	01
8	AEC	21AEC78	Intellectual Property Rights	TD:EG/ME PSB:EG/ME	0	0	2	03	50	50	100	01
9	PROJ	21PROJ79	Project-VII	TD:EG/ME PSB:EG/ME	0	0	2	03	50	50	100	01
10	HSS	21HSM710	Industrial Psychology and Organizational Behavior	TD:EG/ME PSB:EG/ME	1	0	0	03	50	50	100	01
Total					**17**	**0**	**8**	**30**	**500**	**500**	**1000**	**21**

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.

Project (PROJ): A batch of 4 to 5 students (Same branch or different branches) with a guide, may undertake one project (1 hour of theory/tutorial

or two hours of practice /activities.

7TH SEMESTER

Note: Energy Engineering Department students are not allowed to choose the parent department open elective subjects. Energy Engineering Department students have to choose open elective courses from other departments.

Professional Elective Courses -III (For EG Students)			**Professional Elective Courses -IV (For EG Students)**		
SL. No	**Course Code**	**Course Title**	**SL. No**	**Course Code**	**Course Title**
1	21EG731	Hydrogen Energy and Fuels Cells	1	21EG741	Waste to Energy
2	21EG732	Conservation and Energy Audit	2	21EG742	Refrigeration and Air Conditioning System

Open Elective Courses -III (For Non EG Students)		
SLNo	**Course Code**	**Course Title**
1	21EG751	Measurements and Instrumentation

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.

PYTHON FOR ENERGY ENGINEERING

Semester: VII

Course	Code	Credits	Total Hours - 45 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Python for Energy Engineering	21EG71	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.

9 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

9 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.

9 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. **9 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. **9 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	-	1	-	0	-	1
CO2	2	2	3	1	3	1	-	1	-	1	-	1
CO3	3	3	2	2	3	1	-	2	-	2	-	1
CO4	3	3	2	1	2	1	-	2	-	1	-	1
CO5	3	3	2	1	1	1	-	2	-	1	-	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.

WIND ENERGY UTILIZATION

Semester: VII

Course	Code	Credits	Total Hours - 45 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Wind Energy Utilization	21EG72	03	03	00	50	50	03

COURSE OBJECTIVES:

1. To introduce the technology, grid integration and energy assessment for the wind power system to the final year BE student.
2. Outline the origin of global, geostrophic and surface winds.
3. Explain the impact of surface roughness and orography on wind speed profiles.

MODULE-1

Wind Power Basics : Historical- evolution of wind power system, Change in size and output, Wind energy conversion system: turbine, generator, power electronics, grid, Wind power plant and wind mill. Future trend: Cost, capacity, integration issues. **9 Hours**

MODULE-2

Wind energy assessment: Power in the Wind, temperature, altitude correction, impact of Tower, Maximum Rotor Efficiency, Average Power in the Wind, Discrete Wind Histogram, wind power probability density functions, Weibull and Rayleigh Statistics, Average Power in the Wind with Rayleigh Statistics. **9 Hours**

MODULE-3

Technology of wind energy conversion system: Wind Turbines, Generators, Power Electronics Interfaces. Classification of WECS - Fixed speed-based wind turbines, partially rated Converter-based (FRC) Wind Turbines, Fully Rated converter-based (FRC) Wind Turbines.

9 Hours

MODULE - 4

Integration of WECS and Economics: Interconnection issues, Operation of off-grid mode: hybrid system, Operation in grid connected mode, Fault ride through. Wind Turbine Economics - Capital Costs and Annual Cost, Annualized cost of Electricity from Wind Turbines**.** **9 Hours**

MODULE- 5

Wind power and electricity markets: Introduction, The electrical energy market, Balancing, capacity and ancillary services, Support mechanisms, Costs, Investment and risk, future trends. Small Wind turbine and types, towers and their maintenance, power electronic devices and converters for SWT and common mechanical faults. **9 Hours**

COURSE OUTCOMES:

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

CO#	COURSE OUTCOMES
CO1	Comprehend the basic differentiate between different types of wind energy conversion systems.
CO2	Understand the assessment of wind energy conversion systems.
CO3	Recognize the technology uses and various types of systems.
CO4	Comprehend types of components of wind energy systems and analysis of economics
CO5	Know How of Energy forecasting, capacity, energy pricing.

CO-PO Mapping

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

TEXT BOOKS:

1. Wind Power in Power Systems, edited by Thomas Ackermann, Wiley publication, 2nd edition, 2004
2. Renewable and efficient power system
3. Wind Energy: Fundamentals, Resource analysis and Economics, Mathew Sathyajith, 2006
4. Wind Energy Explained: theory, Design and Application, James F. Manwell, Jon G. McGowan, Anthony L. Rogers, 2010.

