GOVERNMENT OF RAJASTHAN
BOARD OF TECHNICAL EDUCATION RAJASTHAN
JODHPUR

SEMESTER SCHEME-2020-21

(SESSION 2021-2022 & ONWARDS)

TEACHING AND EXAMINATION SCHEME AND SYLLABUS

RENEWABLE ENERGY

(RE)

.....

Board of Technical Education, Rajasthan
W-6 Residency Road,
Jodhpur

GOVERNMENT OF RAJASTHAN

BOARD OF TECHNICAL EDUCATION RAJASTHAN, JODHPUR

TEACHING AND EXAMINATION SCHEME

(SEMESTER SCHEME-2020-21)

FOR DIPLOMA **III SEMESTER RENEWABLE ENERGY (RE)**

SESSION 2022-23 & ONWARDS

Subject Category	Subject Code	Subjects	Distribution of Time				Distribution of Max. Marks/ Duration							Total Marks	Credits
			Hours per week				End Semester Exam				Internal Assessment				
			L	T	P	Tot	TH	Hrs.	PR	Hrs.	CT	TU/Assign	PR(S)		
PC	RE 3001	Basic Electrical Engineering	2	1	0	3	60	3	–	3	20	20	–	100	3
PC	RE 3002	Basic Civil Engg -1	2	1	0	3	60	3	–	3	20	20	–	100	3
PC	RE 3003	Green Building And Energy Conservation and Audit	2	1	0	3	60	3	–	3	20	20	–	100	3
PC	RE 3004	Fluid Mechanics	2	1	0	3	60	3	–	3	20	20	–	100	3
PC	RE 3005	Solar Energy	2	1	0	3	60	3	–	3	20	20	–	100	3
PC	RE 3006	Basic Electrical Engineering Lab	0	0	2	2	-	-	40	3	-	-	60	100	1
PC	RE 3007	Basic Civil Engg Lab-1	0	0	2	2	-	-	40	3	-	-	60	100	1
PC	RE 3008	Energy Conservation And Audit Lab	0	0	2	2	-	-	40	3	-	-	60	100	1
PC	RE 3009	Fluid Mechanics Lab	0	0	2	2	-	-	40	3	-	-	60	100	1
PC	RE 3010	Solar Photovoltaic Lab	0	0	2	2	-	-	40	3	-	-	60	100	1
SI	RE3011	Summer Internship-I(4 Weeks After II Sem)	–	–	–	–	–	–	100	–	—	–	–	100	2
VS	+RE 3333	Anandam (Joy of Giving)	--	--	1	1	--	--	--	--	--	--	100	100	2
		Students Centered Activities	0	0	3	3	--	--	--	--	--	--	--	--	--
		Total	**10**	**5**	**14**	**29**	**300**		**300**		**100**	**100**	**400**	**1200**	**24**
			Grand Total :											**1200**	**24**

1. L : Lecture
2. T : Tutorial
3. P : Practical
4. TH : Marks for End Semester Exam for Theory
5. PR : Marks for End Semester Exam for Practical
6. CT : Marks for class tests (Internal Assessment)
7. TU/Assi : Marks for tutorials/Assignment (Internal Assessment)
8. PR(S) : Marks for practical and viva (Internal Assessment)

1. +RE 3333 is same in all branches of Engineering

Student Centered Activities will be graded as A, B, C & D on the basis of attendance and interest of the student in learning.

