B. Tech. Syllabus (2024)

[Energy Engineering]

Department of Energy Engineering

North-Eastern Hill University

Shillong-793022 Meghalaya

Year- 2024

Programme Objectives

The four-year B.Tech program in Energy Engineering aims to prepare professional engineers for advanced studies, research, and the energy industry. The core curriculum provides a robust foundation in scientific and engineering principles essential to the field. Beyond these core courses, the program incorporates cutting-edge and emerging technological processes. To ensure students gain relevant professional knowledge and the ability to tackle complex engineering challenges, the syllabus balances core, specialized, and elective subjects. This comprehensive approach is enhanced through practical and field exercises, along with challenging project activities. The program is designed to cultivate critical thinking, innovation, and problem-solving skills, equipping graduates for higher education, research opportunities, and impactful careers in the energy sector.

MODEL COURSE STRUCTURE & THEME

Definition of Credit

1 Hr. Lecture (L) per week	1 Credit
1 Hr. Tutorial (T) per week	1 Credit
1 Hr. Practical (P) per week	0.5 Credit
2 Hours Practical (P) per week	1 Credit

Range of Credits

The total credit for four year UG programme in Energy Engineering is kept 160. The total credits is equally divided in each semester i.e. 20 credit/semester.

Structure of UG Program in Technology

The structure of the undergraduate program in Technology shall include the following categories of courses with the respective credit distribution:

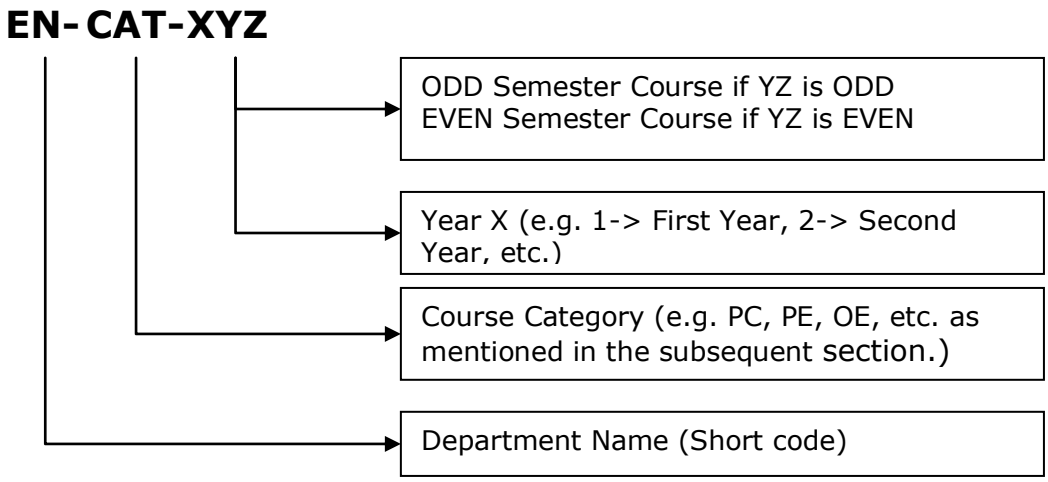
- **Core Courses**: These courses provide fundamental scientific and engineering knowledge essential to the field.
- **Specialized Courses**: Advanced courses focusing on specific areas within the discipline to develop expertise.
- **Elective Courses**: Courses that allow students to explore various topics of interest and emerging technologies.
- **Practical and Field Exercises**: Hands-on training and real-world applications to enhance practical skills.
- **Project Activities**: Challenging projects designed to foster innovation, problem-solving, and research capabilities.

The credit allocation for each category will be as follows:

SL. No.	Category	Breakup of Credits	Papers
1.	Humanities and Social Science Courses	11	04 Papers
2.	Basic Science Courses	18	06 papers
3.	Engineering Science Courses	14	04 papers
4.	Professional Core Courses (Branch specific)	70	22 papers
5.	Professional Elective Courses (Branch specific)	12	03 papers
6.	Open Elective Courses (from Humanities, Technical Emerging or other Subjects)	09	03 papers
7.	Project work, Seminar and Internship in Industry or elsewhere	26	05 items
8.	Audit Courses [Environmental Sciences, Indian Constitution]	(non-credit)	02 papers
	TOTAL	160	49

Course Level Coding Scheme

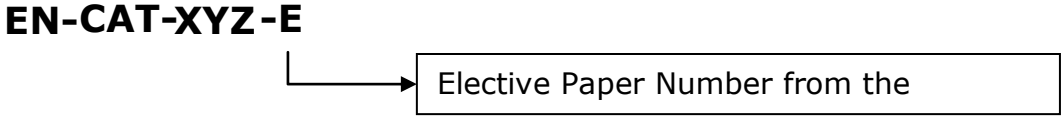
The course code system begins with the department name, followed by the course category to identify the level of the course. The digit in the hundreds place signifies the year in which the course is offered, while the remaining two digits represent the semester number (odd numbers for odd semester courses and even numbers for even semester courses). For example:



Course code	Definition
L	Lecture
T	Tutorial
P	Practical
C	Credits
BSC	Basic Science Courses
ESC	Engineering Science Courses
HSMC	Humanities & Social Science, including Management Courses
PC	Professional Core Courses
PE	Program Elective Courses
OE	Open Elective Courses
LC	Laboratory Courses
MC	Mandatory Courses
AU	Audit Courses

Course Coding for Elective Papers

The format remains consistent with the core course codes, but an additional digit is included to indicate the elective's position within the list. For example:



Programme Outcomes

- Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

- Problem Analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

- Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

- Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions for complex problems.

- Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

- The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

- Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

- Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

- Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

- Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

- Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

- Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

INDUCTION PROGRAM

The essence and details of the Induction Program can be further understood by referring to the 'Detailed Guide on Student Induction Program' available on the AICTE Portal.

Induction program (mandatory)	**Three-week duration**
Induction program for students to be offered right at the start of the first year.	Physical Activity
	Creative Arts
	Universal Human Values
	Literary
	Proficiency Modules
	Lectures by Eminent Persons
	Visits to Local Areas
	Familiarization to Department/Branch and Innovations

1. Course Structure and Scheme of the Syllabus

BRANCH: Energy Engineering Year: I Semester: I

S. No.	Course Code	Course Name	Periods (Contact Hours)			Evaluation Scheme (Distribution of Marks)					Credits
Theory Papers			L	T	P	TA	CT	ST	ESE	TOT	
1	EN-HSM-101	Professional Communications Skills	3	0	0	15	15	30	45	75	3
2	EN-BS-103	Engineering Mathematics-I	3	1	0	20	20	40	60	100	4
3	EN-ES-105	Electronic Devices	3	1	0	20	20	40	60	100	4
4	EN-PC-107	Basic Electrical Engineering	3	1	0	20	20	40	60	100	4
Practical/Design/Laboratory/Seminar											
5	EN-HSM-LC-109	Professional Communications Skills Laboratory	0	0	2	10	_	10	15	25	1
6	EN-ES-LC-111	Electronics Devices Laboratory	0	0	4	20	_	20	30	50	2
7	EN-PC-LC-113	Basic Electrical Engineering Laboratory	0	0	4	20	_	20	30	50	2
Audit Course											
8	EN-AU-115	Environmental Science	2	0	0	20	30	50	0	50	0
Total			14	3	10					500	20

L – Lecture **T** – Tutorial **P** – Practical **TA**– Teachers' Assessment **Total Marks**: **500**
CT– Class Test **ST**– Total Internal Marks **ESE**– End Semester Examination Marks **Total Credit: 20**

Contact Hour:27

BRANCH: Energy Engineering Year: I Semester: II

S. No.	Course Code	Course Name	Periods (Contact Hours)			Evaluation Scheme (Distribution of Marks)					Credits
Theory Papers			L	T	P	TA	CT	ST	ESE	TOT	
1	EN-HSM-102	Universal Human Values -II	3	0	0	15	15	30	45	75	3
2	EN-BS-104	Engineering Physics-I	3	0	0	15	15	30	45	75	3
3	EN-ES-106	Introduction to Energy Engineering	3	1	0	20	20	40	60	100	4
4	EN-PC-108	Thermo-fluids Engineering	3	1	0	20	20	40	60	100	4
Practical/Design/Laboratory/Seminar											
6	EN-BS-LC-110	Engineering Physics Laboratory	0	0	4	20	-	20	30	50	2
7	EN-PC-LC-112	Engineering Workshop	0	0	4	20	-	20	30	50	2
8	EN-PC-LC-114	Thermo-fluid Laboratory	0	0	4	20	-	20	30	50	2
Audit Course											
9	EN-AU-116	Indian Constitution	2	0	0	20	30	50	0	50	0
Total			14	2	12					500	20

L – Lecture **T** – Tutorial **P** – Practical **TA**– Teachers' Assessment **Total Marks**: **500**
CT– Class Test **ST**– Total Internal Marks **ESE**– End Semester Examination Marks **Total Credit: 20**

Contact Hour: 28

Note: Exit/Entry provision after first year of BTech Programme shall be as per B.Tech Regulation RC-20.

BRANCH: Energy Engineering Year: II Semester: III

S. No.	Course Code	Course Name	Periods (Contact Hours)			Evaluation Scheme (Distribution of Marks)					Credits
Theory Papers			L	T	P	TA	CT	ST	ESE	TOT	
1	EN-HSM-201	Industrial Management and Entrepreneurship	3	1	0	20	20	40	60	100	4
2	EN-BS-203	Engineering Chemistry	3	1	0	20	20	40	60	100	4
3	EN-ES-205	Dynamics of Machines	3	1	0	20	20	40	60	100	4
4	EN-PC - 207	Thermal Utilities in Energy Engineering	3	1	0	20	20	40	60	100	4
Practical/Design/Laboratory/Seminar											
6	EN-BS-LC-209	Engineering Chemistry Laboratory	0	0	4	20	-	20	30	50	2
7	EN-PC-LC-211	Energy Utilities and Combustion Laboratory	0	0	4	20	-	20	30	50	2
Total			12	4	8					500	20

L – Lecture **T** – Tutorial **P** – Practical **TA**– Teachers' Assessment **Total Marks**: **500**
CT– Class Test **ST**– Total Internal Marks **ESE**– End Semester Examination Marks **Total Credit: 20**

Contact Hour: 24

BRANCH: Energy Engineering Year: II Semester: IV

S. No.	Course Code	Course Name	Periods (Contact Hours)			Evaluation Scheme (Distribution of Marks)					Credits
Theory Papers			L	T	P	TA	CT	ST	ESE	TOT	
1	EN-BS-202	Engineering Physics-II	3	0	0	15	15	30	45	75	3
2	EN-PC-204	Circuit Theory	3	1	0	20	20	40	60	100	4
3	EN-PC-206	Electrical Machines	3	1	0	20	20	40	60	100	4
4	EN-PC-208	Power Generation, Transmission and Distribution	3	1	0	20	20	40	60	100	4
Practical/Design/Laboratory/Seminar											
5	EN-PC-LC-210	Electrical Machines Laboratory	0	0	4	20	-	20	30	50	2
6	EN-PC-LC-212	Power System Laboratory	0	0	4	20	-	20	30	50	2
7	EN-P-214	Industry Visit	-	-	-	-	-	-	25	25	1
			12	3	8					500	20

L – Lecture **T** – Tutorial **P** – Practical **TA**– Teachers' Assessment **Total Marks**: **500**
CT– Class Test **ST**– Total Internal Marks **ESE**– End Semester Examination Marks **Total Credit: 20**

Contact Hour: 23

Note: Exit/Entry provision after second year of BTech Programme shall be as per B.Tech Regulation RC-20.

BRANCH: Energy Engineering Year: III Semester: V

S. No.	Course Code	Course Name	Periods (Contact Hours)			Evaluation Scheme (Distribution of Marks)					Credits
Theory Papers			L	T	P	TA	CT	ST	ESE	TOT	
1	EN-PC - 301	IC Engine and Gas Turbine	3	1	0	20	20	40	60	100	4
2	EN-PC-303	Heat and Mass Transfer	3	1	0	20	20	40	60	100	4
3	EN-PC-305	Wind and Hydro Energy	3	1	0	20	20	40	60	100	4
4	EN-PE-307E	Program Elective-I	3	1	0	20	20	40	60	100	4
Practical/Design/Laboratory/Seminar											
5	EN-PC-LC-309	Heat and Mass Transfer Laboratory	0	0	4	20	-	20	30	50	2
6	EN-PC-LC-311	Energy Conversion Laboratory	0	0	4	20	-	20	30	50	2
		Total	12	4	8					500	20

Elective

Program Elective-I	
Subject Code	**Subject Name**
EN-PE-3071	Advances of Biotechnology in Energy
EN-PE-3072	Power Electronics
EN-PE-3073 to 3079	MOOCs#

MOOC courses have to be approved by the department before registration for the course

Note: Students shall pursue 4-6 weeks of internship (in-house or outside the university) during winter vacation after completing the 5th-semester examination.

L – Lecture **T** – Tutorial **P** – Practical **TA**– Teachers' Assessment **Total Marks**: **500**
CT– Class Test **ST**– Total Internal Marks **ESE**– End Semester Examination Marks **Total Credit: 20**

Contact Hour: 24

BRANCH: Energy Engineering Year: III Semester: VI

S. No.	Course Code	Course Name	Periods (Contact Hours)			Evaluation Scheme (Distribution of Marks)					Credits
Theory Papers			L	T	P	TA	CT	ST	ESE	TOT	
1	EN-PC-302	Solar Energy Technology	3	1	0	20	20	40	60	100	4
2	EN-PC-304	Biomass and Bio-fuel Technology	3	1	0	20	20	40	60	100	4
3	EN-PC-306	Financial Evaluation of Renewable Energy Systems	3	1	0	20	20	40	60	100	4
4	EN-OE-308E	Open Elective-I	3	0	0	15	15	30	45	75	3
Practical/Design/Laboratory/Seminar											
5	EN-PC-LC-310	Solar Energy Laboratory	0	0	4	20	-	20	30	50	2
7	EN-P-312	Internship	-	-	-	-	-	-	75	75	3
Total			12	3	4					500	20

Elective

Open Elective-I	
Subject Code	Subject Name
EN-OE-3081	Material Science and Engineering
EN-OE-3082	Microprocessor, Microcontroller and Embedded System

L – Lecture **T** – Tutorial **P** – Practical **TA**– Teachers' Assessment **Total Marks**: **500**
CT– Class Test **ST**– Total Internal Marks **ESE**– End Semester Examination Marks **Total Credit: 20**

Contact Hour: 19

Note: Exit/Entry provision after third year of BTech Programme shall be as per B.Tech Regulation RC-20.

BRANCH: Energy Engineering Year: IV Semester: VII

S. No.	Course Code	Course Name	Periods (Contact Hours)			Evaluation Scheme (Distribution of Marks)					Credits
Theory Papers			L	T	P	TA	CT	ST	ESE	TOT	
1	EN-PC-401	Energy Auditing and Management	3	1	0	20	20	40	60	100	4
2	EN-PE -403E	Program Elective-II	3	1	0	20	20	40	60	100	4
3	EN-PE-405E	Program Elective-III	3	1	0	20	20	40	60	100	4
4	EN-OE-407E	Open Elective-II	3	0	0	15	15	30	45	75	3
Practical/Design/Laboratory/Seminar											
5	EN-P-419	Minor Project	0	0	10	50	-	50	75	125	5
		Total	12	3	10					500	20

Elective

Program Elective-II		**Open Elective-II**	
Subject Code	Subject Name	Subject Code	Subject Name
EN-PE-4031	Tariff, Smart Metering and Regulations	EN-OE-4071	Intellectual Property Rights
EN-PE-4032	Statistics	EN-OE-4072	Clean Coal Technology and Environment
EN-PE-4033 to 4039	MOOCs #	EN-OE-4073	Nuclear Energy
		EN-OE-4074 to 4079	MOOCs #
Program Elective-III			
EN-PE-4051	Fuel Cell and Hydrogen Energy		
EN-PE-4052	Energy Resource Assessment		
EN-PE-4053 to 4059	MOOCs #		

MOOC courses have to be approved by the department before registration for the course

L – Lecture **T** – Tutorial **P** – Practical **TA**– Teachers' Assessment **Total Marks**: **500**
CT– Class Test **ST**– Total Internal Marks **ESE**– End Semester Examination Marks **Total Credit: 20**

Contact Hour: 25

BRANCH: Energy Engineering Year: IV Semester: VIII

S. No.	Course Code	Course Name	Periods (Contact Hours)			Evaluation Scheme (Distribution of Marks)					Credits
Theory Papers			L	T	P	TA	CT	ST	ESE	TOT	
1	EN-OE-402E	Open Elective Courses-III	3	0	0	15	15	30	45	75	3
Practical/Design/Laboratory/Seminar											
2	EN-P-404	Major Project	0	0	28	140	-	140	210	350	14
3	EN-P-406	Grand Viva	-	-	-	-	-	-	75	75	3
Total			3	0	28					500	20

Elective

Open Elective-III	
Subject Code	**Subject Name**
EN-OE-4021	Electric Vehicle and Sustainable Transportation
EN-OE-4022	Green Building and Solar Passive Architecture
EN-OE-4023	Research Methodology
EN-OE-4024 to 4029	MOOCs #

MOOC courses have to be approved by the department before registration for the course.

L – Lecture **T** – Tutorial **P** – Practical **TA**– Teachers' Assessment **Total Marks**: **500**
CT– Class Test **ST**– Total Internal Marks **ESE**– End Semester Examination Marks **Total Credit: 20**

Contact Hour: 31

2. Detailed Syllabus for B. Tech program in Energy Engineering

EN-HSM-101: PROFESSIONAL COMMUNICATION SKILLS L-T-P-C: 3-0-0-3
No. of Hours Per Week: *Lectures-3, Tutorial-0.*
Marks Distribution: *Continuous Assessment = 30, End Semester Examination = 45.*
Questions to be set: *Eight*
Questions to be answered: *Any Five*
Duration of End Semester Examination: *Two and Half Hours*

Course Objectives:

- Develop effective written communication skills for various professional contexts, including emails, reports, and memos.
- Enhance verbal communication abilities, including public speaking, presentations, and interpersonal interactions.
- Cultivate active listening skills to improve comprehension and collaboration in professional settings.

Course Outcomes:

- Learn techniques for delivering clear and concise messages tailored to specific audiences and purposes.
- Gain strategies for managing and resolving conflicts constructively in the workplace

Detailed Syllabus

UNIT-I
General Principles of Communication and Oral Communication:
The process of Communication, principles of Communication (Communication barriers, levels of Communication, communication network, verbal, non-verbal) and professional Communication. The Speech Mechanism, IPA Symbols (Vowels and consonant sound),minimal pairs, word transcription, stress and intonation, active listening, types of listening, traits of a good listener, active versus passive listening.

UNIT-II
Constituents of Effective Writing and Vocabulary:
The sentence and its parts, articles, the verb phrase, tense and aspect, the active and passive, the adjective, interrogative and negative sentences, concord, preposition. Paragraph development, summary writing and reading, comprehension word formation processes: affixation, compounding, converting, use of words in different parts of speech, idioms and phrases.

UNIT-III
Business Correspondence and Communication Strategies:
Characteristics of business Letter, Drafting: Bio-data/Resume/Curriculum Vitae (Theory)
Report writing: Structure, Type of Reports (Theory) Presentation skills, public speaking and grouping discussion (Theory) and Soft Skills (theory).