REFERENCE BOOK

1. Wind Energy Fundamentals: A Guide to the Technology" by David A. G. A. Van De Vate.
2. "Wind Energy: Renewable Energy and the Environment" by Bernard V. L. P. Jacques
3. Wind Energy: An Introduction by A. M. Yazdi

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.

HYDROGEN ENERGY AND FUEL CELLS

Semester: VII

Course	Code	Credits	Total Hours - 45 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Hydrogen Energy and Fuel Cells	21EG731	03	03	00	50	50	03

COURSE OBJECTIVES:

1. To understand different basics of hydrogen energy and different production pathways for a sustainable development.
2. To develop a basic understanding of Hydrogen Storage systems and Utilization.
3. To discuss the fundamentals of various types of fuel cell system, its components, characterization and Fuel Cell electrolytes.
4. To explain the kinetics and electrochemistry of different fuel cell systems.
5. To inculcate the technical know-how of different analytical techniques for performance evaluation of fuel cell systems.

MODULE-1

Introduction to Hydrogen energy systems: Current scenario of hydrogen production, General introduction to infrastructure requirement for hydrogen production, dispensing and utilization.

Hydrogen production pathways: Thermal: Steam reformation, Thermo chemical water splitting, Gasification, Pyrolysis and Partial oxidation methods. Electrochemical: Electrolysis, Photo-electro chemical. Biological: Anaerobic Digestion, Fermentative Micro-organisms **09 Hours**

MODULE-2

Hydrogen Storage & Utilization: General storage methods, compressed storage, Zeolites, Metal hydride storage, chemical hydride storage and cryogenic storage, Storage Tanks. Utilization: Overview of hydrogen utilization, I.C. Engines, gas turbines, hydrogen burners, power plant, refineries, domestic, Marine applications, fuel cell.

Hydrogen Transportation & Safe Handling: Transportation (Compressed Hydrogen, Liquefied Hydrogen, and Pipeline). Safety concerns, Safety requirements, Safety Data Sheet of Hydrogen, Hydrogen Codes and Standards. **09 Hours**

MODULE-3

Introduction to Fuel Cell: A simple fuel cell, Schematic representation, fuel cell types, Major differences of fuel cells, advantages & disadvantages, basic fuel cell operation, fuel cell technology, fuel cells and the environment.

Fuel cell electrolytes: different types of electrolytes used, ionomeric membrane in PEFC, mechanism of ion transfer in ionomeric membranes, relation between proton conductivity and water content, alternative membranes **09 Hours**

MODULE-4

Fuel Cell Reaction Kinetics: Introduction to electrode kinetics, activation energy of charge transfer reactions, activation energy determining reaction rate, exchange current density, Galvanic potential, exchange currents and electro-catalysis, Improving kinetic performance.

Fuel Cell Charge Transport: Charges move in response to forces, charge transport results in a voltage loss, characteristics of fuel cell charge transport resistance, physical meaning of conductivity, review of fuel cell electrolyte types (Strong, Weak & Non electrolytes). **09 Hours**

MODULE-5

Fuel Cell Types: Phosphoric acid fuel cell, Polymer electrolyte membrane fuel cell, Alkaline fuel cell, Molten carbonate fuel cell, Solid-oxide fuel cell, other fuel cells.

Safety & Social Implications: Safety concerns, Safety requirements, National and International standards.

Economics: Fuel cell production costs, Infrastructure costs, System costs. Opportunities & Obstacles in Fuel Cells. **09 Hours**

COURSE OUTCOMES

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

CO#	COURSE OUTCOMES
CO1	Understand and identify hydrogen energy and different production pathways.
CO2	Explore different routes for hydrogen storage and utilization.
CO3	Acquire knowledge of Fuel Cell technology and fuel cell electrolyte.
CO4	Ascertain importance of Fuel Cell Reaction Kinetics and Charge Transfer
CO5	Outline different types of fuel cells and differentiate importance of Economics Safety & Social Implications.

CO-PO Mapping

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

TEXT BOOKS:

1. "Hydrogen and Fuel Cells", by Bent Sørensen, Elsevier Academic Press.
2. Fuel Cell Fundamentals (3rd Ed.) by O'Hayre, Ryan/ Colella, Whitney/ Cha, Suk-Won. Wiley Publications.