GOVERNMENT OF RAJASTHAN
BOARD OF TECHNICAL EDUCATION RAJASTHAN, JODHPUR
TEACHING AND EXAMINATION SCHEME
(SEMESTER SCHEME-2020-21)
FOR DIPLOMA **IV SEMESTER RENEWABLE ENERGY (RE)**
SESSION 2022-23 & ONWARDS

Subject Category	Subject Code	Subjects	Distribution of Time				Distribution of Max. Marks/ Duration							Total Marks	Credits
			Hours per week				End Semester Exam				Internal Assessment				
			L	T	P	Tot	TH	Hrs	PR	Hrs	CT	TU/Assi	PR(S)		
PC	RE 4001	Wind Energy	2	1	0	3	60	3	-	-	20	20	-	100	3
PC	RE 4002	Basic Civil Engg -2	2	1	0	3	60	3	-	-	20	20	-	100	3
PC	RE 4003	Thermal Engineering and Heat Transfer	2	1	0	3	60	3	-	-	20	20	-	100	3
PE	RE 4004	**Programme Elective- I** **RE40041**- Power Electronics **RE40042**- Hydraulic Machines	2	1	0	3	60	3	-	-	20	20	-	100	3
PE	RE 4005	**Programme Elective II** **RE40051-** Electric Vehicles **RE40052-**Solar Thermal	2	1	0	3	60	3	-	-	20	20	-	100	3
PC	RE 4006	Wind Energy Lab	0	0	2	2	-	-	40	3	-	-	60	100	1
PC	RE 4007	Thermal Engineering Lab	0	0	2	2	-	-	40	3	-	-	60	100	1
PE	RE 4008	**Programme Elective- I Lab** -**RE40081-**Power Electronics Lab *-**RE40082**-- Hydraulic Machines Lab	0	0	2	2	-	-	40	3	-	-	60	100	1
PE	RE4 009	**Programme Elective II Lab** -**RE40091-** Electric Vehicles Lab **RE40092-** Solar Thermal Lab	0	0	2	2	-	-	40	3	-	-	60	100	1
PR	RE 4010	Minor Project	0	0	4	4	--	--	40	--	--	--	60	100	2
AU	+RE 4222	Essence of Indian Knowledge And Tradition	2	0	0	2		--	--	--	--	--	--	--	**0**
VS	+RE 4444	Anandam (Joy of Giving)	--	--	1	1	--	--	--	--	--	--	100	100	2
		Students Centered Activities	0	0	3	3	--	--	--	--	--	--	--	--	--
		Total	**12**	**5**	**16**	**33**	**300**		**200**		**100**	**100**	**400**	**1100**	**23**
													Grand Total :	**1100**	**23**

1. L : Lecture
2. T : Tutorial
3. P : Practical
4. TH : Marks for End Semester Exam for Theory
5. PR : Marks for End Semester Exam for Practical
6. CT : Marks for class tests (Internal Assessment)
7. TU/Assi : Marks for tutorials/Assignment (Internal Assessment)
8. PR(S) : Marks for practical and viva (Internal Assessment)

1· +RE4222 and +RE 4444 are same in all branches of Engineering *

Student Centered Activities will be graded as A, B, C & D on the basis of attendance and interest of the student in learning.

Note:Students will go for 6 Weeks Summer Internship in the Summer Vacations after Fourth Semester. The assessment of the Summer Internship will be done in Fifth Semester

GOVERNMENT OF RAJASTHAN
BOARD OF TECHNICAL EDUCATION RAJASTHAN, JODHPUR
TEACHING AND EXAMINATION SCHEME
(SEMESTER SCHEME-2020-21)
FOR DIPLOMA **V SEMESTER RENEWABLE ENERGY (RE)**
SESSION 2023-24 & ONWARDS