Text Books

1. B.K Das, K.Samantray,et.al.," An Introduction to professional English and Soft Skills", CUP, New Delhi, 2009.
2. R.C. Sharma and K.Mohan, "Business correspondence and Report Writing", Tata McGraw Hill, New Delhi, 2002.
3. A. Doff,C. Jones, "Language in Use, Upper-Intermediate Classroom Book", CUP, New Delhi, 2004.

Reference Books

1. J.D.O' Connor,"Better English Pronunciation", CUP, London, 2006.
2. P. Patnait, "Group Discussion and Interview Skills", CUP, New Delhi, 2011.
3. Greenbaum, Sidney, Oxford English Grammar, OUP, 1996.
4. SeelJohn, Oxford Guide to Effective Writing and Speaking, OUP, India, 2000.
5. Eastwood John, Oxford guide to English Grammar, OUP, India, 1994.

EN-BS-103: ENGINEERING MATHEMATICS-I **L-T-P-C: 3-1-0-4**

No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Continuous Assessment = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

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

- Apply principles of calculus, complex analysis, and linear algebra to solve mathematical problems and demonstrating proficiency in differential and integral calculus techniques, complex number operations, and linear algebra concepts.
- Utilize understanding of complex numbers, including their algebraic and geometric properties, complex plane representation, and analytic functions, to evaluate contour integrals
- Utilize linear algebra concepts to analyze vector spaces, matrices, and linear transformations, including understanding subspaces, bases, dimensions, systems of linear equations, eigenvalues, eigenvectors, and diagonalization techniques.

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

- Understand the importance of calculus and Linear Algebra in solving Mathematical problems.
- Understand the basics of Complex analysis and its importance.
- Understand the importance of Laplace and Fourier transformations and its role in solving differential equations.

Unit I:

Differential Calculus of Single Variable: Functions, continuity and differentiability *(with emphasis on hyperbolic and inverse hyperbolic functions)***,** Properties of continuous functions on closed intervals, Intermediate value theorem and its applications, Successive differentiation; Taylor's and Maclaurin's series; L'Hospital rule (statements only with applications).

Unit II

Complex analysis*:* Analytic functions, Cauchy-Riemann equations, Cauchy's integral theorem, Cauchy's integral formula, Taylor series and Laurent series. Residues and their applications to evaluating real integrals (statements only with applications).

Unit III

Laplace and Fourier Transforms: Laplace transforms, existing theorem, Inverse transform., Shifting on the s and *t* axes, Laplace transform of derivatives, convolutions, partial fractions, Fourier transforms, Solutions of ordinary differential equations by Laplace transforms.

Unit IV

Linear Algebra: Vector space over the field of real and complex numbers, subspaces, bases and dimension; Elementary row and column operations; echelon form; system of linear equations; Eigen values and eigen vectors; Symmetric, skew-symmetric, Hermitian, skew-Hermitian, orthogonal matrices.

Text Books:

1. E. Kreyszig, *Advanced Engineering Mathematics*, 10/e, John Wiley & Sons Inc., 2017.
2. S. Pal and S. C. Bhunia, *Engineering Mathematics* , 1/e, Oxford University Press, 2015.
3. R. K. Jain and S. R. K. Iyengar, *Advanced Engineering Mathematics*, 5/e, Narosa Publishing House, 2016.

Reference Books:

1. Babu Ram, *Engineering Mathematics*, 1/e, Pearson Education, 2009.
2. S.S. Sastry, *Engineering Mathematics*, 4/e, Prentice Hall India Learning Private Limited, 2008.
3. M. C. Potter, J. L Goldberg and E.F. Aboufadel, *Advance Engineering Mathematics*, 3/e, Oxford University Press, 2005.

EN-ES-105: ELECTRONIC DEVICES **L-T-P-C: 3-1-0-4**

No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Continuous Assessment = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Course Objectives:

- To Understand the principles of semiconductor physics, including the operation of semiconductor devices such as diodes, bipolar junction transistors (BJTs), and field-effect transistors (FETs).
- Students should develop proficiency in analyzing electronic devices and circuits.

Course Outcomes: ***At the end of this course, students shall be able to:***

- Understand the field of electronics and its significance in modern technology.
- Electronic components such as diodes and transistors, including their symbols, characteristics, and applications.
- Analyze various field effect transistors
- Design electronic circuits such as rectifier, clipper, clamper, etc.

Detailed Syllabus

Unit I

Properties of Semiconductors: Energy bands in solids, E-K Diagram; intrinsic & extrinsic semiconductors; carriers transport phenomena: drift & diffusion current, mobility & resistivity. Generation & recombination of carriers; Hall Effect. PN-Junction Diode: General idea; characteristics; Transition capacitance and diffusion capacitance.

Unit II

Bipolar Junction Transistors: Transistors- definition, terminals, types, symbols, formation of NPN and PNP, ratings. Transistor biasing- definition, importance, list types, voltage divider method.CE input and output characteristics- cut off, saturation, and active regions. Transistor as a switch.

Unit III

Field Effect Transistors: JFETs — Drain and Transfer characteristics,-Current equations-Pinch off voltage and its significance, FET- definition, types. MOSFET- definition, types, symbols. N-type enhancement mode- construction, working, characteristics, switching characteristics.

Unit IV

Applications PN-Junction Diodes: Half wave, full wave center-tapped, and bridge rectifiers; Clipping & clamping circuits. Passive Filters.

Text Books:

1. D. Chattopadhyay and P. C. Rakshit, *Electronics Fundamentals and Applications*, 12/e, New Age International(P) Lid., 2014.
2. J. Millman and C. Halkias, *Integrated Electronics*, 42nd Reprint, TMH, 2006.
3. R. Boylestead and L. Nashelsky, Electronic Devices and Circuits Theory, 9/e, PHI, 2006.
4. M. S. Sukhija and T.K. Nagsarkar, Basic Electrical and Electronics Engineering, Oxford, 2012.
5. B. Streeman and S. Banerjee, Solid State Electronics Devices, 6/e , PHI, 2006

Reference Books:

1. A. P. Malvino, *Electronic Principles*, 6/e, TMH, 1998.
2. R. P. Jain, *Modern Digital Electronics*, 3/e, TMH, 2003.
3. R. J. Tocci, *Digital Systems*, 6/e, PHI, 2001.

EN-PC-107: BASIC ELECTRICAL ENGINEERING **L-T-P-C: 3-1-0-4**

No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Continuous Assessment = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Course Objectives:

- To provide the technical understanding of DC and AC electrical circuits/system with fundamental laws and theorems.
- To familiarise with the various electrical machines.

Course Outcomes:

- Acquire the basic knowledge of electrical circuits elements and quantities.
- Equip with the circuit theorems and laws as well as able to apply it in DC circuits.
- Able to analyse the single-phase and three-phase AC system.
- Have understanding on basic concepts of DC machines, transformer and induction motor.

Detailed Syllabus

Unit I

Electrical circuits and network: Node, Branch, Mesh, Loop; Active, passive, linear, non-linear, unilateral, bilateral, symmetrical, unsymmetrical network; Electrical circuit elements: Resistor, Inductor and Capacitor; Sources: Voltage and Current sources; Dependent and Independent source; Ohm's Law; Source Transformation; Series and Parallel Circuits: Current divider and Voltage Divider Rule.

Unit II

Kirchoff's laws: Kirchoff's Current Law (KCL) and Kirchoff's Voltage Law (KVL); Nodal and Mesh Analysis, Star-Delta conversion; Network Theorems: Superposition Theorem, Thevenin Theorem, Norton Theorem and Maximum power transfer theorem.

Unit III

Representation of AC voltage and currents: Different forms of emf equations, time period, frequency, amplitude, phase, phase difference, average value, RMS value, form factor, peak factor; Phasor diagram; Single-phase AC circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel) and their phasor representation; Impedance and Admittance; Complex power; Three phase balanced circuits.

Unit IV

Types of Electrical Machines and their applications; DC Machines: Principle of DC Generator, Principle of DC Motor, Methods of excitation, EMF equation; Transformers: Working principle, Equivalent Circuit, EMF equation, Transformer tests; Three Phase Induction Motor: Working principle, concept of Slip.

Text Books:

1. A. Chakroborty, S. Nath and C.K. Chanda, Basic Electrical Engineering, McGraw Hill Education Pvt. Ltd., 1st Edition, 2017.
2. U. A. Bakshi and A. V. Bakshi, Electrical Circuit Analysis, Technical Publication, 1st Edition, 2020.

Reference Books:

1. V. Del Toro, Electrical Engineering Fundamentals, Pearson Education India, 2nd Edition, 2015.
2. P. S. Bimbhra, Electrical Machinery, Khanna Publishers, 1st Edition (Fully Revised), 2021.
3. A. Hussain, H. Ashfaq, Electric Machines, DhanpatRai& Co. Ltd., 3rd Edition, 2016.

EN-HSM-LC-109: PROFESSIONAL COMMUNICATION SKILL LABORATORY

L-T-P-C: 0-0-2-1

No. of Hours Per Week: *Practical-2.*
Marks Distribution: *Continuous Assessment = 10, End Semester Examination = 15.*
Questions to be Set: *Ten*
Questions to be Answered : *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Two Hours.*

Course Objectives:

- Practice professional etiquette and protocol in various communication contexts, including meetings, networking events, and social interactions

Course Outcomes:

- Demonstrate proficiency in social communication, grammatical accuracy, and clear pronunciation in English.
- Apply advanced learning and soft skills to succeed in professional and social situations.
- Improve overall communication skills, including listening, speaking, reading, and writing, to effectively convey and understand information.

Laboratory Practices:

Communications skills-Social:

1. Meeting people and asking questions
2. Making Friends
3. Dos and don'ts
4. What did you do

English Concept:

1. Grammer- Tenses
2. Grammer- Part of speech
3. Figure of speech
4. Direct and indirect speech

Pronunciation Phonetics- Intonations

1. Vowels
2. Consonants
3. Noun

Advanced learning and soft skills

1. Effective communication
2. Interview handling skills
3. E-mail entiquette

Communication skills Listening- speaking- Reading

1. Listening skills
2. Speaking skills
3. Reading skills
4. Writing skills

Text Books:

1. Jones Daniel, Cambridge English Pronouncing Dictionary with CD, New Delhi, 2011
2. Cambridge Learners Dictionary with Cd, CUP, New Delhi, 2009

Reference Books/Materials:

1. AWL software
2.Software: Orell Digital Language Lab (ODLL) software

EN-ES-LC-111: ELECTRONICS DEVICES LABORATORY L-T-P-C: 0-0-4-2

No. of Hours Per Week:*Practical-4.*
Marks Distribution: *Continuous Assessment = 20, End Semester Examination = 30*
Questions to be set: *Ten*
Question to be answered**:** *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Three Hours*

Course Objectives:

- To study the characteristics of the basic electronic components
- To observe characteristics of Transistors.
- To design and analyze various electronic circuits.

Course Outcomes: ***At the end of this course, students shall be able to:***

- To study the characteristics of the basic electronic components
- To observe characteristics of Transistors
- To design and analyze various electronic circuits.

List of the Experiments:

1. To Study the IV Characteristics of Silicon and/or Germanium Diodes.
2. To Study the IV Characteristics of Zener Diode.
3. To design and Analysis of a Half wave Rectifier using Diode.
4. To design and analyze a center-tap Full wave Rectifier using Diodes.
5. To design and Analysis of a Bridge Rectifier Circuit.
6. To design and Analyze a Clipping Circuit with one voltage source (different possible configurations).
7. To design and Analyze a Clipping Circuits with two voltage sources (different possible configurations).
8. To design and Analysis of Clamper Circuits.
9. To analyse the characteristics of BJT (CE and CB mode).
10. To design and Analysis of fixed bias circuit using NPN transistor (DC).
11. To design and Analysis of voltage divider bias circuit using NPN transistor (DC)
12. To study the characteristics of JFET.
13. To study the characteristics of MOSFET.

Text Books:

1. D. Chattopadhay and P. C. Rakshit, *Electronics Fundamentals and Applications*, 12/e, New Age International(P) Ltd., 2014.

Reference Books

1. M. S. Sukhija and T.K. Nagsarkar, *Basic Electrical and Electronics Engineering*, Oxford, 2012.
2. R. Boylestead and L. Nashelsky, *Electronic Devices and Circuits Theory*, 9/e, PHI, 2006

EN-PC-LC-113: BASIC ELECTRICAL ENGINEERING LABORATORY

L-T-P-C:0-0-4-2

No. of Hours Per Week: *Practical-4.*
Marks Distribution: *Continuous Assessment = 20, End Semester Examination = 30.*
Questions to be set: *Ten*
Question to be answered**:** *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Three Hours*

Course Objectives:

- To familiarize with the basic electrical and electronic equipment and its working.
- To develop the skills to analyse the basic DC circuits.

Course Outcomes (COs):

- Have understanding of network theorems and laws and able to verify it in electrical circuits.
- Able to measure the power in electrical circuits.
- Acquire the knowledge of transformer test and parameters calculations

List of Experiments:

1. Study and verification of Kirchhoff's Current Laws.
2. Study and verification of Kirchhoff's Voltage Laws.
3. To verify Thevenin's theorem.
4. To verify Norton's theorem.
5. To verify Superposition theorem.
6. To verify Maximum Power Transfer theorem.
7. To measure Power and power factor of the load by three ammeters method.
8. To measure Power and power factor of the load by three voltmeters method.
9. To calibrate an ammeter as voltmeter.
10. Measurement of three phase power by two wattmeter method.

Text Books:

1. M. S. Sukhija and T.K. Nagsarkar, Basic Electrical and Electronics Engineering, Oxford, 2012.

Reference Books:

1. P. S. Bimbhra, Electrical Machinery, Khanna Publishers, 1st Edition (Fully Revised), 2021.
2. R. Boylestead and L. Nashelsky, Electronic Devices and Circuits Theory, PHI, 2006.

EN-AU-115: ENVIRONMENTAL SCIENCE **L-T-P-C: 2-0-0-0**
No. of Hours Per Week: *Lectures-2*
Marks Distribution: *Continuous Assessment = 50*

Course Objectives:

- To demonstrate the understanding about the environment and its components
- To demonstrate comprehensive understanding of the causes of different environmental problems and their management.

Course Outcomes:

- Ability to recognize the various components of the environment and how it functions.
- Develop the ability among students to identify the causes and effect of different pollution on human health and environment

Unit I

Environment, Ecosystems and Biodiversity: Concept of environment: Scope of Environmental Science, components of environment and their interactions; abiotic and biotic factors; Ecosystems: characteristic feature and structure and function of forest, grassland, desert and aquatic ecosystem (Ponds, lakes, rivers, oceans); Ecological pyramid; energy flow and nutrient cycling; Biodiversity: value of biodiversity; loss and conservation of biodiversity.

Unit II

Environmental problems and Management: Environmental problems and issues: greenhouse effect, ozone depletion, acid rain; Environmental pollution: sources and effect of air, water, soil, radioactive and noise pollution; Industrial pollutants and their impact on environment and human health; toxic chemicals: heavy metals and pesticides; biotransformation and bioremediation; Aerobic and anaerobic treatment of waste water; waste management.

Text Books

1. W. P. Cunningham and W.B. Saigo, "Environmental Science", McGraw Hill, New York, 1999.
2. E. P. Odum and G. W. Barrett, "Fundamentals of Ecology", Thomson Asia Pvt. Ltd., Singapore, 2005.
3. E. Bacci, "Contaminants in the Environment", CRC Press, 1994.

Reference Books

1. N. J. Sell, "Industrial Pollution Control: Issues and Techniques", Wiley Publication, 1992.
2. Venugopal Rao, "Textbook of Environmental Engineering", PHI, 2003.

EN-HSM-102: UNIVERSAL HUMAN VALUES-II **L-T-P-C: 3-0-0-3**
No. of Hours Per Week: *Lectures-3, Tutorial-0.*
Marks Distribution: *Continuous Assessment = 30, End Semester Examination = 45.*
Questions to be set: *Eight*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Two and half hours*

Course Objectives:

- Development of a holistic perspective based on self-exploration about themselves, family, society and nature/existence.
- Understand harmony in the human being, family, society and nature/existence.

Course Outcomes: At the end of this course, students shall be able to:

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

Detailed Syllabus

Unit I: Introduction to Value Education: Right Understanding to Relationship and Physical Facility, Value Education, Self-exploration, Continuous Happiness and Prosperity, Exploring Human Consciousness. Harmony in the Human Being: Co-existence, needs and Harmony in self and Body.
Unit II: Harmony in the Family and Society: Justice in Human-to-Human Relationship, Vision for the Universal Human Order. Harmony in the Nature/Existence: Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature, Co-existence at All Levels, Holistic Perception of Existence
Unit III: Implications of the Holistic Understanding: Natural Acceptance, Human Conduct, Competence in Professional Ethics, Holistic Technologies, Production Systems and Management Models-Typical
Case Studies, Strategies for Transition towards Value-based Life and Profession.

Text Books:

1. R R GaurRAsthana, G P Bagaria, *A Foundation Course in Human Values and Professional Ethics*, , 2nd Revised Edition, Excel Books, New Delhi, 2019.
2. RR Gaur, R Asthana, G P Bagaria,*The Teacher's Manual- Teachers' Manual for A Foundation Course in Human Values andProfessional Ethics*, , 2nd Revised Edition, Excel Books,New Delhi, 2019.
3. Premvir Kapoor, *Professional Ethics and Human Value*s, ,Khanna Book Publishing Company, New Delhi, 2022.

Reference Books:

1. *EkParichaya*, ANagaraj *JeevanVidya:*,JeevanVidyaPrakashan, Amarkantak, 1999.
2. A.N. Tripathi, *Human Values*, New Age Intl. Publishers, New Delhi, 2004.

EN-BS-104: ENGINEERING PHYSICS – I **L-T-P-C: 3-0-0-3**

No. of Hours Per Week: *Lectures-3, Tutorial-0.*
Marks Distribution: *Continuous Assessment = 30, End Semester Examination = 45.*
Questions to be set: *Eight*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Two and half hours*

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

1. Understand the principles of vibration and waves, including simple harmonic motion, superposition, damped and forced oscillations, and wave equations.
2. Gain knowledge of optics principles such as interference, diffraction, polarization, and optical activity.
3. Explore the interface between physics and engineering, focusing on the role of physics in various industrial applications and technologies.

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

1. Demonstrate proficiency in analyzing and solving problems related to vibration, waves, and optics
2. Apply principles of physics to understand and analyze engineering systems and technologies
3. Gain insight into the applications of physics principles in various engineering fields, including energy production, communications, and materials science

Detailed Syllabus

Unit-I: Vibration and Waves: Simple harmonic motion (SHM). Superposition of SHMs. Lissajous' figures, Damped oscillator, Forced oscillator, Wave equation and solution, Wave and particle velocity. Wave equation in string, Production, properties and application of ultrasonic waves.

Unit-2:Optics: Fermat's principle of least time. Interference. Newton's rings experiment. Fresnel and Fraunhofer diffractions. Diffractiongrating. Polarization of light. Nicol prism, Optical activity, Polarimeter.