REFERENCES BOOKS:

1. Supramaniam Srinivasan, Fuel Cells: From Fundamentals to Applications, Springer.
2. Fuel Cell Handbook by J.H. Hirschenhofer, D.B. Stauffer, R.R. Engleman, and M.G. Klett.

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.

CONSERVATION AND ENERGY AUDIT

Semester: VII

Course	Code	Credits	Total Hours -45		Assessment		Exam Duration in Hours
			Hours/Week				
			Lecture	Tutorial	SEE	CIE	
Conservation and Energy Audit	21EG732	03	03	00	50	50	03

COURSE OBJECTIVES:

1. To understand the current energy scenario and importance of energy conservation.
2. To understand the concepts of energy management.
3. To understand the methods of improving energy efficiency in different electrical systems.
4. To understand the concepts of different energy efficient devices

MODULE:01

Energy Scenario: Commercial and Non-commercial energy, primary energy resources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy and environment, energy security, energy conservation and its importance, restructuring of the energy supply sector, energy strategy for the future, air pollution, climate change. Energy Conservation Act-2001 and its features. **09 Hours**

MODULE:02

Energy Management & Audit: Definition, energy audit, need, types of energy audit. Energy management (audit) approach understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments. Material and Energy balance: Facility as an energy system, methods for preparing process flow, material and energy balance diagrams. **09 Hours**

MODULE:03

Energy Efficiency in Electrical Systems: Electrical system: Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors, performance assessment of PF capacitors, distribution and transformer losses. Electric motors: Types, losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors. **09 Hours**

MODULE:04

Energy Efficiency in Industrial Systems: Compressed Air System: Types of air compressors, compressor efficiency, efficient compressor operation, Compressed air system components, capacity assessment, leakage test, factors affecting the performance and savings opportunities in HVAC, Fans and blowers: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. Pumps and Pumping System: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. Cooling Tower: Types and performance evaluation, efficient system

operation, flow control strategies and energy saving opportunities, assessment of cooling towers. **09 Hours**

MODULE:05

Energy Efficient Technologies in Electrical Systems: Maximum demand controllers, automatic power factor controllers, energy efficient motors, soft starters with energy saver, variable speed drives, energy efficient transformers, electronic ballast, occupancy sensors, energy efficient lighting controls, energy saving potential of each technology. **09 Hours**

COURSE OUTCOMES

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

	COURSE OUTCOMES
CO1	Understand the concepts of energy conservation and audit.
CO2	Analyze the theory of energy management and audit.
CO3	Apply the concepts of energy efficiency in electrical and industrial Systems.
CO4	Examine the different energy efficient technologies in electrical system.
CO5	How the ability to apply the various energy conservation and audit concepts

CO-PO Mapping

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

TEXT BOOKS:

1. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects (available online)
2. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-3, Electrical Utilities (available online)
3. Energy Conservation and Audit by Suresh Kumar Soni and Manoj Nair, Tech India Publications Series, Satya Prakashan, New Delhi,2009
4. Utilization of Electrical Energy and Conservation‖ by S. C. Tripathy, McGraw Hill, Reprint 1991.

REFERENCES BOOKS:

1. Energy management by W.R. Murphy & G. McKay Butter worth, Elsevier publications. 2012
2. Electric Energy Utilization and Conservation by S C Tripathy, TMH publishing company Ltd. New Delhi.
3. Hand Book of Energy Audit by Sonal Desai- Tata McGraw hill
4. Energy management by Paul o' Callaghan, Mc–Graw Hill Book company–1st edition, 1998.
5. Energy management hand book by W.C. Turner, John Wiley and sons.
6. Energy management and conservation – KV Sharma and P. Venkata Seshaiah-I K International Publishing House Pvt. Ltd, 2011.

7. http://www.energymanagertraining.com/download

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.

WASTE TO ENERGY

Semester: VII

Course	Code	Credits	Total Hours - 45 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Waste to Energy	**21EG741**	**03**	**03**	**00**	**50**	**50**	**03**

COURSE OBJECTIVES:

1. To introduce students to the different types of waste and their characterization.
2. To teach students the various methods of converting waste to energy.
3. To develop students' understanding of the principles behind the conversion processes.
4. To teach energy production from thermos chemical conversion
5. To equip students with the knowledge and skills to design and implement waste-to-energy projects.