Subject Category	Subject Code	Subjects	Distribution of Time				Distribution of Max. Marks/ Duration							Total Marks	Credits
			Hours per week				End Semester Exam				Internal Assessment				
			L	T	P	Tot	TH	Hrs.	PR	Hrs.	CT	TU/Assi	PR(S)		
PC	RE 5001	Engineering Material	3	0	0	3	60	3	-	-	20	20	-	100	3
PC	RE 5002	Biomass and Hydro Power Plants	3	0	0	3	60	3	-	-	20	20	-	100	3
OE	RE 5100	**Open Elective-I** +**RE 51001**- Economic Policies In India +**RE 51002**- Engineering Economics & Accountancy	2	1	0	3	60	3	-	-	20	20	-	100	3
PE	RE 5003	**Programme Elective- III** **RE50031-** Machine Design **RE50032** – Renewable Energy Instrumentation Application	3	0	0	3	60	3	-	-	20	20	-	100	3
PE	RE 5004	**Programme Elective- IV** **RE50041-** Electrical Machine and Measurement **RE50042-** Energy Conversion Devices and Methodologies	2	1	0	3	60	3	-	-	20	20	-	100	3
PC	RE 5005	Material Lab	0	0	2	2	-	-	40	3	-	-	60	100	1
PC	RE 5006	Biomass And Micro-Hydro Power Plants Lab	0	0	2	2	-	-	40	3	-	-	60	100	1
PE	RE 5007	**Programme Elective III Lab** RE50071- Drawing and Survey Lab **RE50072-** Renewable Energy Instrumentation Application Lab	0	0	3	3	-	-	40	3	-	-	60	100	1.5
PE	RE 5008	**Programme Elective IV Lab** **RE50081-** Electrical Machine and Measurement Lab **RE50082** - Energy Storage Lab	0	0	3	3	-	-	40	3	-	-	60	100	1.5
SI	RE 5009	Summer Internship-II(6 Weeks After IV S Labem)	0	0	0	0	–	–	100	–	–	–	–	100	3
PR	RE 5010	Major Project	0	0	2	2	–	–	–	–	–	–	–	–	--
VS	+RE 5555	**Anandam (Joy of Giving)**	--	--	1	1	--	--	--	--	--	--	100	100	2
		Students Centered Activities	**0**	**0**	**3**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
		Total	**13**	**2**	**16**	**31**	**300**		**260**		**100**	**100**	**340**	**1100**	**25**
													Grand Total :	**1100**	**25**

1. L : Lecture
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3. P : Practical
4. TH : Marks for End Semester Exam for Theory
5. PR : Marks for End Semester Exam for Practical
6. CT : Marks for class tests (Internal Assessment)
7. TU/Assi : Marks for tutorials/Assignment (Internal Assessment)
8. PR(S) : Marks for practical and viva (Internal Assessment)

1· +RE 51001, +RE 51002 and +RE 5555 are same in all branches of Engineering

Student Centered Activities will be graded as A, B, C & D on the basis of attendance and interest of the student in learning.

Note:Major Project will be continued and Assesed in VI Semester

GOVERNMENT OF RAJASTHAN
BOARD OF TECHNICAL EDUCATION RAJASTHAN, JODHPUR
TEACHING AND EXAMINATION SCHEME
(SEMESTER SCHEME-2020-21)
FOR DIPLOMA **VI SEMESTER RENEWABLE ENERGY (RE)**
SESSION 2023-24 & ONWARDS

Subject Category	Subject Code	Subjects	Distribution of Time				Distribution of Max. Marks/ Duration							Total Marks	Credits
			Hours per week				End Semester Exam				Internal Assessment				
			L	T	P	Tot	TH	Hrs	PR	Hrs	CT	TU/Assi	PR(S)		
HS	+RE 6111	Entrepreneurship and Startups	3	1	0	4	60	3	–	-	20	20	–	100	4
OE	+RE 6200	**Open Elective-II** +**RE 62001**- Project Management +**RE 62002**- Renewable Energy Technologies	3	1	0	4	60	3	–	-	20	20	–	100	4
OE	+RE 6300	**Open Elective-III** +**RE 63001**- Product Design +**RE 63002**- Disaster Management	3	0	0	3	60	3	–	-	20	20	–	100	3
AU	+RE 6333	Indian Constitution	2	0	0	2	–	–	–	–	–	–	–	--	0
PC	RE 6001	Distributed Generation Systems	3	0	0	3	60	3	-	-	20	20	-	100	3
PC	RE 6002	Emerging Renewable Technologies Lab	0	0	2	2	-	-	40	-	-	-	60	100	1
PR	RE 6003	Major Project	0	0	6	6	--	--	40	--	--	--	60	100	4
SE	RE 6004	Seminar	1	0	0	1	–	–	–	–	–	–	100	100	1
VS	+RE 6666	Anandam (Joy of Giving)	--	--	1	1	--	--	--	--	--	--	100	100	2
		Students Centered Activities	0	0	3	3	--	--	--	--	--	--	--	--	--
		Total	**15**	**2**	**12**	**29**	**240**		**80**		**80**	**80**	**320**	**800**	**22**
													Grand Total :	**800**	**22**