Unit-3:Physics-Engineering Interface (Qualitative): Role of physics in the Industrial Revolution, Thermodynamic Rankine cycle, Otto cycle, steam engine, steam turbine, and Internal Combustion (IC) engine, Newton's gravitational law and Satellite; Faraday Law and electric motor and transformer; Total Internal reflection and fiber optical cable; Magnetic hysteresis and memory device; Nuclear fission and Nuclear power, Nuclear reactor and Nuclear Bomb; Semiconductor P-N junction and transistor, solar cell; Quantum confinement of an electron in potential box and Nanotechnology; Molecule rotational spectroscopy and microwave oven, Capacitor, and Supercapacitor Energy Storage; Quantum superposition and quantum technology.

Text Books:

1. H. K. Malik and A. K. Singh, Engineering Physics, 1st ed. Tata McGraw Hill Education Private Limited, 2011.
2. R. Dogra, Engineering Physics, 1st ed. S K Kataria & Sons, 2019

Reference Books

1. H. J. Pain, The Physics of vibrations and waves, 6th ed. John Wiley & Sons Inc, 2005
2. R. W.Webb, ElementaryWaveOptics, Dover Publication Inc, 2005
3. H. Jeff, L. N. Rosenband, and M. R. Smith, Reconceptualizing the Industrial Revolution, The MIT Press, 2010.

EN-ES-106: INTRODUCTION TO ENERGY ENGINEERING L-T-P-C: 3-1-0-4

No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Continuous Assessment = 40, End Semester Examination = 60.*
Questions to be set: *Eight*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Course Objectives:

- To familiarize the students with the overall energy scenario. The course introduces the students with the challenges and environmental concerns of energy utilization
- The course introduces the students with various forms of conventional and renewable energy resources and the technologies available to generate power from these sources
- To familiarize with energy consumption and energy management

Course Outcomes:

- To understand the basic terms, units, quantities associated with the field of energy
- To understand the global and Indian energy scenario in terms of resource availability and utilization
- To understand the fundamentals of conventional and renewable energy sources and the conversion technologies with their impacts on the environment.
- To understand and interpret the concept of energy conservation and efficiency.

Detailed Syllabus

Unit I

Forms and units of energy, electrical quantities, power factor, kVA rating and kW power, energy reserves, world energy demand and utilization, primary and secondary energy, Energy Intensity in relation to GDP, GNP and its dynamics.

Unit II

Classification of various Energy Resources, Introduction to Conventional Energy Resources-Crude Oil, Coal and Natural Gas. Classification of coal, coal qualities, Introduction to crude oil refining and various products obtained. Introduction to natural gas production, environmental aspects involved with conventional energy.

Unit III

Introduction to various renewable energy conversion technologies for Solar, Wind, Hydro, Biomass, Tidal, OTEC, Ocean Wave etc. Environmental impact of renewable energy, National policies on various renewable energy sources.

Unit IV

Introduction to Energy Conservation and Energy Efficiency, Sector wise energy consumption pattern for Industrial, Commercial Building, Household, Agricultural, Municipality, Lighting ,Water Pumping and HVAC systems. Basic understanding of energy management.

Text Books:

1. S. Pugalendhi and J. Gitanjali, Handbook on Renewable Energy and Green Technology, CRC Press, 2024
2. S. Rao and B. BParulekar, Energy Technology, Khanna Publishers, 2015
3. D. P. Kothari, K. C. Singhal and R. Ranjan, Renewable Energy Sources and Emerging Technologies, PHI, 2022.

Reference Books:

1. T. N. Veziroglu, Alternative Energy Sources, Vol 5 and 6, TMH, 2007.
2. F. Kreith and J. F. Kreider, Principles of Solar Engineering, Taylor and Francis, 2000.
4. I.S. Jha and Subir Sen, Renewable Energy Technology, New Age International Publishers, 2018
5. S. MichaelidesandE.Efstathios Alternative Energy Sources, Springer, 2012

EN-PC-108: THERMO-FLUIDS ENGINEERING **L-T-P-C: 3-1-0-4**

No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Continuous Assessment = 40, End Semester Examination = 60.*
Questions to be set: *Eight*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

Course Objectives:

- To provide the technical understanding of Fluid mechanics and Thermodynamics in the back ground of mathematics
- To familiarize the students about its applications to model the real life engineering problems
- To apply the subject knowledge in the areas like CFD

Course Outcomes:

- Analytical Skills - Have developed analytical cognitive skills in thermodynamics and fluid mechanics.
- Problem-Solving Skills - Understand and be able to apply fundamental concepts and equations to practical problems.
- Design and Development Skills - Be equipped with the knowledge of environmentally responsible and current best practice for the design of efficient thermal system and cycles.
- Engineering Knowledge - Have a good understanding of basic gas laws and phase change processes.

Detailed Syllabus

Unit I

Basic Fluid and Thermodynamics Properties, State; Close and open systems; Thermal properties; Temperature and the Zeroth law; Work, heat and internal energy; Process and cycle; Ideal gas and kinetic theory; Equation of state of ideal gas; Fluid properties and thermodynamic properties of air, water and refrigerants, Viscosity and shear stress; Compressibility; Newtonian and Non-Newtonian fluids; Fluid pressure; Pascal's law; Pressure-height relation.

Unit II

Steady and unsteady; Uniform and non-uniform; Incompressible and compressible; Laminar and turbulent; Continuity and Bernoulli's equation; Streamline and stream-tube; Flow; Momentum equation, The three basic modes heat transfer and their governing equations.

Unit III

Conservation of mass and control volume; The first law for a control mass undergoing a process/cycle; Internal energy and enthalpy; Constant volume and constant pressure specific heats; The first law for a control volume; The steady-flow energy equation and its applications.

Unit IV

Heat engines and refrigerators; The second law of thermodynamics; Reversible and irreversible processes; Forward Carnot cycle; Rankine cycle; Thermodynamic temperature scale; Inequality of Clausius; Entropy and irreversibility; T-s diagram; The second law for a control mass/control volume; Isentropic efficiency.

Textbook

1. Y. A.Cengel, R. H. Turner, &J. M.Cimbala, ,*Fundamentals of thermal-fluid sciences.* McGraw-Hill, 2.17.
2. M. Massoud Engineering Thermofluids. Springer, 2005

References

1. T. L. Bergman, A. S. Lavine, F. P. Incropera, andD. P. DeWitt,*Introduction to Heat Transfer*. Wiley, 2011.
2. J. F.Douglas,J. M.Gasiorek, J. A. Swaffield, andL.B.Jack, *Fluid mechanics*. Pearson,2011.
3. B. R. Munson, A. P.Rothmayer, T. H. Okiishi, and W. W.Huebsch, *Fundamentals ofFluid Mechanics*.Wiley, 2012.

EN-BS-LC-110: ENGINEERING PHYSICS LABORATORY L-T-P-C: 0-0-4-2

No. of Hours Per Week: *Practical-4.*
Marks Distribution: *Continuous Assessment = 20, End Semester Examination = 30.*
Questions to be set: *Ten*
Question to be answered**:** *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Three Hours*

Course objectives

- To evaluate the process & outcomes of a physics experiment quantitatively & qualitatively and extend the scope of an investigation whether or not results come out as expected.

Course outcome

- Provide hands-on experience and reinforce theoretical concepts learned in engineering physics through experiments covering various topics such as mechanics, optics, and modern physics.
- Develop practical skills, including experimental setup, data acquisition, analysis, and interpretation, and proficiency in using laboratory equipment and instruments relevant to engineering physics.

List of Experiments

1. To determine the acceleration due to gravity by bar pendulum/Kater's pendulum.
2. To determine the rigidity modulus of a wire by statistical method/dynamical method.
3. To find the wavelength of monochromatic light by using Newton's ring method.
4. To determine the wavelength of sodium light by Michelson's interferometer.
5. To determine the wavelength of prominent mercury lines by plane diffraction grating.
6. To determine he specific rotation of sugar solution by a polarimeter.
7. To determine the magnetic moment of a bar magnet (M) and the earth's horizontal intensity (H) (by deflection and vibration magnetometers).
8. To determine the resistance per unit length of a meter bridge wire by Carey- Foster Method.
9. Calibration of Ammeter and Voltmeter using potentiometer.
10. To study the decay of current in RC circuit.
11. To study the Lissajous figure using CRO
12. To determine the frequency of a tuning fork by Melde's method.
13. To determine ultrasonic velocity in liquid.
14. To obtain the hysteresis curves (B-H) for a ferromagnetic material (thin rod or wire) on a CRO using solenoid and then to determine the related magnetic constants.
15. To study the Hall Effect and determine the Hall Coefficient.
16. To determine the Planck's constant by a Photocell.
17. To determine the e/m value of an electron by any method.

Text Books:

1. Samir Kumar Ghosh, "A Textbook of Practical Physics", New Central Book Agency, Kolkata, 2006.
2. Gupta and Kumar, "Practical Physics", PragatiPrakashan, Meerut, U.P., 2005.
3. C. L. Arora, "Advance B.Sc. Practical Physics", S. Chand, 2004.

Reference Books:

1. H J Pain, "The Physics of Vibrations and Waves", 6th Ed., Wiley Student Edition, 2005.
2. P V Naik, "Principles of Physics", Prentice Hall of India Pvt. Ltd., 2000.

EN-PC-LC-112: ENGINEERING WORKSHOP **L-T-P-C: 0-0-4-2**

No. of Hours Per Week: *Practical-4.*
Marks Distribution: *Continuous Assessment = 20, End Semester Examination = 30.*
Questions to be set: *Ten*
Question to be answered**:** *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Three Hours*

COURSE OBJECTIVES:

- To provide students with practical experience in using various tools, equipment, and techniques commonly used in engineering practice
- To help students develop technical skills related to machining, welding, carpentry, and other essential tasks performed in engineering workshops
- To educate students about the importance of safety protocols and procedures in engineering workshops, including proper handling of tools and machinery

COURSE OUTCOMES:

- Study and practice on machine tools and their operations
- Practice on manufacturing of components using workshop trades including fitting, machining, drilling, carpentry, and welding.
- Identify and apply suitable tools for machining processes including turning, facing, drilling and tapping
- Understanding and practicing welding operations

List of Jobs to be made in the Workshop

1. To make half lap joint using given wooden pieces
2. To make Mortise and Tenon joint using given wooden pieces
3. To make Dovetail joint using given wooden pieces
4. To make Briddle joint using given wooden pieces
5. To make Lap joint by Gas welding on MS plate
6. To make Butt joint by Gas welding on MS plate
7. To perform chamfering and facing on MS rod
8. To perform plain turning and step turning on MS rod
9. To make Lap joint by electric arc welding on MS plate
10. To make Butt joint by electric arc welding on MS plate
11. To make holes of different sizes on MS plate by drilling operation

Text Books:

1. HajraChoudhary, Elements of Workshop Technology, Vol. I and II, Media Promoters and Publishers, 2023.
2. B.S. Raghuwanshu,A Course in Workshop Technology, DhanpatRai& Sons, 2017

Reference Books:

1. Rajender Singh, ‘Introduction to Basic Manufacturing Process and Workshop Technology’, New Age International Publishers, 2022
2. H.S Bawa, ’Workshop Practice’, McGraw Hill Education, 2017
3. O.P Khanna, ’Workshop Technology, Dhanpat Rai Publications, 2018

EN-PC-LC-114: THERMO-FLUID LABORATORY **L-T-P-C: 0-0-4-2**

No. of Hours Per Week: *Practical-4.*
Marks Distribution: *Continuous Assessment = 20, End Semester Examination = 30.*
Questions to be set: *Ten*
Question to be answered**:** *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Three Hours*

Course Objectives:

- To understand and verify the fluid properties.
- To understand the function/Operation of Two Stroke engines and their behaviour
- Provide students with fundamental theoretical knowledge and practical hands-on training in thermal and fluid systems

Course Outcomes:

- Student will learn about the measurement tools and techniques
- Ability to acquire and apply new knowledge as needed, using appropriate learning strategies
- Ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
- Apply Bernoulli's equation to fluid flow problems
- Ability to perform flow analysis in various heat engines

List of Experiments:

1. To verify the Bernoulli's Theorem by Bernoulli's theorem apparatus.
2. To determine the coefficient of discharge of liquid using Venturimeter
3. To determine the meta-centric height of a floating body
4. To determine the coefficient of discharge of an orifice of a given shape
5. To determine the viscosity of a given liquid fuel sample by a Redwood viscometer
6. To evaluate the Reynolds number in different flow conditions.
7. To determine the dryness fraction of wet steam by using separating and throttling calorimeter.
8. To verify that Pressure is an intensive property using nozzle distribution unit.
9. To examine parts and working of four stroke spark ignition engines.
10. To examine parts and working of two stroke spark ignition engines.
11. To examine parts and working of four stroke diesel engines.
12. To examine parts and working of two stroke diesel engines.

Text Books:

1. Y. A. Cengel, R. H. Turner, & J. M. Cimbala, *Fundamentals of thermal-fluid sciences.* McGraw-Hill, 2017.
2. V. Ganesan, *Internal combustion engines* , (4^{TH} Edition) McGraw Hill

Reference Books:

1. B. R. Munson, A. P. Rothmayer, T. H. Okiishi, and W. W. Huebsch, *Fundamentals of Fluid Mechanics*. Wiley, 2012.
2. Domkundwar, Kothandaraman, A Course in Thermal Engineering, Dhanpat Rai Publications, 2016.
3. P.L. Ballaney, *Internal Combustion Engines (Including Gas Turbines)*, Khanna Publishers, 1965.

EN-AU-116: INDIAN CONSTITUTION **L-T-P-C: 2-0-0-0**
No. of Hours Per Week: *Lectures-2*
Marks Distribution: *Continuous Assessment = 50*

Course Objectives:

- The Constitution of India is the noble document facilitating the vision of the Government and has guaranteed the Fundamental rights of the citizen and incorporated fundamental duties.
- The constitution of India carries the legacy of the deeply rooted culture of the nation and up hold the cherished goal of the framers of the Constitution offering integrity of the nation and unity among the diversity of the country. The course will help the students to learn their constitutional rights and duties.

Course Outcomes:

- Students will understand about Fundamental rights of the citizen along with fundamental duties.
- Students will understand about the constitutional principles of governance and basic features of the Constitution.

Unit I

Fundamental Aspect of the Constitution: The preamble, Form of constitution, Features of Indian Constitution, Citizenship (Part II). Fundamental Rights (Part III): Directive Principle of state policy (Part IV), Fundamental Duties (Part IV-A).

Unit II

The Union (PartV),The States (PartVI), The Panchayat (PartIX),Themunicipalities (Part IX-A) The Schedule and Tribal Areas (Part X), Tribunals (Part6 XIV-A). Emergency provisions (Part XVIII), Amendment of the Constitution (Part XX), Schedules: Fifth Schedule, Sixth schedule, seventh schedule, Eight Schedule,

Text Books:

1. H. K. Saheray, Constitution of India, Eastern Law House, 2012.
2. M.BJain, Indian Constitutional Law, 8th ed. LexiNexis, 2018.
3. D. D. Basu, Constitution of India, 26th ed. Educational Printed, 2022

Reference Books:

1. S. C. Kashyap, Our Parliament, National Book Trust, 2021
2. B. Chandra, M. Mukherjee, A. Mukherjee, S. Mahajan, and K. N. Panikar, India's struggle for Independence, Penguin UK, 2016.
3. S. C. Kashyiap, Our Constitution: An Introduction to India's Constitution and Constitutional Law, National Book Trust of India, 2008.
4. M. Laximikand, Indian Polity, 5th ed. McGraw Hill Education (India) Private Limited, 2023.

EN-HSM-201: INDUSTRIAL MANAGEMENT ANF ENTREPRENEURSHIP

L-T-P-C: 3-1-0-4

No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Continuous Assessment = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Course Objectives:

- Understanding Marketing Concepts: Introduce students to the core concepts of marketing and their role in business strategy.
- Analyzing Consumer Behavior: Examine factors influencing consumer behavior and their implications for marketing strategies.
- Segmenting Markets: Understand the process of market segmentation and its significance in targeting specific consumer groups.

Course Outcomes:

- **Understanding Entrepreneurship**: Students will demonstrate an understanding of entrepreneurship, including the entrepreneurial mindset, the entrepreneurial process, and the role of creativity and innovation in entrepreneurship.
- **Foundations of Business Ownership**: Learners will grasp the essentials of business ownership, including legal considerations, financial management, and operational aspects relevant to starting and managing a business venture.
- **Strategic Planning and Venture Creation**: Participants will develop skills in strategic planning, market analysis, and business plan development necessary for creating and launching new ventures.
- **Management Principles and Practices**: Students will gain knowledge of management principles and functions, including decision-making, organizational

Detailed Syllabus

Unit – I
Entrepreneurship Theory -The Entrepreneurial Mind set, The Entrepreneurial Process Creativity and Innovation, Entrepreneurship Practice, Essentials of Business Ownership, New Venture Planning and Creation, Managing and Growing the Venture.

Unit – II
Concept of demand and supply, elasticity of demand, types of market structure, firm and industry, business cycle, input and out analysis, plant location decision,Types of cost., Production process, types of production, plant layout, production planning and control, Inventory control techniques.

Unit – III
Management principles and functions, managerial skills, decision making process, types of organization structures, Maslow's hierarchy of needs, types of communication, leadership styles.

Unit – IV
Marketing concept, factors affecting consumer behaviour, types of market segments, productlife cycle, pricing methods, distribution channels, advertising and sales promotion, value engineering.

Text Books:

1. R.R. Barthwal, Industrial Economics: An Introductory Text Book, New Age, Reprint 2004.
2. Ahuja, H, L., Managerial Economics, S. Chand and Company Ltd., New Delhi, 1st Edition, 2007.

Reference Books

1. Kotler, Keller, Koshy, Jha, Marketing Management-A South Asian Perspective, Pearson Ltd., 2009.
3. Entrepreneurial Development by C. B. Gupta and N. P. Srinivasan, Publisher Sultan Chand & Sons, 1992.
4. Murugan , M and Sakthivel, Management Principles and Practices , New Age International Publishers, New Delhi, 2008.
5. Aswathapa, K, Human Resource and Personnel Management, TMH, New Delhi, 2005.

EN-BS-203: ENGINEERING CHEMISTRY **L-T-P-C: 3-1-0-4**

No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Continuous Assessment = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Course Objectives:

- To understand various concepts of chemistry and their applied aspects in and around us.
- A better understanding about thermodynamics and time dependent study of reactions with certain examples around us.
- To understand the applied aspects of technology in natural and man-made polymeric molecules.
- Rationalization of bulk properties and processes using thermodynamic considerations.
- To learn about the significance of water in our life in various ways one of the most potential matrices of environment, at the constant risk of man-made hazards, and also the water hazards to industries and remedy.

Course Outcomes:

- Quantification of several concepts of chemistry that were introduced at school levels till the higher secondary standard.
- Equipped with the knowledge of the chemical processes in terms of the basic principles of heat transfer, time dependent study at molecular levels through ionic interactions.
- Gaining a clarity about the applied aspects of technology in natural and man-made polymeric molecules.
- Proper understanding about the proper handling of water for personal and industrial use, remedial measures of pollution and optimization of natural resources of water.

Detailed Syllabus

UNIT - I
Chemical Thermodynamics: Second law of thermodynamics, entropy and its physical significance, entropy change of ideal gases, free energy, Maxwell's relations, Gibbs-Helmholtz equation, thermodynamic equilibrium, Van't Hoff equation, Clausius-Clapeyron equation.

UNIT – II
(a) Catalysis: Action of a catalyst, types of catalysts, acid-base catalysis, enzyme catalysis.
(b) Chemical Kinetics: Rate laws of zero, first and second order reactions with examples, reactions above third order, pseudo-uniorder reaction, collision theory and activation energy, role of a catalyst in a reaction.