MODULE-1

Characterisation and classification of waste as fuel: agro based, forest residues, industrial waste, domestic waste, Municipal solid waste**.** **09 Hours**

MODULE-2

Waste to energy options: combustion (unprocessed and processed fuel), gasification, anaerobic digestion, fermentation, pyrolysis. **09 Hours**

MODULE-3

Energy from waste- Bio-chemical Conversion: Anaerobic digestion of sewage and municipal wastes, direct combustion of MSW-refuse derived solid fuel, industrial waste, agro residues, anaerobic digestion, biogas production, land fill gas generation and utilization. **09 Hours**

MODULE-4

Energy from waste-thermo chemical conversion: Sources of energy generation, incineration, pyrolysis, gasification of waste using gasifiers, briquetting, utilization and advantages of briquetting, environmental and health impacts of incineration; strategies for reducing environmental impacts. **09 Hours**

MODULE-5

Biomass energy technologies: Biomass characterization (proximate and ultimate analysis); Biomass pyrolysis and gasification; Biofuels – biodiesel, bioethanol, Biobutanol; Algae and biofuels; Hydrolysis hydrogenation; Solvent extraction of hydrocarbons; Pellets and bricks of biomass; Biomass based thermal power plants; Biomass as boiler fuel. **09 Hours**

COURSE OUTCOMES:

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

	COURSE OUTCOMES
CO1	Differentiate and characterize different waste
CO2	Recognize the various waste to energy conversion processes

CO3	Explain various biochemical conversion processes.
CO4	Explain various thermochemical conversion processes
CO5	Explain various biomass process to energy conversion.

CO-PO Mapping

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

TEXT BOOKS:

1. Desai Ashok V., Non-Conventional Energy, Wiley Eastern Ltd., 1980.
2. Pichtel John, Waste Management Practices Municipal, Hazardous and Industrial, Taylor & Francis, 2005

REFERENCE BOOKS:

1. Rogoff, M. J. and Screve, F., "Waste-to-Energy: Technologies and Project Implementation", Elsevier Store, 2011.
2. Young G. C., "Municipal Solid Waste to Energy Conversion processes", John Wiley and Sons, 2010.
3. Harker, J. H. and Backhusrt, J. R., "Fuel and Energy", Academic Press Inc, 1981.
4. EL-Halwagi, M. M., "Biogas Technology – Transfer and Diffusion", Elsevier Applied Science, 1986.
5. Hall, D.O. and Overeed, R.P.," Biomass – Renewable Energy", John Willy and Sons.
6. Mondal, P. and Dalai, A. K. eds., 2017. Sustainable Utilization of Natural Resources. CRC 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.

REFRIGERATION AND AIR CONDITIONING SYSTEM

Semester: VII

Course	Code	Credits	Total Hours - 45 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Refrigeration and Air Conditioning System	**21EG742**	**03**	**03**	**00**	**50**	**50**	**03**

COURSE OBJECTIVES:

1. Learning the fundamental principles and different methods of refrigeration and air conditioning.
2. Study of various refrigeration cycles and evaluate performance using Mollier charts and/ or refrigerant property tables.
3. Comparative study of different refrigerants with respect to properties, applications and environmental issues.
4. Understand the basic air conditioning processes on psychometric charts, calculate cooling load for its applications in comfort and industrial air conditioning.
5. Study of the various equipment-operating principles, operating and safety controls employed in refrigeration air conditioning systems.

MODULE-1

Applications of Refrigeration and Air Conditioning and Refrigerants: Applications Domestic Refrigerator, Domestic Air Conditioners, Automotive Air Conditioners, Evaporative coolers, water coolers, Commercial Refrigeration- Dairy, Cold storage, Ice plant, Commercial Air Conditioning-Multiplex, Hospitals.

Refrigerants: Classification of refrigerants, Designation of refrigerants, Desirable properties of refrigerants, environmental issues, Ozone depletion and global warming, ODP, GWP & LCCP, selection of environment friendly refrigerants, secondary refrigerants, anti-freeze solutions, Zeotropes and Azeotropes, refrigerant: recovery reclaims, recycle and recharge. **09 Hours**

MODULE-2

Vapour Refrigeration Systems: Vapour compression systems Working of simple vapour compression system, representation of vapour compression cycle (VCC) on T-s and P-h diagram, COP, EER, effect of operating parameters on performance of VCC, actual VCC, methods of improving, sub-cooling, liquid vapour heat exchanger, comparison of VCC with Reverse Carnot cycle.