1. L : Lecture
2. T : Tutorial
3. P : Practical
4. TH : Marks for End Semester Exam for Theory
5. PR : Marks for End Semester Exam for Practical
6. CT : Marks for class tests (Internal Assessment)
7. TU/Assi : Marks for tutorials/Assignment (Internal Assessment)
8. PR(S) : Marks for practical and viva (Internal Assessment)

1. + RE 6111, +RE 62001, +RE 62002, +RE 63001, +RE 63002, +RE 6333 and +RE 6666 are same in all branches of Engineering

Student Centered Activities will be graded as A, B, C & D on the basis of attendance and interest of the student in learning.

GOVERNMENT OF RAJASTHAN

BOARD OF TECHNICAL EDUCATION RAJASTHAN JODHPUR

SEMESTER SCHEME-2020-21

III SEMESTER

(SESSION 2021-2022 & ONWARDS)

BASIC ELECTRICAL ENGINEERING

Course Code	RE3001
Course Title	Basic Electrical Engineering
Number of Credits	3(L-2, T-1, P-0)
Prerequisites	None
Course Category	PC

COURSE OBJECTIVES

1. To know the fundamentals related to electrical engineering.
2. Covers basics of D.C. circuits, magnetic circuits, A. C. circuits, and polyphase system.

COURSE OUTCOMES

After completing the course, the student will be able to:

1. Understand the basics of both D.C. circuits and A.C. circuits.
2. Identify different types of magnetic circuits and their behaviour.
3. Know about the concepts related to phasor algebra and polyphase system.

COURSE CONTENTS

1. **D.C. CIRCUITS and MAGNETIC CIRCUITS**
   - 1.1 Resistance, specific resistance, Ohm's law, Resistance in series, parallel and series parallel circuits
   - 1.2 Kirchhoff's laws
   - 1.3 Application of Kirchhoff's laws
   - 1.4 Introduction
   - 1.5 Comparison between magnetic circuit and electric circuits
   - 1.6 Behaviour of magnetic circuits
   - 1.7 Composite magnetic circuits
   - 1.8 Parallel magnetic circuits
   - 1.9 B-H curve
   - 1.10 Rise of current in inductive circuit
   - 1.11 Decay of current in inductive circuit

2. **PHASOR ALGEBRA**
   - 2.1 Mathematical representation of a vector
   - 2.2 Symbolic notation
   - 2.3 Significance of operator-j
   - 2.4 Conjugate complex number
   - 2.5 Trigonometrical form of vector representation
   - 2.6 Exponential form of vector representation
   - 2.7 Polar form of vector representation
   - 2.8 Addition and subtraction of vector
   - 2.9 Multiplication and division of vector quantity
   - 2.10 120^{o} operator

3. **A.C. CIRCUITS**
   - 3.1 Alternating quantity and its equation
   - 3.2 Maximum, Average and RMS values
   - 3.3 Form factor
   - 3.4 Behaviour of R, L and C in A.C. circuits with phasor diagrams
   - 3.5 A.C. through R-L circuit, power factor, active and reactive component of current, power
   - 3.6 Q-factor of a coil
   - 3.7 A.C. through R-C circuit, dielectric loss and power factor of a capacitors
   - 3.8 Solving series R-L-C circuits