UNIT – III
Application of Chemistry in Engineering - I

(a) Polymers: Types of Polymerization; Classification and structures of polymers; application of a few commercially important artificial polymers (like Nylons, Polyester, Polyurethane, Rubber, Teflon, PVC, Polycarbonate, Bakelite, Silicones).

(b)Applications of Electrochemical cells: EMF and its applications, commercially important cells, Corrosion - electrochemistry of rusting of iron and remedial measures.

UNIT – IV

Application of Chemistry in Engineering - II

Water and Industry

(a) Hazards of water in industry - Soft & Hard water and estimation of hardness of water, hazards of hard water in industry and treatment of industrial purpose water (external and internal methods).

(b) Hazards of water from industry – Effluents, impact of effluents on the environment matrices, treatment measures of effluents.

Text books:

1. Prakash, Tuli, Basu and Madan, *Advanced Inorganic Chemistry, Vol. I & II* (Diamond Ed.), S.Chand, reprinted, 2006.
2. Jain & Jain, *Engineering Chemistry*, DhanpatRai Publishing Co., 2008.
3. Levine, *Physical Chemistry*, 5/e (7^{th} reprint), Tata McGraw Hill, 2006.

Reference Books:

1. Shriver, Atkins and Langford; *Inorganic Chemistry*, 5/e, ELBS, 2009.
2. S.S. Dara, *A Textbook Engineering Chemistry*, Publ. S. Chand & Company Pvt. Ltd., New Delhi, 2007.

EN-ES-205: DYNAMICS OF MACHINES **L-T-P-C: 3-1-0-4**

No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Continuous Assessment = 40, End Semester Examination = 60.*
Questions to be set: *Eight*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

Course Objectives:

- Familiarize with common mechanisms and carryout mobility and motion analysis of mechanisms.
- Understand gears and analyze gear train.
- Emphasize the concept of friction and friction drives
- Understand various cam motion profiles and follower mechanism, analyze cam motions.

Course Outcomes:

- To identify mechanisms with basic understanding of motion.
- To choose the gear trains for a different speed and torque transmission.
- Assimilate friction and its use in power transmission.
- Design and evaluate the performance of different cams and followers.

Detailed Syllabus

Unit I

Definitions Link or element, kinematic pairs, Degrees of freedom, Grubler's criterion (without derivation), Kinematic chain, Mechanism, Structure, Mobility of Mechanism, Inversions of Four bar chain; Single slider crank chain and Double slider crank chain. Quick return motion mechanisms

Unit II

Velocity and acceleration analysis of Four Bar mechanism, slider crank mechanism.Mechanism illustrating Coriolis component of acceleration. Angular velocity and angular acceleration of links, velocity of rubbing.

Unit III

Gear terminology, law of gearing, Path of contact, Arc of contact, Contact ratio of spur gear. Methods of avoiding interference, Back lash. Comparison of involute and Cycloidal teeth. Rack& Pinion. Simple gear trains, Compound gear trains.

Unit IV

Belt drives: Flat belt drives. Ratio of belt tensions, centrifugal tension and power transmitted. V-Belt Drive: Ratio of belt tensions, power transmitted. Types of cams, Types of followers. Displacement, Velocity and Acceleration curves for SHM.

Textbook

1. S.SRattan, "Theory of Machines", Tata McGraw-Hill Publishing Company Ltd., New Delhi, 3rd edition -2009.
2. Sadhu Singh, "Theory of Machines", Pearson Education (Singapore) Pvt. Ltd, Indian Branch New Delhi, 2nd Edi. 2006.

References

1. J.J. Uicker, G.R. Pennock, J.E. Shigley, "Theory of Machines & Mechanisms ", OXFORD 3rd Ed. 2009.
2. Ambekar, "Mechanism and Machine theory", PHI, 2007

EN-PC-207: THERMAL UTILITIES IN ENERGY ENGINEERING L-T-P-C: 3-1-0-4
No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Continuous Assessment = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Course Objectives:

- To familiarize the students with the steam generators and accessories for power generation
- The course introduces the students with the features and applications of various thermal utilities like steam condensers, air compressors, furnaces etc
- The course aims to skill the students with the performance evaluation of various thermal utilities used in power plants

Course Outcomes:

- To interpret and explain the basic technologies used for steam boilers. The students will also learn the applicability and limitations associated with such technologies
- To understand and explain the basic classifications, characteristics, applications and challenges involved in using various thermal utilities for power generation
- To understand and explain the performance and design calculations involved in important thermal systems used for power generation
- To study the environmental concerns involved in the combustion systems.

Detailed Syllabus

Unit I
Steam generators, selection and features of a boiler, water tube and fire tube boilers, high pressure boilers, natural draught, chimney height and diameter, efficiency of a chimney, draught losses, Boiler efficiency

Unit II
Steam condensers, classifications, comparison of jet and surface condensers, effects of air leakage in a condenser, maximum vacuum in a condenser, vacuum efficiency, condenser efficiency, cooling towers

Unit III
Air compressors, classification of air compressors, equation for work for single stage compressor, volumetric efficiency, actual indicator diagram, multistage compression, conditions for minimum work, efficiency of compressor, effect of clearance volume, free air delivery

Unit IV
Furnaces, classifications, characteristics of an efficient furnace, typical furnace systems, methods of evaluating performance, various losses in the furnaces, fuel economy measures in furnaces

Text Books:

1. Shiv Kumar, Thermal Engineering, Springer Nature Switzerland AG, 2023
2. R.K Rajput, Thermal Engineering, Laxmi Publications, 2020
3. Domkundwar and Kothandaraman, A Course in Thermal Engineering, DhanpatRai Publications, 2016

Reference Books:

1. Carl Bozzutu, Boiler Operator's Handbook, River Publishers, 2021
2. P.K. Das and A.K.Das, An Introduction to Thermal Power Plant Engineering and Operation : For Power Plant Professionals, 2018.

EN-BS-LC-209: ENGINEERING CHEMISTRY LABORATORY L-T-P-C: 0-0-4-2

No. of Hours Per Week: *Practical-4.*
Marks Distribution: *Continuous Assessment = 20, End Semester Examination = 30.*
Questions to be set: *Ten*
Question to be answered**:** *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Three Hours*

Course Objectives:

- Exposure to a chemistry lab culture – the do's and don'ts, with an emphasis on performance with care and caution.
- Learning of and practising the respect to chemicals, glassware and equipment – handling, maintenance and optimization of resources.
- Enhancement of theoretical knowledge through do it yourself (DIY) experience.
- Learning various techniques of qualitative and quantitative analyses, useful in chemistry.

Course Outcomes:

- To experience the principles of chemistry in reality by verifying them, relevant to the study of science and engineering.
- Quantitative and analytical study of the properties of matter (solid, liquid, solution, mixture).
- Analysis of an unknown organic compound, the basis of life around human being.
- Analytical study of water, one of the most essential components of environment.

List of Experiments

1. Standardisation of the given Mg^{2+} solution by EDTA titration (complexometric titration).
2. Standardisation of $KMnO_4$ solution by oxalic acid solution.
3. Volumetric estimation of Mg^{2+} and Ca^{2+} ions by EDTA titration (Hardness of water).
4. Volumetric estimation of Fe^{2+} ions by permanganatometry.
5. Determination of composition of the given liquid mixture by viscosity measurement.
6. Standardization of strong base by conductometric titration method using a strong acid.
7. Experimental verification of Hasselbach-Henderson equation by pH measurement and to determine the dissociation constant of weak acid.
8. Verification of Beer-Lambert law with potassium permanganate and the estimation of potassium present in the given solution.
9. Verification of cell constant of the given conductivity cell with the help of known KCl solutions and to determine the concentration of the given KCl solution conductometrically.
10. Determination of λ_{max} of $KMnO_4$, $K_2Cr_2O_7$ and K_2CrO_4 in aqueous solution, spectrophotometerically and determination of molar absorption coefficient of each compound of potassium.
11. Conductometric determination of the rate constant of the second order reaction of saponification of an ester by NaOH.
12. Determination of alkalinity of water used for industry.

Text books:

1. Pandey, Bajpai and Giri, *Practical Chemistry* (reprinted), S.Chand& Co. Ltd., 2006.
2. Dr. Sunita Rattan, *Experiments in Applied Chemistry,* S.K.Kataria& Sons Publishers, New Delhi 2012.
3. M.S. Kaurav, *Engineering Chemistry with Laboratory Experiments*, PHI Learning Pvt. Ltd. Publishers, New Delhi, 2011.

Reference Books:

1. Gurtu&Kapoor, *Advanced Experimental Chemistry*, Vol.I& II, 4/e, (reprinted), S.Chand& Co. Ltd., 1989.
2. *Vogel's Textbook of Quantitative Chemical Analysis*, 5/e, ELBS, 1991.
3. *Vogel's Textbook of Practical Organic Chemistry*, 5/e, ELBS, 1996.
4. Banwell & McCash, *Fundamentals of Molecular Spectroscopy*, 4/e, Tata McGraw Hill, 1962.

EN-PC-LC-211: ENERGY UTILITIES AND COMBUSTION LABORATORY

L-T-P-C: 0-0-4-2

No. of Hours Per Week: *Practical-4.*
Marks Distribution: *Continuous Assessment = 20, End Semester Examination = 30.*
Questions to be set: *Ten*
Question to be answered**:** *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Three Hours*

Course Objectives:

- To familiarize the students with the steam generators and accessories for power generation
- The course introduces the students with the features and applications of various thermal utilities like steam condensers, air compressors, furnaces etc.
- The course introduces practical aspects of combustion equipments

Course Outcomes:

- Student will learn about the various practical aspects of power plant equipments
- To understand the basics of combustion
- To understand and evaluate important properties of solid and liquid fuel

List of Experiments:

1. To examine low pressure boilers and their accessories and mountings with the help of models
2. To examine high pressure boilers and their accessories and mountings with the help of models
3. To examine the working of impulse and reaction steam turbines with the help of working models
4. To determine the volumetric efficiency of a reciprocating air compressor.
5. To evaluate the heat loss and energy consumption of a given furnace at different given conditions.
6. To determine the flash point and fire point of a given sample of oil in the flash point apparatus.
7. To determine the cloud point and pour point of a given sample oil with the help of a cloud and pour point apparatus.
8. To determine the Calorific value of a given solid and liquid fuel sample by a Bomb Calorimeter
9. To perform proximate analysis of a given sample of solid fuel
10. To determine the carbon residue of a given sample of lubricating oil / Fuel
11. To determine the calorific value of a given gaseous fuel sample with help of a Junker's Gas calorimeter

Text Books:

1. Shiv Kumar, Thermal Engineering, Springer Nature Switzerland AG, 2023.
2. R.K Rajput, Thermal Engineering, Laxmi Publications, 2020.
3. P Gupta, Elements of Fuel & Combustion Technology, Khanna Publishers, 2018.

Reference Books:

1. Bureau of Energy Efficiency (BEE). Study material for Energy Managers and Auditors Examination: Volume I-IV. 2015.
2. Domkundwar andKothandaraman, A Course in Thermal Engineering, DhanpatRai Publications, 2016.

EN-BS-202: ENGINEERING PHYSICS-II **L-T-P-C: 3-0-0-3**

No. of Hours Per Week: *Lectures-3, Tutorial-0.*
Marks Distribution: *Continuous Assessment = 30, End Semester Examination = 45.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Two and Half Hours*

Course Objectives:

- To introduce fundamental concepts in mechanics, including degrees of freedom, constraints, and the principles of virtual work and D'Alembert's principle, to lay a strong foundation for further studies in engineering dynamics.
- To familiarize students with basic principles in fluid mechanics, such as surface tension, Bernoulli's theorem, viscosity, and different flow regimes, providing essential knowledge for understanding and analyzing fluid behavior.
- To introduce students to basic concepts in nuclear physics and quantum mechanics, including nuclear forces, atomic mass unit, nuclear binding energy, wave-particle duality, and the Heisenberg uncertainty principle, setting the stage for further exploration in advanced physics and engineering disciplines.

Course Outcomes:

- Students will gain a solid understanding of fundamental mechanical principles and techniques, enabling them to analyze and solve simple engineering problems involving motion and equilibrium in mechanical systems.
- Students will be able to apply basic principles of fluid mechanics to solve problems related to fluid behavior, including surface tension phenomena, pressure differences, and the calculation of viscosity in various flow conditions.
- Students will develop a basic understanding of nuclear physics and quantum mechanics, allowing them to appreciate the wave-particle duality of matter and its implications, laying a groundwork for further studies in advanced physics and engineering disciplines.

Detailed Syllabus

Unit-I: Classical Mechanics: Degrees of freedom. Constraints, Principle of virtual work. D'Alembert principle. Lagrange equation of motion and its derivation. Applications of Lagrange equation. Hamilton's canonical equation and its applications

Unit-II: Basic of fluid mechanics: Surface tension. Angle of contact. Surface energy. Pressure difference on the surface of a spherical drop. Surface tension of a liquid inside a capillary tube. Bernoulli's theorem of an incompressible fluid. Coefficient of viscosity. Poiseuille method. Streamline and turbulent flow. Stokes formula

Unit-III: Quantum mechanics: Wave nature of particles. de Broglie hypothesis. Phase and group velocity of matter waves. Davisson and Germer experiment. Heisenberg uncertainty principle. Wavepacket. Applications of Heisenberg principle. Wave function and its interpretation. Schrödinger equation.

Unit-IV: Nuclear Physics: Nuclear forces. Atomic mass unit and its energy equivalent. Nuclear binding energy. Fission reaction and Q-value. Nuclearfission. Chainreaction. NuclearReactor. Classification of reactors. Nuclearfusion. Source of energy in sun and stars. Hydrogen bomb

Text Books:

1. Hitendra K Malik and A K Singh, Engineering Physics, Tata McGraw Hill Education Private Limited, New Delhi, 1st edition, 2011.

Reference Books:

1. Rakesh Dogra, Engineering Physics, S K Kataria & Sons 1st edition, 2019.
2. Arthur Beiser, Concept of Modern Physics, McGraw Hill Education, 6th edition, 2009.
3. Herbert Goldstein, Classical Mechanics,Pearson Education, 3rd edition, 2011.

EN-PC-204: CIRCUIT THEORY **L-T-P-C: 3-1-0-4**

No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Continuous Assessment = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Course Objectives:

- To demonstrate the electrical circuit theorems.
- To provide the knowledge of steady state and transient responses as well as Laplace transform in electrical circuits.
- To familiarise with the magnetic circuits and basic laws of magnetism.

Course Outcomes:

- Able to analyse the basics of electrical and magnetic circuits.
- Acquire the knowledge of network theorems and its application in DC circuits.
- Have understanding on the steady state and transient responses of DC circuits.
- Able to apply Laplace transform in electrical circuits.

Detailed Syllabus

Unit I

Nodal Analysis, Mesh Analysis, Thevenin's theorem; Norton's theorems, Superposition theorem, Maximum power transfer theorem, Reciprocity theorem, Compensation theorem, Tellegen's theorem, Analysis of circuits with dependent and independent sources for voltage and current, Star connection, Delta connection, Star-Delta conversion.

Unit II

Analysis of AC electrical circuits, Impedance, Admittance, Power in AC circuits, Characteristics and properties of resonance circuits, Series and parallel resonance circuits, Selectivity, Bandwidth and Quality factor, Steady state and transient response of RL, RC and RLC Circuits to DC excitation.

Unit III

Definition and basic theorems of Laplace transform, Laplace transform of some basic functions, Inverse Laplace transform, Application of Laplace transform in electrical circuit analysis, Step response, Impulse response and Pulse response of R-L, R-C, R-L-C Circuit.

Unit IV

Magnetic Circuit: MMF, Flux, Reluctance, Inductance, Self-inductance, Mutual inductance, Coupling coefficient, Dot convention in coupled coils, Electrical Equivalents of Magnetically Coupled Circuits, Magnetic materials, B-H curve of magnetic materials, Laws of Electromagnetism.

Text Books:

1. U. A. Bakshi and A. V. Bakshi, Electrical Circuit Analysis, Technical Publication, 1st Edition, 2020.
2. W.H. Hayt, J.E. Kemmerly and S.M. Durbin, Engineering Circuit Analysis, McGraw Hill, 8th Edition, 2013.
3. A. Chakrabarti, Circuit Theory (Analysis and Synthesis), DhanpatRai& Co. Pvt. Ltd., 6th Edition, 2014.

Reference Books:

1. D. Roy Choudhury, Network and Systems, New Age International Publishers, 2nd Edition, 2013.
2. M. E. Van Valkenburg, Network Analysis, Prentice-Hall of India Pvt. Ltd., 3rd Edition, 2014.
3. S. P. Ghosh and A. K. Chakraborty, Network Analysis and Synthesis, McGraw Hill Education India Pvt. Ltd., 4th Edition, 2010.

EN-PC-206: ELECTRICAL MACHINES **L-T-P-C: 3-1-0-4**

No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Continuous Assessment = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Course Objectives:

- To impart the technical features of two winding transformer (single-phase and three-phase) and auto transformer.
- To demonstrate the performance and operation of DC and AC machines.

Course Outcomes:

- Able to analyse the construction, operating principle and tests of single-phase transformers.
- Have understanding on the basic concepts of three-phase transformers and auto-transformers.
- Acquaint with the construction and characteristics of DC motor as well as generators.
- Understand the concepts of induction motor and synchronous machines.

Detailed Syllabus

Unit I

Construction and operating principle of single-phase transformers, Types, EMF equation, Equivalent circuit, Phasor diagram, Open circuit and Short circuit tests, voltage regulation, losses and efficiency, polarity test, back-to-back test, separation of hysteresis and eddy current losses; Three-phase transformer - construction, types of connection; Autotransformers - construction, principle, applications, comparison with two winding transformer, conversion of two winding transformer to autotransformer.

Unit II

Basic construction of a DC machine, Methods of excitation, separately excited, shunt, series and compound generators, Voltage build up, Armature winding- Lap and Wave winding, EMF equation, Torque equation, Armature reaction-cause, effect & remedial measures, Operating characteristics of DC Generator and DC Motor, Losses and efficiency of DC machines, Starting, braking and speed control of DC motor.

Unit III

Poly-phase induction Machines: Construction, Principle of operation, Types – Squirrel cage and Slip ring, Slip, Equivalent circuits, Comparison with transformer, Expression for output power and torque, Slip torque characteristics, Starting, braking and speed control of induction motor; Construction and starting of single phase induction motor.

Unit IV

Synchronous machines: Operating principle, Types – cylindrical and salient pole, EMF equation, Phasor diagram, Power flow equation, Open circuit and short circuit characteristic, Synchronization of two alternators, Starting of synchronous motor, Hunting in synchronous motor.

Text Books:

1. P. S. Bimbhra, Electrical Machinery, Khanna Publishers, 1st Edition (Fully Revised), 2021.
2. I. J. Nagrath, D.P. Kothari, Electric Machines, McGraw Hill Education, 4th Edition, 2015.

Reference Books:

1. A. Fitzgerald, C. Kingsley, S. Umans, Electric Machinery, McGraw Hill, 6th Edition, 2013.
2. A. Hussain, H. Ashfaq,Electric Machines, DhanpatRai and Co. (Pvt.) Ltd., 3rd Edition, 2016.
3. Bhag S. Guru, H. R. Hiziroglu, Electric Machinery and Transformers, Oxford, 4thEdition,2014.