Vapor absorption systems: Introduction, Working of simple vapour absorption system (VAS), desirable properties of binary mixture (aqua-ammonia), performance evaluation of simple VAS (simple numerical treatment), actual VAS, Li-Br absorption system, three fluid system (Electrolux refrigeration), applications of VAS, comparison between VCC and VAC. **09 Hours**

MODULE-3

Multiple pressure Refrigeration Systems: Introduction, need of multistage system, Intermediate pressure, two stage compression with flash gas removal and liquid intercooler, single compressor with multiple evaporator: individual and multiple expansion valves, individual compressors, cascade system: application and numerical (numerical only by using p-h chart), Introduction to cryogenics (Linde - Hampson cycle) and applications (no numerical treatment. **09 Hours**

MODULE-4

Psychrometry and Air conditioning load estimation: Psychrometry Basic Psychrometry and processes, BPF of coil, ADP, adiabatic mixing of two air streams, SHF, RSHF, GSHF, ESHF. Factors contributing to cooling load, Numerical based on load analysis

Human Comfort: Thermodynamics of human body, comfort and comfort chart, factors affecting human comfort, concept of infiltration and ventilation, indoor air quality requirements. **09 Hours**

MODULE-5

Air Conditioning Systems: Air Conditioning Systems Working of summer, winter and all year-round AC systems, all air system, all water system, variable refrigerant flow and, unitary and central air conditioning.

Components of refrigeration and air conditioning systems: Working of reciprocating, and scroll compressors, working of air cooled, water cooled and evaporative condensers, working of DX, Flooded, forced feed evaporators, Expansion devices – Capillary tube, EXV, operating and safety controls. **09 Hours**

COURSE OUTCOMES:

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

	COURSE OUTCOMES
CO1	Illustrate the fundamental principles and applications of refrigeration and air conditioning system.
CO2	Obtain cooling capacity and coefficient of performance by conducting test on vapour compression refrigeration systems.
CO3	Present the properties, applications and environmental issues of different refrigerants.
CO4	Calculate cooling load for air conditioning systems used for various.
CO5	Operate and analyse the refrigeration and air conditioning systems.

CO-PO Mapping

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

TEXT BOOKS:

1. Arora C. P., Refrigeration and Air Conditioning, Tata McGraw-Hill
2. Manohar Prasad, Refrigeration and Air Conditioning, Willey Eastern Ltd, 1983
3. McQuiston, — Heating Ventilating and air Conditioning: Analysis and Design‖ 6th Edition, Wiley India.
4. Arora and Domkundwar, Refrigeration & Air Conditioning, Dhanpatrai & Company, New Delhi.
5. Khurmi R.S. and Gupta J.K., Refrigeration and Air conditioning, Eurasia Publishing House Pvt. Ltd, New Delhi,1994.

REFERENCE BOOKS:

1. Dossat Ray J, Principles of refrigeration, S.I. version, Willey Eastern Ltd, 2000.
2. Stockers W.F and Jones J.W., Refrigeration and Air conditioning, McGraw Hill International editions 1982.
3. Threlkeld J.L, Thermal Environmental Engineering, Prentice Hall Inc., New Delhi4.
4. Aanatnarayan, Basics of refrigeration and Air Conditioning, Tata McGraw Hill Publications.
5. Roger Legg, Air Conditioning System Design, Commissioning and Maintenance
6. ASHRAE & ISHRAE handbook

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.

MEASUREMENTS AND INSTRUMENTATION

Semester: VII

Course	Code	Credits	Total Hours - 50 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Measurements and Instrumentation	21EG751	04	04	00	50	50	03

COURSE OBJECTIVES:

1. Understand types of Transducers and concept of Measurement system.
2. Understand the working of various types of flow meters.
3. Understand the Measurement of force, Torque, Pressure.
4. Understand working of Strain and Temperature measurement techniques.
5. Understand the basic concept of comparators and types of comparators.

MODULE-1

Measurement system and basic concepts of measurement methods: Definition, Significance of measurement, generalized measurement system, Static characteristics- Accuracy, Precision, Calibration, Threshold, Sensitivity, Hysteresis, Repeatability, Linearity, Loading effect, Dynamic characteristics- System response, Time delay. Errors in measurement, Classification of errors.