3.9 Solving A.C. parallel circuit by phasor diagram and phasor algebra
3.10 Solving A.C. series and parallel circuits

4. **POLYPHASE SYSTEM**
   4.1 Need and advantage of 3-phase system
   4.2 Generation of 3-phase voltage
   4.3 Phase sequence
   4.4 Star-Delta connections
   4.5 Phase and Line relations of voltage and current in star -delta connections (for balanced load)
   4.6 Expression of power in 3-phase circuits (for balanced load)

5. INTRODUCTION OF MACHINES
   5.1 DC Machine (Generator, Motor)
   5.2 Single Phase AC Machine
   5.3 Three Phase AC Machine
   5.4 Synchronous Motor
   5.5 Transformer (Single Phase, Three Phase)

REFERENCES/SUGGESTED LEARNING RESOURCES

1. C. L. Wadhwa, "Basic Electrical Engineering ", New Age International Publishers.
2. B. L. Theraja, "Electrical Technology Vol. –I" S. Chand Pulications.
3. D. R. Nagpal, "Fundamentals of Electrical Engineering", Standard Publishers.
4. J. B. Gupta, "Basic Electrical Engineering", S. K. Kataria and Sons.
5. Nagrath & Kothari, "Basic Electrical Engg.", McGrawHill.
6. K. R. Niazi, "Basic Electrical Engineering", Genus Publications.

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BASIC CIVIL ENGINEERING-1

Course Code	RE 3002
Course Title	Basic Civil Engineering-1
Number of Credits	L: 2, T: 1, P: 0
Prerequisites	NIL
Course Category	PC

Course Objectives:

Following are the objectives of this course:

- To learn properties of area and structural material properties.
- To understand the concept of stress and strain.
- To calculate shear force, bending moment for different shapes of structural elements and corresponding stresses.
- To understand the concept of buckling loads for short and long columns.
- To understand Basic of Soil Engineering.
- To learn about various construction materials, and understand their relevant characteristics.

Course outcomes:

After competing this course, student will be able to:

- Analyse structural behaviour of materials under various loading conditions.
- Interpret shear force and bending moment diagrams for various types of beams and loading conditions.
- Determine the bending and shear stresses in beams under different loading conditions.
- Analyse the column for various loading and end conditions
- Interpret basic terminology of Soil Engineering
- Identify and use of relevant construction materials.

CONTENTS OF COURSE

1. Stress and Strain:

1.1. Various mechanical properties: Elasticity, Plasticity, Ductility, Brittleness, Toughness, Hardness
1.2. Concept of stress and strain
  1.2.1. Type of force - Direct, shear
  1.2.2. Stress - Tensile, compressive, shear
1.3. Hook's law
  1.3.1. Statement of Hook's law
  1.3.2. Young's modulus of elasticity
  1.3.3. Tensile test diagram
1.4. Working stress and factor of safety
1.5. Stress and strain calculations
  1.5.1. Principle of superposition
  1.5.2. Bar of homogeneous section
  1.5.3. Bar of uniform cross-section
  1.5.4. Bar of steeped cross-section
  1.5.5. Bar of composite section
1.6. Temperature stresses
  1.6.1. Homogeneous section
  1.6.2. Composite section
1.7. Shear stresses
  1.7.1. Modulus of rigidity
  1.7.2. Complementary shear stress
  1.7.3. Concept of single shear and double shear
  1.7.4. Shear strain
1.8. Poisson's ratio and volumetric strain
  1.8.1. Lateral strain
  1.8.2. Longitudinal strain

1.8.3. Volumetric strain
1.8.4. Bulk modulus
1.9. Stress components on an inclined plane
1.10. Mohr's circle
1.11. Strain energy from stress - strain diagram