EN-PC-208: POWER GENERATION, TRANSMISSION AND DRISTIBUTION

L-T-P-C: 3-1-0-4

No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Continuous Assessment = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Course Objectives:

- The course will create an overall idea of electric power generation, transmission and distribution. The students will be able to visualize and analyze the process of electric power generation, transmission and distribution including various phenomena associated with.
- Also students will be familiarised with various components associated with electric power generation, transmission and distribution.

Course Outcomes:

- To understand the basic concepts of electrical power generation, transmission and distribution.
- To compute the transmission line parameters, sag of an overhead transmission line and string efficiency of insulators.
- To analyze the performance of various types of transmission lines and distribution system topologies.
- To illustrate the different types of insulators, underground cables, effect of corona, various faults.

Detailed Syllabus

Unit I

General layout of a typical coal fired power station, Hydro-electric power station, Nuclear power station, their components and working principles, comparison of different methods of power generation; Introduction to Solar & Wind energy system; Inductance and Capacitance of a single phase and three phase symmetrical configurations line; Skin effect.

Unit II

Insulators: Types, potential distribution over a string of suspension insulators; String efficiency and methods of increasing string efficiency; Short, medium & long lines and their representation; ABCD constants, Voltage regulation, Ferranti effect.

Unit III

D.C. Distribution Systems: Classification of distribution systems, voltage drop calculations in DC distributors for the following cases: Radial DC distributor fed one end and at the both the ends (equal/unequal voltages) and ring main distributor.

Unit IV

A.C. Distribution Systems: Voltage drop calculations in A.C. distributors for the following cases: Power Factors referred to receiving end voltage and with respect to respective load voltages. Underground Cables: Types, different layers; Skin effect; Various line faults associated with transmission and distribution.

Text Books:

1. J.B. Gupta, Transmission and Distribution of Electrical Power - S.K. Kataria and Sons,10th Edition, 2012, Reprint 2021.

2. Dr. S. N. Singh, Electric power generation Transmission & Distribution- PHI learning Pvt Ltd, New Delhi, 2nd Edition, 2010.

Reference Books:

1. I.J. Nagarath & D.P. Kothari, "Power System Engineering", McGraw-Hill Education, 3rd Edition, 2019.
2. C.L. Wadhwa, Generation, Distribution and Utilization of Electrical Energy, New Age International publishers, 6th Edition, 2018.

EN-PC-LC-210: ELECTRICAL MACHINES LABORATORY L-T-P-C: 0-0-4-2

No. of Hours Per Week: *Practical-4.*
Marks Distribution: *Continuous Assessment = 20, End Semester Examination = 30.*
Questions to be set: *Ten*
Question to be answered**:** *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Three Hours*

Course Objectives:

- To understand the fundamentals of single phase and three phase transformers.
- To familiarise with the characteristics of DC generator and DC motor.
- To enhance the practical understanding of the induction motor.

Course Outcomes:

- Able to conduct the tests on single phase transformer.
- Students will learn the various connection of three phase transformer.
- Ability to analyse the characteristics of DC generator and DC motor.
- Enable students to perform the test on induction motor for parameter determination.

List of Experiments:

1. To perform the open circuit test on a single-phase transformer.
2. To perform the short circuit test on a single-phase transformer.
3. To determine the parameters efficiency and voltage regulation of single-phase transformer.
4. To perform the load test on a single-phase transformer.
5. To perform the polarity test on a single- phase transformer.
6. To convert the two winding transformer to auto-transformer and perform open circuit and short circuit tests on the auto-transformer.
7. To perform the speed control of separately excited DC motor and draw the characteristics curve.
8. To determination of the characteristics of a separately excited DC generator.
9. To perform the no load and blocked rotor test of Induction motor.
10. To find the different vector groups of three phase transformer.

Text Books:

1. P. S. Bimbhra, Electrical Machinery, Khanna Publishers, 1st Edition (Revised), 2021.
2. I. J. Nagrath, D.P. Kothari, Electric Machines, McGraw Hill Education, 4th Edition, 2015.

Reference Books:

1. A. Fitzgerald, C. Kingsley, S. Umans, Electric Machinery, McGraw Hill, 6th Edition, 2013.
2. A. Hussain, H. Ashfaq, Electric Machines, DhanpatRai and Co. (Pvt.) Ltd., 3rd Edition, 2016.
3. Bhag S. Guru, H. R. Hiziroglu, Electric Machinery and Transformers, Oxford, 4thEdition, 2014.

EN-PC-LC-212: POWER SYSTEM LABORATORY **L-T-P-C: 0-0-4-2**

No. of Hours Per Week: *Practical-4.*
Marks Distribution: *Continuous Assessment = 20, End Semester Examination = 30.*
Questions to be set: *Ten*
Question to be answered**:** *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Three Hours*

Course Objectives:

- To familiarise with AC transmission lines.
- To analyze the performance of DC distribution system.
- To understand the mechanism of electrical switch gear and protective devices.

Course Outcomes:

- Student will learn about the AC transmission and DC distribution system.
- Able to study various electrical switch gear and protective devices.
- Enable to understand the components of three phase starter.
- Help to understand electrical parameter like voltage, current, PF, kVA, kVAR and percentage of loading of electrical motor with single phase and three phase.

List of Experiments:

1. To determine of the generalized constants A, B, C, D of short and medium transmission line.
2. To determine of the generalized constants A, B, C, D of long transmission line and regulation of a 3-phase transmission line model.
3. To analyse the distribution system with network analyser.
4. To find the different characteristics of over current relay.
5. To perform no load test and observe Ferranti effect.
6. To examine the operation of RCCB
7. To examine the performance of three phase DOL starter.
8. To determine the percentage of electrical loading of single phase motor using power analyser.
9. To determine the percentage of electrical loading of three phase motor using power analyser.
10. To calibrate the Electronic Energy Meter by using ammeter, voltmeter, wattmeter and timer.

Text Books:

1. J.B. Gupta, Transmission and Distribution of Electrical Power - S.K. Kataria and Sons,10th Edition, 2012, Reprint 2021.
2. S. N. Singh, Electric power generation Transmission & Distribution- PHI learning Pvt Ltd, New Delhi, 2nd Edition, 2010.
3. P. S. Bimbhra, Electrical Machinery, Khanna Publishers, 1st Edition (Revised), 2021

Reference Books:

1. D.P. Kothari, I.J.Nagrath, Basic Electrical Engineering, 4th edition, McGraw Hill Publishers, 2019
2. S.K Bhattacharya, Basic Electrical and Electronics Engineering, Pearson Publications, 2017
3. C.L. Wadhwa, Generation, Distribution and Utilization of Electrical Energy, New Age International publishers, 6th Edition, 2018

EN-P-214: INDUSTRY VISIT **L-T-P-C: 0-0-2-1**

Marks Distribution:*, End Semester Examination = 25.*

Course Objectives:

- To Acquire First-hand Knowledge: Provide opportunities for students to gather first-hand information through direct experiences.
- To Deepen Academic Understanding: Foster a deeper comprehension of academic concepts through practical application and real-world examples.

Course Outcome:

- Integrating Theory with Practice: Students will demonstrate the ability to connect theoretical concepts with real-world scenarios, enhancing their understanding and application of academic studies and professional development.
- Active Learning Engagement: Students will actively engage in hands-on activities and interactive experiences, promoting a dynamic learning environment

Modalities:

- Strategic Location Selection: Carefully select locations that directly relate to the academic curriculum, offering students valuable learning opportunities aligned with their studies.

- Optimal Timing: Conduct Industry visits during breaks after semester III examinations or on non-working days during semester IV, ensuring minimal disruption to academic schedules. In exceptional cases, the Industry visit could be conducted during the working days with the permission of the competent University authority.

- Transparent Communication: Provide clear and timely communication to students regarding the purpose, objectives, and logistics of the field trip well in advance.

- Collaborative Arrangements: Establish necessary permissions and logistical arrangements with chosen locations or institutions to facilitate a smooth and enriching visit experience.

- Safety Protocols and Supervision: Implement comprehensive safety protocols and ensure adequate supervision during the field trip to prioritize the well-being of students and adherence to guidelines.

- Facilitated Learning Experiences: Facilitate interactive sessions, guided tours, and discussions during the field trip to encourage active participation and meaningful engagement with the subject matter.

- Promotion of Inquiry-Based Learning: Encourage students to ask questions, take notes, and actively inquire about their surroundings, fostering a spirit of curiosity and discovery

Comprehensive Evaluation Process:

Design a robust evaluation process that includes the submission of detailed reports summarizing observations and insights, along with a presentation by the student in semester IV to assess learning outcomes effectively.

- The Industry Visit will be conducted during:
  (1) Vacation after Semester III final examinations **and/Or**
  (2) Non-working days during semester IV and will be evaluated during Semester IV.
- For Evaluation, a candidate will submit a detailed report and has to appear for a presentation.

EN-PC-301: I.C. Engine and Gas Turbine **L-T-P-C: 3-1-0 -4**

No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Continuous Assessment = 40, End Semester Examination = 60.*
Questions to be set: *Eight*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

Course Objectives:

- Acquire knowledge about the IC engine cycles, classification and working principles
- Describe the testing and performance parameters along with heat balance sheet
- Explain different alternate fuels, gas turbines and about jet propulsion

Course Outcomes:

- Analytical Skills - Explain basic concepts of actual cycles with analysis and to describe the fundamental concepts of IC engines along with its working principles.
- Problem-Solving Skills - Evaluate the performance of IC engines and the importance of alternate fuels.
- Design and Development Skills - Be equipped with the knowledge of the essential components of gas turbine along with its performance improving methods.
- Engineering Knowledge – Understand the working of different components of I.C. engine

Detailed Syllabus

Unit I

Classification of IC engines, working cycles, comparison of two stroke & four stroke engines, Comparison between SI & CI engines. Fuel combustion &Fuel injection: Structure & composition of IC engine fuel, Fuel rating properties of fuel, Fuel additives and non-petroleum fuels. Simple Carburetor & its drawback. Requirements& type of diesel injection system, fuel pump, injectors &nozzles.

Unit II

Ignition &combustion in IC Engines: Battery, magneto & Electronic ignition systems, Ignition timing, spark advance mechanism. Stages of SI engine combustion, Effect of engine variables on ignition lag flame front propagation. Abnormal combustion, pre-ignition & detonation, Theory of detonation, Effect of engine variables on detonation, Control of detonation. Diesel Knock & methods of control in CI engine combustion chambers.

Unit III

Fuel and air measurement methods, performance of SI and CI Engines, Characteristics curve. Cooling and Lubricating Systems, Engine Emission & Controls: Air cooling and Water cooling system.

Unit IV

Gas turbines: Introduction, open & closed cycle gas turbines, Constant volume &constant pressure cycles. Thermodynamic analysis of ideal basic cycle with regeneration, reheat & inter-cooling. Application of gas turbine.

Text Books:

1. V. Ganesan, *Internal combustion engines* , (4^{TH} Edition) McGraw Hill, 2017.
2. V. Ganesan, *Gas Turbines*, (4^{TH} Edition) McGraw Hill, 2017.

Reference Books:

1. P.L. Ballaney, *Internal Combustion Engines (Including Gas Turbines)*, Khanna Publishers, 1965.
2. John B. Heywood , *Internal combustion engines fundamentals,* McGraw – Hill, 2017.

EN-PC-303: HEAT AND MASS TRANSFER **L-T-P-C: 3-1-0-4**

No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Continuous Assessment = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Course Objectives:

- To understand the behaviour of thermal energy systems
- To investigate the influence of boundary conditions and system parameters on the resulting response of the system
- To understand the performance evaluation for the energy conversion and heat recovery systems

Course Outcomes:

- To understand the mechanisms of heat transfer and their applications
- To develop analytical and computational skills for solving heat transfer problems
- To apply heat transfer principles to engineering design and analysis.
- To understand the mass transfer processes and their applications in engineering systems.

Detailed Syllabus

Unit I

One-dimensional steady-state conduction through homogeneous and composite plane walls and cylinders, electrical analogy, critical thickness of insulation, heat transfer from fins.

Unit II

Concept of hydrodynamic and thermal boundary layers, momentum and energy equation for boundary layers on a flat plate, application of dimensional analysis to free and forced convection; important dimensionless numbers.

Unit III

Heat exchangers, compact, shell and tube heat exchangers, plate heat exchangers, flow arrangements in heat exchangers, LMTD, overall heat transfer co-efficient; effectiveness of a heat exchanger (NTU) method, Mass Transfer: Introduction, Fick's law of diffusion, analogy between mass, momentum and heat transfer, convective mass transfer, evaporation of water into air.

Unit IV

Thermal radiation, Kirchoff's law, Planck's distribution law, Wien's displacement law, Stefan-Boltzmann's relation, Gray body, configuration factors, radiant interchange between black and grey surfaces, radiation shielding.

Text Books:

1. Frank P Incropera and David P Dewitt, Incropera's Principles of Heat and Mass Transfer, Wiley, 2018
2. A. Yunus.Cengel , Afshin J. Ghajar, Heat and Mass Transfer: Fundamentals and Applications, McGraw Hills Publication, 6th edition 2020

Reference Books:

1. J.P.Holman and Souvik Bhattacharyya, Heat Transfer, 10th Edition, McGraw Hill Education, 2017
2. P.K.Nag, Heat and Mass Transfer, 3rd edition, McGraw Hill Education, 2011
3. C.P. Kothandaraman, Heat and Mass Transfer Data Book, 10th Edition, New Age International Private Limited, 2022

EN-PC-305: WIND AND HYDRO ENERGY **L-T-P-C: 3-1-0-4**

No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Continuous Assessment = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Course Objectives:

- To provide the technical understanding of hydroelectric plant.
- To familiarise with operating features of wind energy conversion system along with fundamentals of aerodynamics.

Course Outcomes:

- Acquire the knowledge regarding the operation of hydro energy power plant.
- Equip with the basics of hydraulic turbines and its classifications.
- Have understanding on aerodynamics fundamentals and theories.
- Able to analyse wind energy conversion system and its various parts.

Detailed Syllabus

Unit I

Introduction to Hydro-energy systems, application of hydro power plant, advantages and disadvantages of hydro power plant, Hydrographs and Flow duration curve, Essential elements of hydroelectric power plant, safety measures in hydro power station, Site selection for hydro plant, Classification of hydro power plant, Optimization of hydro-thermal mix

Unit II

Hydraulic turbines, Classification of hydraulic turbines, turbine size, Pelton wheel turbine, Francis Turbine, Kaplan turbine, Performance of turbine: Specific speed, Scale ratio, unit speed, unit power, unit discharge, Comparison of turbines, Selection of Turbines, Efficiency of hydro power plant, Governing of Hydraulic turbines

Unit III

Introduction to wind energy system, Kinetic energy of wind, Measurements of wind, Classification of wind turbine, Horizontal wind turbine, Vertical axis wind turbine, Aerodynamics of wind turbines, Airfoil, Lift force, Drag Force, Aerodynamic theories, Axial momentum theory, Betz coefficient, Blade element theory, Blade momentum theory or Strip theory, Design procedure of wind rotor

Unit IV

Wind Energy Conversion Systems, Different parts of wind turbine generator, Tower, rotor, gearbox, power regulation, safety mechanism, Generator: Induction generator and synchronous generator, Fixed and variable speed operations, Grid integration, Wind farms, Wind pump

Text Books:

1. U. Ahrens, M. Hecht, Airborne Wind Energy: An Overview of the Technological Approaches, Springer, 1st Edition, 2022.
2. P. K. Nag, Power Plant Engineering, McGraw Hill Education, 4th Edition, 2017.
3. S. Mathew, Wind Energy Fundamentals, Resource Analysis and Economics, Springer, 1st Edition, 2006.

Reference Books:

1. G. R. Nagpal, Power Plant Engineering, Khanna Publishers, 15th Edition, 2002.
2. P. Jain, Wind Energy Engineering, McGraw Hill Professional, 2nd Edition, 2011.
3. J. Twidell, Renewable Energy Resources, Routledge, 4th Edition, 2021.

EN-PE-3071: ADVANCES OF BIOTECHNOLOGY IN ENERGY L-T-P-C: 3-1-0-4
No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Continuous Assessment = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Course Objectives

- Ability to understand the basic cellular structures and functions, and multiplication/ growth of organisms
- Ability to understand the presence of biomolecules and their importance in biological/ living systems
- Ability to understand the fundamentals of biotechnology and its relevance to energy engineering
- Explore biotechnological approaches for energy production, conversion, and optimization.

Course outcome

- Interpret the basic cellular organizations in entire living system and mechanism of their multiplication and growth.
- Evaluate the presence of diverse biomolecules in the living system and how they control all biological metabolism and characters.
- Corroborate the importance of biotechnological tools and its relevance to energy engineering.
- Comprehend biotechnological approaches for energy production, conversion, and optimization.

Detailed Syllabus

Unit I:
Structure of prokaryotic and eukaryotic cells; Bacterial chromosomes and plasmids; Cellular organelles: cell wall, plasma membrane, mitochondria, nucleus, Golgi bodies and endoplasmic reticulum; and other organelles and their organization; Cell cycle and cell division: Mitosis and Meiosis.

Unit II:
Types of macromolecules in biological systems; Conformational properties of polysaccharides and polypeptides; Secondary and tertiary structural features of proteins. Conformational properties of polynucleotides and Structure of DNA; Concept of regulation of gene expression: Prokaryotic gene expression with reference to inducible and repressible operon; Molecular tools and their applications in development of transgenic organism;

Unit III:
Introduction to Biotechnology and Energy Engineering: Overview of biotechnology and its applications, Introduction to energy engineering and its challenges; Microbial biotechnology for energy production: Microbial fuel cells, Biogas production, Microbial fermentation for biofuel production; Algal biofuel production; Plant Biotechnology for Bioenergy: Genetic engineering for bioenergy crops, Concept of safety and ethics associated with gene manipulation,

Unit IV:
Enzyme biotechnology for energy conversion: Biomass conversion technologies; Enzymes in biofuel production, Enzymatic processes for biomass conversion, Enzyme engineering for energy applications; Biotechnological approaches for energy optimization: Bioremediation in energy production processes, Biotechnological approaches for waste-to-energy conversion; Synthetic biology for energy optimization; Concept of Biorefinery.

Text Books:

1. B. Albert,et al. Molecular Biology of Cell, Garland Publishers, 2001 or latest
2. Lodish et al., Molecular Cell Biology, Scienti_c American Books, 2000.
3. B. D. Singh. Biotechnology, Kalyani Publishers, New Delhi, 2015.
4. Sunggyu Lee, Y.T. Shah. Biofuels and Bioenergy: Processes and Technologies. CRC Press, Taylor & Francis, 2013.
5. Prakash Kumar Sarangi, Sonil Nanda, PravakarMohanty. Recent Advancements in Biofuels and Bioenergy Utilization. Springer, 2018.
6. Rajesh Arora. Microbial Biotechnology: Energy and Environment. CAB International, 2012.

Reference Books:

1. P. K. Gupta. Elements of Biotechnology, Rastogi Publications, Meerut, 2010.
2. R. C. Dubey. A Text Book of Biotechnology, S. Chand & Co. Ltd, New Delhi, 1993.
3. Biotechnology for Biofuel Production and Optimization" edited by VandanaVinayak, 2021.