Transducers: Transfer efficiency, Primary and Secondary transducers, Electrical transducers, Mechanical, Electronic transducers, Relative comparison of each type of transducers. **10 Hours**

MODULE-2

Introduction Flow meters, differential pressure type flow meters, variable area flow meters, positive displacement flow meters for liquids and gas services, Hot wire Anemometers, EM flow meter and turbine flow meter. Ultrasonic flow meter, Vortex flow meter, Cross correlation flow meter, Mass flow meter: Direct and Indirect methods. **10 Hours**

MODULE-3

Applied mechanical measurement: Measurement of force, Torque, Pressure, Types of Dynamometers, Absorption dynamometer, Prony brake and Rope brake dynamometer, and Power Measuring Instruments. Use of elastic members, Bridgeman gauge, McLeod gauge, Pirani gauge. **10 Hours**

MODULE-4

Measurement of strain and temperature: Theory of strain gauges, Types, Electrical resistance strain gauge, Preparation and mounting of Strain gauges, Gauge factor, Methods of strain measurement, temperature compensation, Resistance thermometers, Thermocouple, Law of thermocouple, Pyrometer, Optical pyrometer**.** **10 Hours**

MODULE-5

Comparators: Introduction to Comparators, Need for Comparator, Characteristics of Comparator,

Classification of Comparators, Mechanical Comparators, Optical Comparators, Pneumatic Comparators, Brookes Level Comparator – Vernier Bevel Protractor, Optical Bevel Protractor, Sine Bar. **10 Hours**

COURSE OUTCOMES:

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

CO#	COURSE OUTCOMES
CO1	Understand the various types of Transducers and the concept of measurement system.
CO2	Analysis the working of various types of flow meters.
CO3	Describe the Measurement of force, Torque, Pressure.
CO4	Analysis working of Strain and Temperature measurement techniques.
CO5	Describe the basic concept of comparators and types of comparators.

CO-PO Mapping

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

TEXT BOOKS:

1. Mechanical Measurements, Beckwith Marangoni and Lienhard 6th Ed., 2006
2. Instrumentation, Measurement and Analysis, B C Nakra, K K Chaudhry McGraw–Hill 4thEdition
3. Engineering Metrology, R.K. Jain Khanna Publishers 2009.
4. Ogata K, "Modern Control Engineering", 4th Edition, Prentice Hall, New Delhi, 2002.
5. Stephanopoulos, "Chemical Process Control, 2nd edition, Prentice Hall, New Delhi, 2003.

REFERENCE BOOKS:

1. Engineering Metrology and Measurements, Bentley, Pearson Education
2. Theory and Design for Mechanical Measurements, III edition, Richard S Figliola, Donald E Beasley, WILEY India Publishers
3. Engineering Metrology, Gupta I.C, DhanpatRai Publications
4. Deoblin's Measurement system, Ernest Deoblin, Dhaneshmanick McGraw–Hill
5. Engineering Metrology and Measurements, N.V.Raghavendra and L. Krishnamurthy, Oxford 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**.**

PYTHON LAB FOR ENERGY ENGINEERING

Semester: VII

Course	Code	Credits	Total Hours		Assessment		Exam Duration in hrs
			Hours /Week				
			Lecture	Practical	SEE	CIE	
Python Lab for Energy Engineering	**21EGL76**	**01**	**00**	**02**	**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:

	COURSE OUTCOMES
CO1	Ability to Develop Python Programs for Renewable Energy Systems
CO2	Proficiency in Simulating and analysing 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	3	2	1	2	2	-	1	-	-	1	-	2
CO2	3	2	1	2	2	-	1	-	-	1	-	2
CO3	3	2	1	2	2	-	1	-	-	1	-	2
CO4	3	2	1	2	2	-	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

ENVIRONMENTAL ENGINEERING LAB

Semester: VII

Course	Code	Credits	Total Hours		Assessment		Exam Duration in hrs
			Hours /Week				
			Lecture	Practical	SEE	CIE	
Environmental Engineering Lab	21EGL77	01	00	02	50	50	03

COURSE OBJECTIVES:

1. To learn different methods of water & waste water quality
2. To conduct experiments to determine the concentrations of water and waste water
3. To determine the degree and type of treatment
4. To understand the environmental significance and application in environmental engineering practice
5. Understanding professional and ethical responsibility

LIST OF EXPERIMENTS:

PART-A

1. Preparation chemical reagents required for laboratory analysis by standard method
2. Determination of pH, Conductivity, TDS and Turbidity.
3. Determination of Acidity and Alkalinity
4. **.** Determination of Calcium, Magnesium and Total Hardness
5. Determination of Dissolved Oxygen
6. Determination of BOD
7. Determination of Chlorides

PART-B

8. Determination of percentage of % of available chlorine in bleaching powder sample, Determination of Residual Chlorine and chlorine demand.
9. Determination of Solids in Sewage: i) Total Solids, ii) Suspended Solids, iii) Dissolved Solids.
10. Determination of optimum coagulant dosage using Jar test apparatus.
11. Determination of Fluoride, Nitrate and Sulphate by spectrophotometer
12. Determination of COD(Demonstration)
13. Air Quality Monitoring (Demonstration)