2. Bending Moments and Shear Force:
2.1. Basic concept
2.1.1. Types of support: Movable hinge support (roller), Immovable hinge support, Fixed support
2.1.2. Types of beams: Cantilever beam, simply supported beam, Fixed beam, Continuous beam, Overhanging beam
2.1.3. Types of loads: Point load, Distributed load - uniformly and non-uniformly
2.2. Shear force and bending moment
2.3. Bending moment and shear force diagrams

3. Bending Stresses and Shear Stresses
3.1. Concept of bending stress
3.2. Theory of simple bending
3.2.1. Assumptions in theory of simple bending and flexural equation (without derivation)
3.2.2. Calculation of max bending stress in beams
3.3. Concept of Shear Stresses
3.3.1. Shear stress equation (without derivation) and Shear stress distribution

4. Columns and Struts
4.1. Concept of column and struts
4.2. Modes of failure
4.3. Types of columns; long and short
4.4. Buckling loads
4.5. Slenderness ratio
4.6. Euler's formula (without proof)
4.6.1. Both ends hinged
4.6.2. One end fixed and other end free
4.6.3. Both ends fixed
4.6.4. One end fixed and other end hinged
4.6.5. Limitations of Euler's Formula
4.6.6. Equivalent length
4.7. Rankine's formula

5. Torsion of Shaft:
5.1. Concept of torsion
5.1.1. Angle of twist
5.1.2. Polar moment of Inertia
5.1.3. Assumptions in the theory of pure torsion
5.2. Relation between T, J, r, q, θ (without derivation)
5.3. Relation between power and torque
5.4. Combined stress due to bending and torsion in solid and hollow shaft

6. Basic of Soil Engineering
6.1. Representation of soil as a three-phase system
6.2. Definition of moisture content, unit weights, density, and specific gravity, void ratio, porosity, degree of saturation
6.3. Classification of soils as per particle size and plasticity chart
6.4. Consistency of soils – Liquid limit, Plastic limit and Shrinkage limit
6.5. Definition of permeability and Factors affecting permeability
6.6. Meaning of Compaction and Consolidation

7. Overview of Construction Materials
7.1. Scope of construction materials.
7.2. Broad classification of materials –Natural, Artificial, special, finishing and recycled
7.3. General properties and uses of Materials: Stone, Timber, Bricks, Cement, Lime.

REFERENCE BOOKS:

1. Strength of Materials & Theory of Structures (vol. I) B. C. Punmia
2. Strength of Materials Ramamurtham

3. Strength of Materials	Junarkar
4. Strength of Materials	R.S. Khurmi
5. Strength of Materials (Hindi)	Gurcharan singh
6. Basic Soil Engg.	Dr. Alam Singh
7. Soil and Foundation Engineering (Hindi)	B. C. Punmia
8. Soil and Foundation Engineering (Hindi)	B. L.Gupta
9. Engineering Materials.	S. C. Rangwala

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GREEN BUILDING, ENERGY CONSERVATION and AUDIT

Course Code	RE3003
Course Title	Green Building, Energy Conservation and Audit
Number of Credits	3(L-2, T-1, P-0)
Prerequisites	None
Course Category	PC

COURSE OBJECTIVES

1. The knowledge of existing and upcoming industrial utility and energy management theory that allows the student to have a solid theoretical knowledge and be able in the future to design and development of various energy management technologies.
2. the skill to identify, formulate and solve fields problem in a multi-disciplinary frame individually or as a member of a group.

COURSE OUTCOMES

After completing the course, the student will be able to:

1. Interpret energy conservation policies in India.
2. Apply energy conservation techniques in electrical installation.

Use co-generation and relevant tariff reducing losses in facilities

COURSE CONTENTS

1. Elements of Energy Conservation

1.1 General energy problem,
1.2 Sector wise Energy consumption, demand supply gap,
1.3 Scope for energy conservation and its benefits
1.4 Energy conservation Principle – Maximum energy efficiency, Maximum cost effectiveness,
1.5 Mandatory provisions of EC act, Features of EC act-Standards and labelling,
1.6 Energy Conservation Building Codes (ECBC),