EN-PE-3072: POWER ELECTRONICS **L-T-P-C: 3-1-0-4**

No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Continuous Assessment = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Course Objectives

- This course provides a comprehensive understanding of the functioning and characteristics of power switching devices, principle of operation of converters, different triggering circuits and techniques of commutation of SCR

Course Outcome:

- Understand the principle of operation of converters.
- Understand different triggering circuits and techniques of commutation of SCR.

Detailed Syllabus

Unit I

Basics of power diodes, power transistors, power MOSFETS, IGBT and GTO. PNPN devices: Thyristors, brief description of members of Thyristor family with symbol, V-I characteristics and applications. Two transistor model of SCR, SCR turn on methods, switching characteristics, gate characteristics, ratings, SCR protection, series and parallel operation, gate triggering circuits, different commutation techniques of SCR.

Unit II

Phase controlled converters: Principle of operation of single phase and three phase half wave, half controlled, full controlled converters with R, R-L and RLE loads, effects of freewheeling diodes and source inductance on the performance of converters. Single phase and three phase dual converters.

Unit III

DC-DC converters: Principle of operation, control strategies, step down & step up choppers, types of choppers circuits based on quadrant of operation, multiphase choppers. Cyclo-converter: Principle of operation and schematic.

Unit IV

Inverter: Principle of operation, classification of inverters based on nature of input source, wave shape of output voltage, method of commutation & connections. Principle of operation of single phase and three phase bridge inverter with R and R-L loads, performance parameters of inverters, methods of voltage control and harmonic reduction of inverters. Applications: Speed control of AC & DC motors, HVDC transmission, VAR controller.

Text Books:

1. M.H. Rashid, Power Electronics, Pearson, 2017.
2. P.S. Bimbhra, Power Electronics, Khanna Publishing House, 2018.

Reference Books:

1. M.D. Singh and K.B. Khanchandani, Power Electronics, Tata McGraw Hill, 2017.
2. Phillip T Krein, Element of power Electronics, Oxford, 2017.

EN-PC-LC-309: HEAT AND MASS TRANSFER LABORATORY L-T-P-C: 0-0-4-2

No. of Hours Per Week: *Practical-4.*
Marks Distribution: *Continuous Assessment = 20, End Semester Examination = 30.*
Questions to be set: *Ten*
Question to be answered**:** *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Three Hours*

Course Objectives:

- To understand the behaviour of thermal energy systems
- To investigate the influence of boundary conditions and system parameters on the resulting response of the system
- To understand the performance evaluation for the energy conversion and heat recovery systems

Course Outcomes:

- To understand the mechanisms of heat transfer and their applications
- To develop analytical and computational skills for solving heat transfer problems
- To apply heat transfer principles to engineering design and analysis.

List of Experiments:

1. To determine the thermal conductivity of a metallic rod.
2. To determine the rate of Heat Transfer through Composite Wall
3. To determine the thermal conductivity of a solid by the guarded hot plate method
4. To determine the rate of Heat Transfer through Composite Cylinder
5. To determine the value of Stefan boltzman constant for radiation heat transfer
6. To determine the Thermal Conductivity of Liquid
7. To determine the Effectiveness of a Metallic fin.
8. To determine the Heat Transfer Coefficient in a free Convection on a vertical tube.
9. To determine the Heat Transfer Coefficient in a Forced Convention flow through a pipe.
10. To determine the Emissivity of a surface.

Text Books:

1. Frank P Incropera and David P Dewitt, Incropera's Principles of Heat and Mass Transfer, Wiley, 2018
2. AYunus. Cengel, Afshin J. Ghajar, Heat and Mass Transfer: Fundamentals and Applications, McGraw Hills Publication, 6th edition 2020

Reference Books:

1. J.P.Holman and Souvik Bhattacharyya, Heat Transfer, 10th Edition, McGraw Hill Education, 2017
2. P.K.Nag, Heat and Mass Transfer, 3rd edition, McGraw Hill Education, 2011
3. C.P. Kothandaraman, Heat and Mass Transfer Data Book, 10th Edition, New Age International Private Limited, 2022

EN-PC-LC-311: ENERGY CONVERSION LABORATORY L-T-P-C: 0-0-4-2

No. of Hours Per Week: *Practical-4.*
Marks Distribution: *Continuous Assessment = 20, End Semester Examination = 30.*
Questions to be set: *Ten*
Question to be answered**:** *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Three Hours*

Course Objectives:

- To familiarise with operating features of wind energy conversion system along with fundamentals of aerodynamics.
- Enable students to understand the principles and mechanisms involved in wind energy.
- Provide hands-on experience in conducting experiments to analyze the performance of energy storage devices.

Course Outcomes:

- Have understanding on aerodynamics fundamentals and theories.
- Able to analyse wind energy conversion system and its various parts.
- Able to analyse PEMFC system and charge-discharge cycle of a battery.

List of Experiments:

1. To examine the effect of Spherical model using the sub-sonic wind tunnel
2. To examine the effect of Cylindrical model using the sub-sonic wind tunnel
3. To examine the effect of Aerofoil model using the sub-sonic wind tunnel
4. To Determine the Lift and Drag in a Spherical model using the sub-sonic wind tunnel
5. To Determine the Lift and Drag in a Cylindrical model using the sub-sonic wind tunnel
6. To Determine the Lift and Drag in a Aerofoil model using the sub-sonic wind tunnel
7. To obtain the performance characteristics of PEMFC.
8. To determine the maximum power output in PEMFC under different moisture conditions
9. To plot the IV curve and study the effect of activation, ohmic and mass transport losses in Fuel Cell
10. To examine the performance of the charge-discharge cycle of a super-capacitor.
11. To examine the charge-discharge cycle of a battery.

Text Books:

1. U. Ahrens, M.Hecht, Airborne Wind Energy: An Overview of the Technological Approaches, Springer, 1st Edition, 2022.
2. P. K. Nag, Power Plant Engineering, McGraw Hill Education, 4th Edition, 2017.
3. S. Mathew, Wind Energy Fundamentals, Resource Analysis and Economics, Springer, 1st Edition, 2006.

Reference Books:

1. G. R. Nagpal, Power Plant Engineering, Khanna Publishers, 15th Edition, 2002.
2. P. Jain, Wind Energy Engineering, McGraw Hill Professional, 2nd Edition, 2011.
3. J. Twidell, Renewable Energy Resources, Routledge, 4th Edition, 2021.

EN-PC-302: SOLAR ENERGY TECHNOLOGY **L-T-P-C: 3-1-0-4**

No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Continuous Assessment = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Course Objectives:

- To understand the relationship between the Earth and the Sun, including solar angles, day length, and the angle of incidence on tilted surfaces, analyze solar radiation characteristics, including extraterrestrial characteristics, the effect of Earth's atmosphere on terrestrial solar radiation, and methods for measuring and estimating solar radiation on horizontal and tilted surfaces.
- To study the design, operation, and performance parameters of various types of solar collectors, including flat-plate collectors, evacuated tubular collectors, and concentrating collectors.
- To comprehend the physics of solar cells, including p-n junctions, homo- and hetero-junctions, dark and illumination characteristics, efficiency limits, and efficiency measurements.

Course Outcomes:

- Analytical Skills - Ability to analyze and calculate solar angles, day length, and the angle of incidence on tilted surfaces, and apply this knowledge to design solar energy systems.
- Problem-Solving Skills - Proficiency in evaluating solar radiation characteristics, including extraterrestrial characteristics, and applying measurement and estimation techniques on horizontal and tilted surfaces for solar energy applications.
- Design and Development Skills - Competence in designing, analyzing, and selecting appropriate solar collector systems based on their performance parameters and specific application requirements.
- Engineering Knowledge - Understanding of the performance characteristics of solar cells, including efficiency limits, and the ability to design solar cell structures for optimal efficiency and performance.
- Experimental Skills - Proficiency in fabricating and characterizing different types of solar cells, including silicon-based, III-V, II-VI multi-junction, and organic photovoltaic cells.

Detailed Syllabus

Unit I

Earth and Sun Relation, Solar angles, day length, angle of incidence on tilted surface, Sun-path diagrams, Shadow determination, Extra-terrestrial characteristics, Effect of earth atmosphere on terrestrial solar radiation, Measurement and estimation on horizontal and tilted surfaces, Analysis of Indian solar radiation data and applications.

Unit II

Flat plate Collectors, Effective energy losses, Thermal analysis,Heat capacity effect, Testing methods, Evacuated tubular collectors, Types of Air flat plate Collectors, Anti reflective coating. Concentrating Collector Designs, Classification, and performance parameters,Tracking systems, Compound parabolic concentrators, Parabolic trough concentrators, Concentrators with point focus, Heliostats.

Unit III

Solar Cell Physics, p- n junction, homo and hetero-junctions, Metal- semiconductor interface, Dark and illumination characteristics, Figure of merits of solar cell, Efficiency limits, Variation of

efficiency with band- gap and temperature, Efficiency measurements, High efficiency cells, Tandem structure, Junctions in Organic Solar Cells, Working and Efficiency limits.

Unit IV

Solar Cell Fabrication Technology, Design of a complete silicon, GaAs, InP solar cell; High efficiency III- V, II- VI multi-junction solar cell, a- Si- H based solar cells, Quantum well solar cell.Organic photovoltaic materials, principle and working, exciton generation, dissociation and transport, Basic principle of DSSC, Excitonic solar cell materials, Solar Photovoltaic System Design, Solar cell array system analysis and performance prediction

Text Books:

1. Ismail Tosun and Reza A. Sarraj, Solar Thermal Engineering: Applications and Components, CRC Press, 1st Edition, 2021
2. G. N. Tiwari and ArvindTiwari, Solar Energy: Fundamentals, Design, Modelling and Applications, Alpha Science International Ltd, 1st Edition, 2017.
3. C. S. Sollonki, Solar Photovoltaics: Fundamental Technologies and Applications, PHI Learning Pvt Ltd. India, 3rd Edition, 2023.

Reference Books:

1. K. Boer, Handbook of physics of Thin-Film solar cells, Springer 2013.
2. K. Kalyanasundaram, Dye Sensitized Solar cell, CRC Press, 2010.
3. Solar Energy International, Photovoltaics: Design and Installation Manual, New Society Publishers, 2004.
4. D. P. Larry, Solar Cells and their Applications, John Wiley and Sons, New York, 1995.

EN-PC-304: BIOMASS AND BIO-FUEL TECHNOLOGY L-T-P-C: 3-1-0-4

No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Continuous Assessment = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Course Objectives

- The course will create an overall idea of biomass as source of energy and power generation. The students will be able to identify particular biomass for a typical technology for energy extraction
- To enhance comprehensive understanding of various biomass conversion technologies, types and applications

Course Outcomes:

- To explain the importance of Biomass in energy sector with respect to its vastness in variety. The students will be able to choose the right technology for a particular type of biomass.
- To analyze the basic theories and variety in applications for various technologies to harness energy from biomass
- To understand the design and development aspects associated with various technologies available in the field of biomass.

Detailed Syllabus

Unit I

Selection of biomass as feedstock, Introduction to photosynthesis, physicochemical characteristics of biomass as fuel, Concept of Waste land utilization, Energy plantation, Biochemical, chemical and thermo- chemical routes of conversion of biomass.

Unit II

Anaerobic and aerobic digestion of biomass, types of digesters, design of biogas plants, installation, operation and maintenance of biogas plants, Biogas storage, biogas for motive power generation. Alcohol production from biomass, types of biomass for alcohol production, process description.

Unit III

Thermo-chemistry of Biomass gasification and pyrolysis, fixed and fluidised bed gasifiers, gasification based power generation, challenges and economics. Mechanism of transesterification, fuel characteristics of biodiesel, technical aspects of biodiesel engine application, Bio-diesel storage, Induction time, Oxidation stability.

Unit IV

Landfill technology for municipal solid waste disposal. types and composition of solid waste, Landfill site selection, gas collection, upgrade and utilization, Incineration of urban waste and power generation, various types of incinerators and their applications.

Text Books:

1. P. Basu, Biomass Gasification and Pyrolysis: Practical Design and Theory, Academic Press, 2023
2. Darshna Patel, Biogas a Sustainable Approach Towards Waste Energy, Lambert Academic Publishing, 2021
3. Ruth Owen, Energy from Plants and Trash: Biofuels and Biomass Power, Power Kids Press, 2013.
4. R. C. Brown, Thermochemical Processing of Biomass: Conversion into Fuels, Chemicals and Power, John Wiley & Sons, 2019.

Reference Books:

1. H. S. Mukunda, Understanding Clean Energy and Fuels From Biomass, Wiley India Pvt Ltd, 2011.
2. Rosillo Calle Frank and Francisco Rosillo, The Biomass Assessment Handbook: Bioenergy for a Sustainable Environment, Earthscan, 2015.
4. G. D. Rai, Non conventional Energy Sources, Khanna Publishers, 2007.
5. David Herak, Biomass for Energy Application, Mdpi Ag, 2021
6. S. Bent, Renewable Energy, 2/E, Academic press, 2000.

EN-PC-306: FINANCIAL EVALUATION OF RENEWABLE ENERGY SYSTEMS

L-T-P-C: 3-1-0-4

No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Continuous Assessment = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Course Objectives:

- To provide students with a thorough grounding in the key concepts of energy economics.
- To illustrate how these concepts and standard economic tools can be used to analyze energy-related policy issues.
- To be able to apply this knowledge to the analysis of specific energy issues in India.

Course Outcomes:

- Appreciate and understand economics of energy production and supply, energy consumption and demand, energy regulation, and energy market
- Understand the role of engineering economy for decision making
- Students learn about cash flows, time value of money and evaluation of investments and projects
- To provide students an understanding of the economic fundamentals and principles of decision making involved in energy projects.

Detailed Syllabus

Unit I

Introduction to Engineering Economics, , Economic theory of demand and supply, fixed cost and variable cost of power production, tariff and electrical revenue market structure, levelized cost of energy, annualized value, customer/ producer surplus, Uncertainty and risk, time points and periods, unit cost of power generation for conventional power plant and renewable energy power plant.

Unit II

Investment-need, Appraisal and criteria, Economic measures and Financial analysis techniques-Simple payback period, Return on investment, Net present value, Internal rate of return, Cash flows, Risk and TLCC analysis, benefit to cost ratio, savings to investment ratio; Financing options, Selection criteria for the Economic Evaluation Measures Matrix, CUSUM.

Unit III

Relevance of financial and economic feasibility, Uncertainties and social cost benefit analysis of renewable energy systems, Renewable energy projects for reductions in CO2 emissions, Case studies on techno-economics of energy conservation and renewable energy technologies, Indicator of financial performance, Incremental analysis of investment project.

Unit IV

Energy Action Planning key elements, Force field analysis, Definition and scope of project, Technical design and Implementation, Financing, Contracting, Implementation and performance monitoring, Elements of monitoring & targeting, Energy policy, Performance contracts, ESCOs, Kyoto Protocol & Clean Development Mechanism (CDM).

Text Books:

1. R. Lea, Business Models for Renewable Energy for Built Environment, Taylor and Francis, 2013.
2. S.C. Bhattacharya, Energy Economics: Concepts, Issues, Marketsand Governance, Springer, 2011.

Reference Books:

1. T. C. Kandpal, H. P. Garg, Financial Evaluation of Renewable Energy Technology, Macmilan India Ltd., 2003.
2. E. B. Ferdinand, Energy Economics: A Modern Introduction, 1/E, Kluwer, London, 2000.
3. R.L. Pirog and S.C.Stamos, Energy Economics: Theoryand Policy,Prentice Hall, NewJersey, 1997.

EN-OE-3081: MATERIAL SCIENCE AND ENGINEERING L-T-P-C: 3-0-0-3

No. of Hours Per Week: *Lectures-3, Tutorial-0*
Marks Distribution: *Continuous Assessment = 30, End Semester Examination = 45.*
Questions to be set: *Eight*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Two and a half hours.*

Course Objectives:

- Be engaged in understanding the basic concepts of materials science and engineering.
- Employ elements of the materials research process in their careers.
- Maintain their curiosity and expand their knowledge and skills through lifelong learning.

Course Outcomes:

- Ability to acquire and apply new knowledge as needed, using appropriate learning strategies.
- Ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
- Ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
- Ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.

Detailed Syllabus

Unit – I

Classification and Structure of Materials: Classification of materials: metals, ceramics, polymers and composites. Nature of bonding in materials: metallic, ionic, covalent and mixed bonding; structure of materials: fundamentals of crystallography, symmetry operations, crystal systems, Bravais lattices, unit cells, primitive cells, crystallographic planes and directions.

Unit –II

Mechanical properties: Mechanical properties of metals, ceramics, polymers and composites at room temperature; stress-strain response (elastic, anelastic and plastic deformation). Electronic properties: free electron theory, Fermi energy, density of states, elements of band theory, semiconductors, Hall effect, dielectric behaviour, piezo- and ferro-electric behaviour.

Unit – III

Heat treatment of ferrous and aluminum alloys; preparation of ceramic powders, sintering; thin film deposition: evaporation and sputtering techniques, and chemical vapour deposition, thin film growth phenomena.

Text Books:

1. William D. Callister, Jr., David G. Rethwish; *Materials Science and Engineering AnIntroduction* , 10th Edition Wiley, 2018.
2. William F. Smith, Java Hashemi and Ravi Prakash, *Materials Science and Engineering;* McGraw Hill, 2017.

Reference Books:

1. I P Singh; *Materials Science and Engineering;* 13th Edition, Jain Brothers, 2018.
2. R. Balasubramaniam; *Materials Science and Engineering;* 2nd Edition, Wiley, 2014.

EN-OE-3082: MICROPROCESSOR, MICROCONTROLLER AND EMBEDDED SYSTEM

L-T-P-C: 3-0-0-3

No. of Hours Per Week: *Lectures-3, Tutorial-0.*
Marks Distribution: *Continuous Assessment = 30, End Semester Examination = 45.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Two and Half Hours*

Course Objectives:

- Students will be familiarised with fundamental operating concepts of microprocessors and microcontrollers.
- Students will be enriched with the knowledge of interfacing of various peripherals and design aspects.

Course Outcomes:

- To understand the Architecture of 8085 microprocessor and 8051 microcontroller.
- To understand the Assembly level programming.
- To understand various sensors, ADCs and peripherals used in embedded systems.
- To learn the hardware aspects & interfacing of embedded systems.

Detailed Syllabus

Unit I

8085-architecture, operation, pin configuration and functions, bus organization, control signal generation for external operations- fetch, IO/M, read/write, machine cycles and bus timings. Addressing mode, instruction set, interrupt; Overview/concept of peripheral interfacing devices-8251, 8253, 8255 and 8279.

Unit II

Microcontroller: Architecture of 8051 – Special Function Registers(SFRs) – I/O Pins Ports and Circuits – Instruction set –Addressing modes – Assembly language programming.

Unit III

Interfacing of Temperature Sensor, Light Sensor, Proximity Sensor; Analog to digital converters: ADC Interfacing; Actuators Displays, Motors, Opto couplers/Opto isolators, relays; DMA controller.

Text Books:

1. Ramesh S. Goankar, 8085 Microprocessors Architecture Application and Programming, Penram International, 6th Edition, 2013.
2. Muhammad Ali Mazidi and J. G. Mazidi, The 8051 Microcontroller and Embedded systems, Pearson Education, 2nd Edition, 2007.