COURES OUTCOMES:

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

CO#	COURSE OUTCOMES
CO1	Acquire capability to conduct experiments and estimate the concentration of different parameters.
CO2	Compare the result with standards and discuss based on the purpose of analysis.
CO3	Determine type of treatment, degree of treatment for water and waste water.
CO4	Identify the parameter to be analyzed for the student project work in environmental stream.
CO5	Compute and visualize the working of various units and write report.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	-	-	2	3	1	2	2	-	2
CO2	3	2	3	-	-	2	3	1	2	2	-	2
CO3	3	2	3	-	-	2	3	1	2	2	-	2
CO4	3	2	3	-	-	2	3	1	2	2	-	2
CO5	3	2	3	-	-	2	3	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 part –A: 20 Marks
ONE question from part –B: 20Marks
Viva -Voice: : 10 Marks
Total : 50 Marks

IPR FOR ENGINEERS AND ENTREPRENEURS

SEMESTER: VII

Course	Code	Credits	Total Hours		Assessment		Exam Duration in hrs
			Hours /Week				
			Lecture	Practical	SEE	CIE	
IPR for Engineers and Entrepreneurs	**21AEC78**	**01**	**00**	**01**	**50**	**50**	**03**

OBJECTIVE: The main objectives are to

1. To introduce fundamental aspects of Intellectual property Rights to Engineering students who are going to be Entrepreneurs and play a major role in development and management of innovative projects in industries.
2. To disseminate knowledge on Patents, patent regime in India and abroad and registration aspects.
3. To disseminate knowledge on Copyrights and its related rights and registration aspects.
4. To disseminate knowledge on Trademarks and registration aspects.
5. To disseminate knowledge on Design, Geographical Indication (GI), Plant Variety and Layout Design Protection and their registration aspects.
6. Too aware about current trends in IPR and Professional opportunities in IPR.

MODULE- 1: Overview of Intellectual Property

Introduction and the need for intellectual property right (IPR) - IPR in India: Genesis and development - IPR in abroad. Major International Instruments concerning Intellectual Property Rights: Paris Convention, 1883, the Universal Copyright Convention, 1952, the WIPO Convention, 1967, the Patent Co-operation Treaty, 1970 and the TRIPS Agreement, 1994. **4 Hours**

MODULE-2: Patents

Elements of Patentability: Novelty, Registration Procedure, Rights and Duties of Patentee, Assignment and license, Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies & Penalties – Patent office and Appellate Board. **4 Hours**

MODULE-3: Copyrights

Nature of Copyright - Subject matter of copyright: original literary, dramatic, musical, artistic works; cinematograph films and sound recordings - Registration Procedure, Term of protection, Ownership of copyright, Assignment and License of copyright - Infringement, Remedies & Penalties – Related Rights - Distinction between related rights and copyrights. **4 Hours**

MODULE-4: Trademarks

Concept of Trademarks - Different kinds of marks (brand names, logos, signatures, symbols, well known marks, certification marks and service marks) - Non-Registrable Trademarks - Registration of Trademarks - Rights of holder and assignment and licensing of marks - Infringement, Remedies & Penalties - Trademarks registry and appellate board. **4 Hours**

MODULE-5: Other forms of IP

Design: Meaning and concept of novel and original - Procedure for registration, effect of registration and term of protection.

Geographical Indication (GI): Meaning, and difference between GI and trademarks - Procedure for registration, effect of registration and term of protection. **4 Hours**

Self-Study

India's New National IP Policy, 2016 – Govt. of India step towards promoting IPR – Govt. Schemes in IPR – Career Opportunities in IP (Patent Agent – Trademark agent) - IPR in current scenario with case studies. **4 Hours**

COURSE OUTCOMES

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

CO#	COURSE OUTCOMES
CO1	Demonstrate an understanding of the concept and significance of intellectual property rights (IPR) globally and in India.
CO2	Identify and analyze the essential elements of patentability, including novelty and the registration procedure.
CO3	Describe the nature and subject matter of copyright, including various forms of creative works and their protection under the law.
CO4	Analyse the key concepts of trademarks and distinguish between various types of marks, including non-registrable marks.
CO5	Discuss the importance of design and GI in the context of intellectual property and their effects on market competition and consumer awareness

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

Text book:

1. "Fundamentals of IP for Engineer", Bansl & P.Bans
2. "Intellectual Property Rights: Protection and Management" India, Nithyananda, K V. (2019), Cengage Learning India Private Limited.