Reference Books:

1. Anita Gehlot, Rajesh Singh, et al., Microprocessor and Microcontroller Interview Questions: A complete question bank with real-time examples, 1st Edition, 2020.
2. Soumitra Mandal, Microprocessors and Microcontrollers Architecture, Programming and Interfacing Using 8085, 8086 and 8051, Mc-Graw Hill Education, 2017.

EN-PC-LC-310: SOLAR ENERGY LABORATORY **L-T-P-C: 0-0-4-2**

No. of Hours Per Week: *Practical-4.*
Marks Distribution: *Continuous Assessment = 20, End Semester Examination = 30.*
Questions to be set: *Ten*
Question to be answered**:** *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Three Hours*

Course Objectives:

- Enable students to understand the principles and mechanisms involved in various solar thermal devices
- Provide hands-on experience in conducting experiments to analyze the performance and characteristics of solar thermal devices
- Provide hands-on experience in conducting experiments to analyze the performance and characteristics of solar photovoltaic devices

Course Outcome:

- To understand the concept of heat loss factor in solar flat plate collectors and its significance in system efficiency.
- To apply practical knowledge of the design, components, and operation of flat plate solar thermal devices.
- To understand the principles of solar photovoltaic devices

List of Experiments:

1. To study the I-V characteristics of a solar cell or panel under solar simulator.
2. To determine the diffuse, beam and total solar radiation at solar noon at a given site
3. To determine the FF of a given solar cell/module using solar simulator.
4. To determine the Quantum efficiency of a given solar cell using IPCE system
5. To determine the maximum voltage and current output of series and parallel combination of four solar cells under a solar simulator
6. To determine the maximum power point of series and parallel combination of four solar cells
7. To study of the heat loss factor of a solar flat plate collector.
8. To study the flat plate solar water heater
9. To determine the figure of merit for a box type solar cooker.
10. To evaluate the zeta potential of the given nanoparticles is three different solvents provided
11. To estimate the particle size distribution and molecular mass of the given sample
12. To study the absorption spectra of the given sample in Visible, UV and NIR range.

Text Books:

1. C. Richter, D. Lincot and C. A. Gueymard, Solar Energy, Springer 2013.
2. S.P. Sukhatme, Solar Energy:Principles of Thermal Collection and Storage, TMH, 2008.
3. Ismail Tosun and Reza A. Sarraj, Solar Thermal Engineering: Applications and Components, CRC Press, 1st Edition, 2021

Reference Books:

1. G.N. Tiwari, Solar Energy, Fundamentals design, modelling and Applications, Narosa publication, 2010.
2. C. S. Sollonki, Solar Photovoltaics: Fundamental Technologies and Applications, PHI Learning Pvt Ltd. India, 3rd Edition, 2023.

EN-P-312: INTERNSHIP **L-T-P-C: 0-0-0-3**

Marks Distribution: *End Semester Examination = 75*

Course Objectives:

- Hands-on Training and Experience: Provide students with immersive hands-on training and direct experience to complement theoretical knowledge.
- Experiential Learning Reinforcement: Reinforce experimental and contextual learning by integrating practical experiences into the academic curriculum.

Course Outcomes:

- Skill Development for Career Readiness: Enable students to develop practical skills and techniques essential for their future careers through hands-on training and experiential learning opportunities.
- Interpersonal Skill Enhancement: Offer students the chance to cultivate attitudes conducive to effective interpersonal relationships through collaborative projects and teamwork during their internships.
- Deepened Understanding through Practical Engagement: Foster in-depth knowledge acquisition by immersing students in real-world settings, allowing for active participation and interactive learning experiences.

Ordinarily the internship shall be undertaken before commencement of semester classes. The students need to submit a report on the work he has carried out during the internship period duly certified by the supervisor. The evaluation of the internship shall be done based on the submitted report and a seminar presented by the student to the Department.

EN-PC-401: ENERGY AUDITING AND MANAGEMENT L-T-P-C: 3-1-0-4
No. of Hours Per Week: *Lecture-3, Tutorial-1.*
Marks Distribution: *Continuous Assessment = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Course Objectives:

- To understand the energy management, conservation processes, principles of energy accounting, energy flow diagram, economics of energy conservation opportunities.
- To understand the energy management information systems, various key features of Energy Conservation Act and ECBC.
- To understand the scope for energy conservation in electrical and thermal energy utilities.

Course Outcomes:

- Discuss the principles of energy management, conservation and auditing in thermal and electrical utilities
- Assess scope of energy conservation in electrical and thermal utilities
- Analysis of economics of energy conservation opportunities in electrical and thermal utilities and reporting of energy audit
- Understand the general energy scenario and various provisions of the Energy Conservation Act, 2001.

Detailed Syllabus

Unit I
Basic concepts of Energy Efficiency and Energy Conservation, Energy conservation in household, transportation, agricultural, service and industrial sectors, Energy Audit, Need and types of energy audit, Energy management (audit) approach, Understanding energy costs, bench marking, Fuel and energy substitution, Energy audit instruments.

Unit II
Energy Conservation Act 2001 and amendments, Duties and responsibilities of energy managers and auditors as per Energy Conservation Act 2001, National Mission for Energy Efficiency Enhancement Program, Material and Energy balance, Facility as an energy system, Methods for preparing process flow, material and energy balance diagrams, Sankey Diagram.

Unit III
Boilers Types, Combustion in boilers, Analysis of losses in boilers, Energy conservation opportunities in boilers, Insulation-types and application, Economic thickness of insulation, Heat savings and application criteria, need for cogeneration and waste heat recovery Classification, Advantages and applications, Saving potential.

Unit IV
Energy management information systems, SCADA system. Energy performance assessment of Heat exchangers, Energy performance assessment of HVAC, Energy performance assessment of lighting system, Energy performance assessment of motors, variable speed drives, fan & blowers, Energy performance assessment of water pumps.

Text Book

1. Dall'O' Giuliano, Green Energy Audit of Buildings, Springer,2013.
2. Y. P. Abbi, S. Jain, Energy Audit and Environment Management, The Energy Research Institute India, 2006.
3. I. C. Flavio, The Energy Audit of Electric Motor Driven Systems, Springer,2003.

Reference Books:

1. T. Thumann, W. J. Younger. Hand Book of Energy Audits, CRC Press2003
2. Bureau of Energy Efficiency (BEE). Study material for Energy Managers and Auditors Examination: Volume I-IV.2003.
3. I. Hamies, Energy Auditing and Conservation; Methods, Measurements, Management and Case study, Hemisphere, Washington, 1990.

EN-PE-4031: TARIFF, SMART METERING AND REGULATIONS L-T-P-C: 3-1-0-4
No. of Hours Per Week: *Lecture-3, Tutorial-1.*
Marks Distribution: *Continuous Assessment = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Course Objectives:

- To provide students with a comprehensive understanding of electrical regulations and policies governing the design, installation, operation, and maintenance of electrical systems, and to equip them with the knowledge and skills necessary for compliance and adherence to these regulations.
- To provide an in-depth exploration of tariff structures and smart metering technologies in the context of energy engineering. Students will study various components of smart grids, dynamic pricing strategies, intelligent electronic devices, and advanced metering infrastructure.

Course Outcomes:

- Understand the significance of electrical regulations and policies for ensuring safety, efficiency, and reliability in electrical systems.
- Apply key national and international electrical codes, standards, and regulations to design, install, and maintain electrical systems, ensuring compliance and adherence to safety standards.
- Understanding the role of Smart Meters in electricity tariff structures, including different electrical tariff system.
- Analyze the impact of dynamic pricing on consumer behavior and energy consumption patterns.
- Understanding the role of smart energy efficient end-use devices, load curves, load shaping methodologies, and energy management in demand response; and demand-side management.

Detailed Syllabus

Unit I
Components of smart grids, Difference between conventional & smart grid, introduction to smart meters, electricity tariff structures: one-part tariff, two-part tariff, power factor tariff and maximum demand tariff, Role of tariff in DSM and in energy management.

Unit II
Dynamic pricing strategies: time-of-use (TOU) pricing, critical-peak pricing (CPP), real-time pricing; automatic meter reading, smart sensors, home & building automation, Home Area Network (HAN), Neighborhood-Area Networks (NANs).

Unit III
Wide area measurement system (WAMS) & phase measurement unit (PMU), load curves and load shaping methodologies, peak load shaving techniques, role of technology in demand response, advanced metering infrastructure (AMI), smart grid system monitoring.

Unit IV
Introduction to electrical regulations and policies in India, legal framework for electrical regulation, role of government agencies and regulatory authorities, legal responsibilities of stakeholders in the electrical industry, electrical codes and standards, compliance requirements for electrical installations and equipment, safety regulations and practices, environmental regulations, case studies and practical applications.

Text Books:

1. Ray C. Mullin and Phil Simmons, Electrical Wiring Residential, 19th Edition, Cengage Learning, 2017.
2. P. Fereidoon Sioshansi, Smart Grid Handbook, Academic Press, 2016.
3. James Momoh, Smart Grid: Fundamentals of Design and Analysis, Wiley, 2012.
4. B. Janaka Ekanayake and Nick Jenkins, Smart Grid: Technology and Applications, Wiley, 2021.

Reference Books:

1. "National Electrical Code Handbook" by National Fire Protection Association, NFPA, 1st Edition,2020,
2. Kimberley Keller "Electrical Safety Code Manual: A Plain Language Guide to National Electrical Code, OSHA, and NFPA 70E", McGraw-Hill Education,1st Edition, 2010
3. Fabio Toscano, Smart Metering Handbook by, Wiley, 2013.
4. Nouredine Hadjsaid, Smart Grids: Infrastructure, Technology, and Solutions, ISTE Press, 2023.

EN-PE-4032: STATISTICS **L-T-P-C: 3-1-0-4**

No. of Hours Per Week: *Lecture-3, Tutorial-1.*
Marks Distribution: *Continuous Assessment = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Course Objectives:

- Understanding of fundamental statistical concepts such as probability distributions, hypothesis testing, confidence intervals, correlation, regression analysis, and statistical inference
- Learning various methods for collecting energy-related data, including experimental design, sampling techniques, and data acquisition from sensors and monitoring systems
- Apply statistical techniques to analyze data from energy systems, including power generation, distribution, consumption, and efficiency. This includes techniques for time series analysis, frequency domain analysis, and spatial analysis

Course Outcomes:

- Students should gain proficiency in using statistical methods to develop mathematical models and simulations of energy systems
- Students should learn techniques for forecasting energy demand, renewable energy generation, market prices, and other relevant variables using time series analysis, regression models, and forecasting methods
- Students should learn how to assess risks associated with energy projects and make informed decisions using probabilistic methods, sensitivity analysis, and decision trees.
- Students should be able to effectively communicate the results of statistical analyses to various stakeholders, including policymakers, engineers, and the general public, through reports, presentations, and data visualization techniques

Detailed Syllabus

Unit I Probability and Distribution
Probability theory - Different concepts and approaches, Laws and axioms of probability, Conditional probability and concept of interdependence; Concept of random variable: Probability, Mass and density functions, Expectations, Bayes theorem and its applications; Probability distributions: Binomial, Multinomial, Hyper geometric, Poisson, and Normal.

Unit -II: Correlation, Regression and Sampling
Correlation and Regression analysis: Simple, multiple and partial correlations, Rank correlation, Least squares estimation; Coefficient of determination; Standard error of estimate; Sampling: Concepts and types.

Unit -III: Theory of Estimation and Hypothesis Testing
Concept of an estimator and its sampling distributions, Properties of good estimator; Formulation of statistical hypotheses- Null and alternative; Goodness of fit; Confidence interval and level of significance; Errors of types II and I, Hypothesis testing: Z, t, F tests, and chi-square test.

Unit -IV: Time Series and Forecasting
Time series: Components, Approaches to time series, Process of decomposition, Estimation of trend variations, De-trending of time series, Estimation of seasonal and cyclical variations; Forecasting: Types and approaches to forecasting, Forecasting techniques. SQC. Data Analysis in SPSS.

Text Books:

1. Goon, Gupta and Dasgupta, Fundamentals of Statistics Vol. I & II, World Press, 2005.
2. D.NGujarati, D.C. Porter and S. Gunasekar, Basic Econometrics, Tata McGraw Hill, 2012
3. R. Hooda,Statistics for Business and Economics, Vikas Publishing House, 2013
4. C. RRao, Linear Statistical Inference and Applications, Wiley and Sons, 2018
5. M. Sulivan, , Fundamentals of Statistics, Pearson, 2012

Reference Books:

1. Y.LChou,Statistical Analysis for Business and Economics, Elsevier Publishing Company, 1989
2. W. Feller,An Introduction to Probability Theory and Its Applications, Vol. I (3e), Wiley, 1968
3. R.AJohnson,. and D.W. Wichern, Applied Multivariate Statistical Analysis, Prentice Hall, ND, 1996

EN-PE-4051: FUEL CELL AND HYDROGEN ENERGY **L-T-P-C: 3-1-0-4**

No. of Hours Per Week: *Lecture-3, Tutorial-1.*
Marks Distribution: *Continuous Assessment = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Course Objectives:

- To provide students with a comprehensive understanding of hydrogen as an alternate fuel, including its physical and chemical properties, advantages, and limitations over conventional fuels.
- To familiarize students with the concept of the hydrogen economy and its implications on global energy systems.
- To analyze the suitability of hydrogen as a fuel and fuel cell as an energy conversion device, considering technical feasibility, efficiency, and sustainability aspects.

Course Outcomes:

- **Fundamental Understanding:** Upon completion of the course, students will demonstrate a comprehensive understanding of the fundamental principles of hydrogen as an alternative fuel, encompassing its physical and chemical properties, as well as its advantages and limitations over conventional fuels, in alignment with NBA standards.
- **Problem-Solving Skills:** Graduates will exhibit the ability to analyze and address technical constraints and safety measures associated with the production, transport, and storage of hydrogen, proposing viable solutions within the framework of NBA accreditation standards.
- **System Design and Optimization:** Students will develop proficiency in designing and optimizing fuel cell systems considering various factors such as efficiency, reliability, and environmental impact, aligning with NBA standards for engineering education.
- **Experimental Investigation:** Graduates will conduct experiments, analyze data, and interpret results related to fuel cell performance, utilizing appropriate experimental techniques and methodologies as per NBA accreditation standards.

Detailed Syllabus

Unit I

Hydrogen as an alternate fuel, Physical and chemical properties of Hydrogen as a fuel, Advantages and limitations of Hydrogen over conventional fuels, Hydrogen Economy, Suitability of Hydrogen as a fuel and Fuel Cell as energy conversion device, Hydrogen Transport, Technical constraints of transport of Hydrogenby Road, Railway, Pipeline, and by Ship. Safety measures for Hydrogen production, transport and storage.

Unit II

Hydrogen Production from fossil fuels, electrolysis, thermal decomposition, photochemical, photo-catalytic, hybrid, Sea as a source of Deuterium, production of hydrogen from sea water, Photo-catalytic hydrogen production. Hydrogen Storage in Metal hydrides, Metallic alloy hydrides, Safety measures for Hydrogen production, transport and storage.

Unit III

Basic thermodynamics of Fuel Cell, Reaction kinetics, Charge and mass-transport. Fuel Cell modelling for charge and mass transport, In- situ and Ex- situ Fuel Cell characterization, System and components of a Fuel Cell, Types of Fuel Cells based on working temperature, electrolyte and fuel, Fuel Cell power stations, Power management, Thermal management, Pinch analysis.

Unit IV

Working principle of low temperature Fuel Cells, Alkaline Fuel Cell and Polymer Electrolyte Fuel Cell, Working principle of high temperature Fuel Cells- Solid Oxide Fuel Cell and Molten Carbonate Fuel Cell, Fuel Cell systems and sub- systems, system and subsystemintegration.

Text Books:

1. Seyed Ehsan Hosseini, Fundamentals of Hydrogen Production and Utilization in Fuel Cell Systems, Elsevier, 1st Edition, 2023
2. Kreuer, Klaus-Dieter, Fuel Cells, Springer, 2013.

Reference Books:

1. R. O'Hayre, S. Cha, W. Colella and F. B. Prinz, Fuel Cell Fundamentals, John Wiley and Sons, New York, 2006.
2. N. Sammes, Fuel Cell: Technology: Reaching Towards Commercialization, Springer, 2006.
3. Sorensen B. Hydrogen and Fuel Cells, Academic Press, 2005.
4. M. Shao, Electro-catalysis in fuel cells, Springer, 2013.

EN-PE-4052: ENERGY RESOURCE ASSESSMENT **L-T-P-C: 3-1-0-4**

No. of Hours Per Week: *Lecture-3, Tutorial-1.*
Marks Distribution: *Continuous Assessment = 40, End Semester Examination = 60.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours*

Course Objectives:

- To understand the importance of natural resources and the need for their conservation.
- To assess the environmental degradation caused due to energy production and its utilization.
- To understand the techniques used to assess the potential environmental impacts that are associated with a product, process, or service through life cycle assessment (LCA).
- To identify and evaluate the effects of activities (mainly human) on the environment - natural and social through the use of Environmental Impact assessment (EIA
- To make student aware about the problems of climate change, international pressure on climate change compliance and competition for energy and global initiative to address the issue.

Course Outcomes:

- **Comprehend Natural Resource Dynamics**: Understand the fundamental concepts of natural resources and recognize the imperative need for their conservation in sustaining ecological balance.
- **Classify and Evaluate Resources**: Classify natural resources into renewable and nonrenewable categories, assess their importance, and critically analyze the associated problems arising from their utilization.
- **Formulate Conservation Strategies**: Devise effective strategies for the conservation of energy, forest, and water resources, considering the diverse challenges posed by their exploitation.
- **Analyze Environmental Impacts**: Evaluate the environmental impacts of energy production and utilization, including emissions, air and water pollution, ozone layer depletion, and their repercussions on human health and the environment.
- **Understand Global Environmental Initiatives**: Comprehend international efforts and agreements such as the UNFCCC, Kyoto Protocol, and Clean Development Mechanism (CDM) aimed at mitigating global environmental pollution and fostering sustainable development.

Detailed Syllabus

Unit I

Natural resources and its conservation: Natural resources- basic concept and the need for conservation; Classification of natural resources- renewable and nonrenewable resources; Importance, associated problems of its uses and strategies for conservation ofnatural resources (energy, forest and water resources).

Unit II

Energy production and utilization: Emission due to energy conversion, primary and secondary air pollution, water pollution, depletion of Ozone layer, Greenhouse gases, acid rain and its effect on environment and human health. Various methodologies for their control.

Unit III

Assessment of Energy Resources: Life cycle assessment (LCA) in energy resource assessment-introduction to LCA, methodologies and tools. Environmental management and assessment-objectives and components; Environmental Impact of solar, wind, hydroelectric and geothermal

power; Environmental Impact assessment (EIA)- historical background, detailed procedure and design of EIA.

Unit IV

Global Environmental Pollution Control Laws and Initiatives: Carbon credit: concept and examples; Carbon trading and its limitation; United Nation Framework Convention on Climate Change (UNFCC), Kyoto Protocol, Conference of parties (CoP); Clean Development Mechanism (CDM), Prototype Carbon Funds (PCF).

Text Books:

1. G. Boyle, B. Everett and J. Ramage, "Energy Systems and Sustainability" Oxford University Press, 2005.
2. W. P. Cunningham and W.B. Saigo, "Environmental Science", McGraw Hill, New York, 1999.
3. G. Kiely "Environmental Engineering", Tata McGraw-Hill, New Delhi, 2007.

Reference Books:

1. Venugopal Rao, "Textbook of Environmental Engineering", PHI, 2003.
2. G. Tyler Miller Jr. "People and Environment", CENGAGE Learning, 2007.

EN-OE-4071: INTELLECTUAL PROPERTY RIGHTS L-T-P-C: 3-0-0-3

No. of Hours Per Week: *Lecture-3, Tutorial-0.*
Marks Distribution: *Continuous Assessment = 30, End Semester Examination = 45.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Two and Half Hours*

Course Objectives:

- To recognize the importance of IP and to educate the pupils on basic concepts of Intellectual Property Rights and Engineering Ethics.
- To make the students to understand the statutory provisions of different forms of IPRs in simple forms.
- To learn the procedure of obtaining Patents, Copyrights, Trade Marks &Industrial Design

Course Outcomes:

- Distinguish and explain various forms of IPRs and Engineering Ethics.
- Identify criteria's to fit one's own intellectual work in particular form of IPRs.
- Apply statutory provisions to protect particular form of IPRs.
- Analyze rights and responsibilities of holder of Patent, Copyright, Trademark, Industrial Design etc and Identify procedure to protect different forms of IPRs national and international level.

Detailed Syllabus

Unit – I

Engineering as a profession, historical and social context, Ethics in Engineering, Codes of Engineering Ethics, history and purpose, Engineer's moral responsibility for safety and human right, risk assessment and communication, product liability, development ethics, publication Ethics.

Unit –II

IPR I: Intellectual property, definition, types, rights and functions, patents, trademark, software design, industrial designs, copyright, Geographical indicator, grant of patent in India, authority and procedure, patent forms, surrender and revocation of patents and compulsory licensing, acquisition of inventions by the Government.

Unit – III

IPR II: Contents of draft application for patents, Drafting patent specification and claims, WTO and drafting patent specification and claims, IPR infringement, Misconduct in research publication, Research metrics.

Text Books:

1. Vinod V. Sople, Managing Intellectual Property: The Strategic Imperative, PHI,2006.
2. Charles and Harri Michael S Pritchard and Michael J Robins, Engineering Ethics: Concepts and cases, Wordsworth/ Thompson Learning, Belmont Calif, 2000.
3. B. L. Wadehra, Law Relating to Intellectual Property, Universal Law Publishing,2009

Reference Books:

1. Huff and Finholt, Social Issues in Computing: Putting Computing in Place, McGrawHill,1994.
2. Govindarajan, Natarajan and Senthil Kumar, Engineering Ethics, PHI,2004.
3. Jones and Bartlett, Cyber Ethics: Morality and Law in Cyber Space,4/e, Jones and Bartlett India Pvt. Ltd 2011.

EN-OE-4072: CLEAN COAL TECHNOLOGY AND ENVIRONMENT L-T-P-C: 3-0-0-3
No. of Hours Per Week: *Lecture-3, Tutorial-0.*
Marks Distribution: *Continuous Assessment = 30, End Semester Examination = 45.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Two and Half Hours*

Course Objectives:

- The course enhances the concepts of energy potential and utilization of coal globally and environmental concerns associated with coal technologies
- The course provides basic understanding of coal ranks, grades, classification and characteristics.
- The course enhances the knowledge of functions of various equipments for cleaner coal technologies

Course Outcomes:

- To understand the coal properties, classifications, ranks etc.
- To explain the global and Indian scenario of utilization of coal
- To understand and explain coal handling, coal processing, storage and related indexes
- To understand and explain coal combustion technologies and emission control strategies

Detailed Syllabus

Unit-I
Coal formation, rank of coal, structure of coal, classification of coal, global coal reserve and utilization, Indian coal, environmental pollution standards, solid, liquid and gaseous pollutants and control.

Unit-II
Demineralization procedure for coal, proximate analysis, swelling index, caking index, hardgrovegrindability index, reactivity of coal and coke, Float and sink washability tests, washability index, coal handling, storage and size reduction

Unit III
Coal combustion technologies, fluidized bed combustion (FBC), integrated gasification combined cycle(IGCC), CO_2 sequestration, Emission control strategies for power plants, coal carbonization, coal gasification, utilization of coal wastes

Text Books:

1. Dave Osborne, The Coal Handbook: Towards Cleaner Coal Utilization, Woodhead Publishing, 2023.
2. S. KomarKawatra, Advanced Coal Preparation and Beyond, CRC Press, 2022
3. B. Mazumder, Coal Science and Engineering, Woodhead Publishing, 2012
4. B. G. Miller, Clean Coal Engineering Technology, Butterworth-Heinemann, 2016.

Reference Books:

1. D.V. SubhaRao, T. Gouricharan, Coal Processing and Utilization, CRC Press, 2016
2. P. J. Reddy, Clean coal Technologies for Power Generation, CRC Press, 2013.
3. Qi Aiying and Zhao Bo, Cleaner Combustion and Sustainable World, Springer 2013
4. O.P Gupta, Elements of Fuel and Combustion Technology, Khanna Publishing, 2018

EN-OE-4073: NUCLEAR ENERGY **L-T-P-C: 3-0-0-3**

No. of Hours Per Week: *Lecture-3, Tutorial-0.*
Marks Distribution: *Continuous Assessment = 30, End Semester Examination = 45.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Two and Half Hours*

Course Objectives:

- To impart a deep understanding of the fundamental principles of nuclear physics and nuclear reactions, including nuclear fission and fusion processes
- To teach the principles of nuclear reactor design, operation, and safety, including reactor kinetics, reactor control, and the role of various reactor components.
- To explore the complete nuclear fuel cycle, from fuel fabrication to spent fuel management, including reprocessing and waste disposal techniques

Course Outcomes:

- The students will be able to explain the principles of nuclear physics, including nuclear reactions, radioactive decay, and the interactions of radiation with matter.
- To analyse the design, operation, and safety aspects of nuclear reactor systems, including reactor kinetics, heat transfer, and reactor control mechanisms.
- To understand the stages of the nuclear fuel cycle, reactor operation, spent fuel management, and waste disposal and environmental factors.

Detailed Syllabus

Unit I
Mechanism of Nuclear Fission and Nuclear Fusion, Nuclides, Radioactivity, Decay Chains, Neutron Reactions, the Fission Process, Reactor types, Fast Breeding.

Unit II
Design and Construction of Nuclear reactors, Heat Transfer Techniques in Nuclear Reactors, Reactor shielding. Nuclear Fuel Cycles, Characteristics of Nuclear Fuels, Uranium.

Unit III
Production and Purification of Uranium, Conversion to UF_4 and UF_6. Other Fuels like Zirconium, Thorium, Beryllium, Nuclear Fuel Cycles for other fuels, Spent Fuel Characteristics, Thorium based green nuclear energy.

Text Books:

1. Raymond Murray and Keith E. Holbert, Nuclear Energy: An Introduction to the Concepts, Systems, and Applications of Nuclear Processes' Butterworth-Heinemann, 8th edition, 2019
2. N. Tsoulfanidis, Nuclear Energy, Springer 2013.
3. M. Greenberg, Nuclear Waste management, Nuclear power, and Energy Choices, Springer 2013.

Reference Books:

1. M. Manu, Nuclear Power, Economic development discourse and the environment: The case of India, Taylor and Francis Group, 2013.
2. T. Jevremovic, Nuclear principles in engineering, 2/E, Springer 2009.
3. D. Bodansky, Nuclear Energy: Principles, practices, and prospects, 2/E, Springer; 1996.

EN-P-419: MINOR PROJECT **L-T-P-C: 0-0-10-5**

No. of Hours Per Week: *Practical- 10*

Marks Distribution: *Continuous Assessment = 50 End Semester Examination = 75.*

Course Objectives:

- **Understanding Energy Systems:**Students should demonstrate a comprehensive understanding of energy systems, including renewable energy sources, conventional energy sources, energy conversion processes, and energy storage technologies.
- **Applications of Engineering Principles:**Apply engineering principles and concepts learned throughout the B.Tech Energy Engineering curriculum to solve practical energy-related problems.
- **Research Skills:** Develop research skills by gathering and analyzing data, reviewing literature, and conducting experiments or simulations relevant to the chosen topic of the minor project.
- **Problem Solving**: Abilities: Demonstrate the ability to identify, analyze, and solve complex problems related to energy engineering, considering technical, economic, environmental, and societal factors.

Course Outcomes:

- Design and implement innovative solutions or improvements in energy systems, components, or processes, addressing specific challenges or requirements as identified
- Manage the project effectively, including planning, scheduling, resource allocation, and risk management, to ensure timely completion and achievement of project objectives.
- Communicate effectively through written reports, presentations, and discussions, conveying technical information, project findings, and recommendations to various stakeholders, including peers, faculty, and industry professionals
- Critical Thinking an Foster critical thinking and innovation by exploring new ideas, evaluating alternative approaches, and proposing creative solutions to advance knowledge and address emerging challenges in energy engineering
- Adhere to ethical principles and professional standards in conducting research, handling data, and interacting with colleagues and stakeholders, demonstrating integrity, accountability, and respect for diversity

Modalities

Each student individually or in a group will undertake a sizeable project involving a survey of the literature, development of new techniques and/or implementation of systems, writing of reports etc. under the guidance of one or more faculty members of the department. The evaluation of the minor project shall be done as per the guidelines laid down in RC-20.

EN-OE-4021: ELECTRIC VEHICLE AND SUSTAINABLE TRANSPORTATION

L-T-P-C: 3-0-0-3

No. of Hours Per Week: *Lectures-3, Tutorial-0.*
Marks Distribution: *Continuous Assessment = 30, End Semester Examination = 45.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Two and Half Hours*

Course Objectives:

- To introduce students to the concept of electric vehicles (EVs) and sustainable transport, providing an understanding of the different types of EVs and their role in promoting environmentally friendly transportation solutions.
- To familiarize students with the principles and importance of sustainable transport, emphasizing the significance of reducing greenhouse gas emissions and mitigating climate change through the adoption of sustainable transportation practices.
- To educate students about the various energy sources used in EVs and their environmental impact, enabling them to analyze the sustainability of different propulsion systems and make informed decisions regarding energy use in transportation.
- To provide students with a comprehensive understanding of electric powertrain components, including motors, batteries, power electronics, and control systems, enabling them to comprehend the functioning and characteristics of key components in EVs.

Course Outcomes:

- Comprehensive Understanding: Upon completion of the course, students will demonstrate a comprehensive understanding of electric vehicle technologies and sustainable transport principles.
- Analysis Skills: Graduates will be able to analyze the environmental impact of different energy sources used in electric vehicles and evaluate their suitability for sustainable transport.
- Proficiency in Powertrain Components: Students will demonstrate proficiency in understanding and analyzing electric powertrain components, including motors, batteries, power electronics, and control systems.
- Battery Technology Evaluation: Graduates will be able to evaluate different battery technologies used in electric vehicles and assess their performance and suitability for practical applications.

Detailed Syllabus

Unit I

Introduction to E-Vehicles and Sustainable Transport, Definition and types of EVs: Battery Electric Vehicles (BEVs), Plug-in Hybrid Electric Vehicles (PHEVs), Hybrid Electric Vehicles (HEVs), Fuel Cell Electric Vehicles (FCEVs Advantages and challenges of EV adoption in transportation. Sustainable Transport Concepts-Importance of sustainable transport in reducing greenhouse gas emissions and mitigating climate change. Role of e-vehicles in promoting sustainable transport. Comparison of energy sources for EVs: electricity, hydrogen, biofuels. Environmental impact assessment: life cycle analysis, carbon footprint, air quality benefits.

Unit II:

E-Vehicle Technology and Infrastructure. Electric Power train Components, Overview of electric powertrains: motor, battery, power electronics, and control systems. Functionality and characteristics of key components in electric vehicles. Battery Technologies, Types of batteries used in EVs: lithium-ion, solid-state, and emerging technologies, Battery management systems (BMS) and thermal management.
Charging Infrastructure, Types of charging stations: Level 1, Level 2, and DC fast charging, charging network expansion and smart charging.

Unit III:
Policy, Regulations, and Future Trends, Overview of national and international policies promoting e-vehicles and sustainable transport. Incentives, subsidies, and regulations for EV adoption. Case studies of successful policy implementation in various regions. Global market trends and forecasts for e-vehicles.
Emerging technologies and innovations in sustainable transport: autonomous vehicles, vehicle-to-grid (V2G) integration, shared mobility solutions. Role of stakeholders: government, industry, academia, and civil society in shaping the future of sustainable transport.

Text Books:

1. James Larminie and John Lowry, Electric Vehicle Technology Explained, Wiley, 2nd Edition, 2020.
2. Preston L. Schiller, Jeffrey R. Kenworthy, and Erik W. Johnston, Introduction to Sustainable Transportation: Policy, Planning and Implementation, Routledge, 2md Edition, 2019.

Reference Books:

1. Andres Carvallo and RajitGadh, Electric Vehicle Integration into Modern Power Networks, Springer, 1st Edition, 2020.
2. William R. Black, Sustainable Transportation: Problems and Solutions, The Guilford Press, 2nd Edition, 2018.

EN-OE-4022: GREEN BUILDING AND SOLAR PASSIVE ARCHITECTURE

L-T-P-C: 3-0-0-3

No. of Hours Per Week: *Lectures-3, Tutorial-0.*
Marks Distribution: *Continuous Assessment = 30, End Semester Examination = 45.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Two and Half Hours*

Course Objectives:

- Understand the Definition, Concept & Objectives of the terms cost effective, energy efficiency and green building
- To create awareness about the principles of green building technology and to have insight about the criteria for rating systems along with the established Indian codes and guidelines
- To discuss about the energy efficient green building materials and to have understanding on the cost effective Building Technologies, Strategies for construction of building and Energy Conservation Measures.

Course Outcomes:

- Explain the application of design guidelines of green and passive building considering the energy conservation measures and perform cost/benefit analysis and life-cycle analysis of buildings.
- To identify, formulate, analyze and interpret governments rules and regulation in the sustainable aspect of energy efficient building
- Identify various Renewable and Non-renewable sources of energy along with comprehend techniques and benefits of building performance such as building modeling and energy analysis and monitoring.
- To identify the criteria for rating systems along with the established Indian codes and guidelines.

Detailed Syllabus

Unit I

Thermal Properties and Energy content of Building materials - Psychometric-Comfort conditions – Air conditioning Systems, Lighting and Visual ability-Light sources and Luminaries - Lighting System Design-Day lighting-Lighting Economics and aesthetics-Impacts of lighting efficiency.

Unit II

Thermal comfort-Ventilation and air quality-Air conditioning requirement-visual perception-illumination Requirement-Auditory requirement-Energy Management Options-Energy Audit and Energy Targeting-Technological Options for Energy Management

Unit III

Passive architecture, Thermal comfort, sun motion, Building orientation and design, passive heating and cooling concepts, thumb rules, heat transfer in buildings, thermal modelling of passive concepts, evaporative cooling, Energy efficient windows and day lighting, Earth air tunnel and heat exchanger, ECBC, Zero energy building concept and buildings rating systems.

Text Books:

1. C.J. Kibert, Sustainable Construction: Green Building design and delivery, John Wiley and Sons, 2008.
2. M. Bauer, PMosle, MSchwarz, , Green Buildings, Springer 2013
3. CSnell, TCallahan, Building Green, Lark Crafts; 2/E, 2009.

Reference Books:

1. Kundoo Anupama, Sustainable Buildings: Design Manual, TERI, Volume 1-2. (ISBN: 81-7993-053-X) 2004.
2. Passive Solar Design Handbook, Volume 3, Report of U.S. Department of Energy (DOE/CS-0127/3), USDOE, 2011.
3. Eco- NiwasSamhita, Part I Building Envelope, Bureau of Energy Efficiency (BEE), GoI, BEE, 2018
4. Eco- NiwasSamhita, Part II Electro-Mechanical and Renewable Energy Systems, Bureau of Energy Efficiency (BEE), GoI, BEE, 2018

EN-OE-4023: RESEARCH METHODOLOGY **L-T-P-C: 3-0-0-3**

No. of Hours Per Week: *Lectures-3, Tutorial-0.*
Marks Distribution: *Continuous Assessment = 30, End Semester Examination = 45.*
Questions to be set: *Eight.*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Two and Half Hours*

Course Objectives:

- Understanding the nature of problem to be studied and identifying the related area of knowledge.
- Reviewing literature to understand how others have approached or dealt with the problem.
- Collecting data in an organized and controlled manner so as to arrive at valid decisions.
- Analyzing data appropriate to the problem.

Course Outcomes:

- Demonstrate the ability to choose methods appropriate to research aims and objectives.
- Understand the limitations of particular research methods.
- Develop skills in qualitative and quantitative data analysis and presentation.
- Develop advanced critical thinking skills.

Detailed Syllabus:

UNIT-I

Introduction: Concept of research; Objectives of research; Types of research; Steps to be followed to carry out a research; Research Methods and Methodologies; Various stages of Research; Selection of a research topic and problem; Attributes of a Research Scholar; Points to be kept in mind to do a good research; Concept Research ethics

UNIT–II

Research Components: How to read a paper; How to find a research topic; How to write a paper; How to present a research citation in front of audience; How to write a thesis; How to choose a relevant dataset

UNIT–III

Associated Tools of a research: How to write a paper or slides using LATEX; Results representation using graphical tools like MS Excel, ORIGIN or similar tools, Presentation of Photographs in papers using suitable appropriate software platforms.

Text Books:

1. R Panneerselvam, *Research Methodology*, Prentice Hall India Learning Private Limited, 2013.
2. Deepak Chawla, Neena Sondhi, *Research Methodology: Concepts and Cases*, Vikas Publishing House, 2016

Reference Books:

1. John W. Creswell and J. David Creswell, *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, Sage Publication, 2022.
2. C. R. Kothari and G Garg, *Research Methodology, Methods and Techniques,* New Age International Publishers, 2023.

EN-P-404: MAJOR PROJECT **L-T-P-C: 0-0-28-14**

No. of Hours Per Week: *Practical-28*

Marks Distribution: *Continuous Assessment = 140, End Semester Examination = 210*

Course Objectives:

- **Problem Solving Skills:**Students will be able to identify, analyze, and propose solutions to complex problems in the field of energy engineering.
- **Project Management Skills:** Students will develop skills in planning, organizing, and executing a major project, including time management and resource allocation.
- **Technical Proficiency:** Students will gain in-depth knowledge and hands-on experience in the application of energy engineering principles and techniques relevant to their project.
- **Research Skills:** Students will learn how to conduct literature reviews, gather data, and use appropriate research methodologies to support their project objectives.

Course Outcomes:

- Students will collaborate with peers, faculty, and industry professionals from diverse backgrounds, fostering teamwork and communication skills
- Students will be encouraged to explore innovative approaches and propose novel solutions to energy engineering challenges
- Students will understand the ethical considerations and professional standards relevant to their project, including issues related to safety, environmental impact, and intellectual property
- Students will be able to effectively communicate their project findings and recommendations through written reports, oral presentations, and visual aids

Modalities

Each student individually or in a group will undertake a sizeable project involving a survey of literature, development of new techniques and/or implementation of systems, writing of reports etc. The evaluation of the major project shall be done as per the guidelines laid down in RC-20.

EN-P-406: GRAND VIVA **L-T-P-C: 0-0-0-3**

Marks Distribution: *End Semester Examination = 75*

Modalities: Overall course proficiency will be evaluated through a grand viva covering all the subjects studied during entire B.Tech.