Reference book:

1. Ahuja, V K. (2017). Law relating to Intellectual Property Rights. India, IN: Lexis Nexis.

E-resources:

1. Subramanian, N., & Sundararaman, M. (2018). Intellectual Property Rights – An Overview. Retrieved from http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf
2. World Intellectual Property Organization. (2004). WIPO Intellectual property Handbook. Retrieved from https://www.wipo.int/edocs/pubdocs/en/intproperty/489/ wipopub489.pdf

Useful Websites:

1. Cell for IPR Promotion and Management (http://cipam.gov.in/)
2. World Intellectual Property Organization (https://www.wipo.int/about-ip/en/)
3. Office of the Controller General of Patents, Designs & Trademarks (http://www.ipindia.nic.in/)

Scheme of Examination:

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

PROJECT-VII

Semester: VII

Course	Code	Credits	Total Hours		Assessment		Exam Duration in hrs
			Hours /Week				
			Lecture	Project	SEE	CIE	
Project-VII	21PROJ79	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	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

INDUSTRIAL PSYCHOLOGY AND ORGANIZATIONAL BEHAVIOR

Semester: VII

Course	Code	Credits	Total Hours		Assessment		Exam Duration in Hours
			Hours/Week				
			Lecture	Tutorial	SEE	CIE	
Industrial Psychology and Organizational Behavior	**21HSM710**	**01**	**01**	**00**	**50**	**50**	**03**

COURSE OBJECTIVES:

1. Relating human psychology to science
2. Understand the human psychology
3. Understand the nature of organization and organization models
4. Understand the human social communication
5. Understand the leadership qualities

MODULE-1

Introduction to I/O psychology: Major fields of I/O psychology, brief history of I/O psychology, employment of I/O psychology, ethics in I/O psychology (Chapter-1) **04 Hours**

MODULE-2

Organisational communication: Types of organizational communication, interpersonal communication, improving employee communication skills. (Chapter-11) **05 Hours**

MODULE-3

Leadership: Introduction, personal characteristics associated with leadership, interaction between the leadership and the situation specific leader skills, leadership where we are today. (Chapter-12) **05 Hours**

MODULE-4

Group behaviour- teams and conflicts: Group dynamics, factors affecting group performance, individual versus group performance, group conflicts. (Chapter-13) **05 Hours**

MODULE-5

Stress management: Dealing with the demands of life and work, stress defined, predisposition to stress, sources of stress, consequences of stress, stress reduction intervention related to life /work issues. (Chapter-15) **05 Hours**

COURSE OUTCOMES:

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

CO#	COURSE OUTCOMES
CO1	Comprehend the knowledge and concepts of human psychology

CO2	Know the importance of psychology
CO3	Have insight into individual and group behavior
CO4	Deal with people in better way
CO5	Motivate groups and build groups

CO-PO Mapping

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

TEXT BOOKS:

1. Michael G.Aamodt, Industrial/Organizational Psychology: An Applied Approach, 6th Edition, Wadsworth Cengage Learning, ISBN: 978-0-495-60106-7.

REFERENCE BOOKS:

1. Blum M.L. Naylor J.C., Horper & Row, Industrial Psychology, CBS Publisher, 1968
2. Luthans, Organizational Behaviour, McGraw Hill, International, 1997
3. Morgan C.t.,King R.A.,John Rweisz &John Schoples, Introduction to Psychology, Mc Hraw Hill, 1966
4. Schermerhorn J.R.Jr., Hunt J.G &Osborn R.N., Managing, Organizational Behaviour, John Willy

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

SHARNBASVA UNIVERSITY, KALABURAGI

Faculty of Engineering & Technology (Co-Edu.)

Scheme of Teaching and Examination 2021-22

Outcome Based Education (OBE) and Choice Based Credit System

(CBCS)(Effective from the academic year 2021-22)

Programme: B.Tech.: Energy Engineering

VIII SEMESTER

Sl. No.	Course category	Course Code	Course Title	Teaching Dept. (TD) Question Paper Setting Board (PSB)	Teaching Hours/week			Examination				Credits
					Theory Lecture	Tutorial	Practical	Duration in Hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	PROJ	21PROJ81	Project -8		0	0	14	03	50	50	100	07
2	INT	21EGI82	Internship		0	0	16	03	50	50	100	08
Total					**0**	**0**	**30**	**06**	**100**	**100**	**200**	**15**

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 (PROJ): A batch of 4 to 5 students (Same branch or different branches) with a guide, may undertake one project (1 hour of theory/tutorial or two hours of practice /activities.

Note: Project-8 Manufacturable and marketable project / Research project/Field Project.