2. Energy Conservation Approaches in Industries

2.1 Energy saving opportunities in electric motors, Benefits of Power factor improvement and its techniques-Shunt capacitor, Synchronous Condenser etc., Effects of harmonics on – Motors, and remedies leading to energy conservation.
2.2 Energy conservation by VSD, Methods and techniques of energy conservation in ventilation and air conditioners, compressors pumps, fans and blowers, Area Sealing, Insulating the Heating / cooling fluid pipes, automatic door closing- Air curtain, Thermostat / Control.
2.3 Energy conservation in electric furnaces, ovens and boilers., lighting techniques –Natural, CFL, LED lighting sources and fittings

3. Techno-economic Evaluation of Energy Conservation Option

3.1 New equipment, technology, staffing, training, Calculation and costing of energy conservation project.
3.2 Depreciation cost, sinking fund method., Cost evaluation by Return on Investment (ROI) and pay back method etc., Risk analysis., Case study

4. Energy Audit

4.1 Energy audit and its benefits, Energy flow diagram, Preliminary
4.2 Detailed energy audit, Methodology of preliminary energy audit and Detailed energy audit – Phase I, Pre audit.
4.3 Phase II- Audit and Phase III- Post audit, Energy audit report.
4.4 Electrical Measuring Instruments - Power Analyzer, Combustion analyser, fuel efficiency monitor, thermometer-contact, infrared, pitot tube and manometer, water flow meter, leak detector, tachometer and luxmeter, IE rules and regulations for energy audit, Electricity act (Numerical)

5. Orientation

5.1 Orientation of buildings as per I.S. 7662 in relation to sun and wind directions, rain, internal circulation and placement of room, commensurate with available areas and requirements

5.2 Preparation and study of sun chart on polar graphs. Sun shading devices-types sketches suitability, for different orientations.

6. Passive Solar Building

6.1 Constructional element for residential building,

6.2 passive solar design use the sun Power,

6.3 Radiant panel,

6.4 Thermal storage walls,

6.5 Trombe walls,

6.6 concrete walls,

6.7 concrete block walls,

6.8 water walls,

6.9 material considerations,

6.10 levels of application

REFERENCES/SUGGESTED LEARNING RESOURCES

1. Electric Energy Generation, Utilisation and Conservation Sivaganaraju, S Pearson, New Delhi,
2. Electrical Power V. K. Mehta Khanna and Khanna Publishers, New Delhi
3. Electrical Power S. L. Uppal Khanna and Khanna Publishers, New Delhi
4. Art and Science of utilization of Electrical Energy H. Partab, Dhanapat Rai and Sons, New Delhi
5. Project Management Prasanna Chandra Tata Mcgraw Hill, New Delhi
6. Financial Management Prasanna Chandra Tata Mcgraw Hill, New Delhi
7. Energy Management Handbook Wayne C. Turner
8. Energy management Paul O Callaghan Mcgraw Hill, New Delhi
9. Fundamentals of electrical system Bureau of Energy Efficiency.
10. Building Construction Bindra & Arora
11. The Passive Solar Energy Book: A Complete Guide to Passive Solar Home, Greenhouse, and Building Design, Edward Mazria

Fluid Mechanics

Course Code	RE3004
Course Title	**Fluid Mechanics**
Number of Credits	3(L-2, T-1, P-0)
Prerequisites	None
Course Category	PC

COURSE OBJECTIVES

- To understand fundamental concept of fluid flow.
- To Select and use appropriate flow measuring device.
- To Select and use appropriate pressure measuring device.
- To nurture the students to solve fluid dynamics problems.

COURSE OUTCOMES

After completing the course, the student would have:

1. The knowledge of fundamental concept of fluid dynamics.
2. Ability to measure various properties such as pressure, velocity, flow rate using various instruments.
3. Ability to analyse and compute the frictional flow and head loss in pipes.
4. The ability to solve fluid flow problems.

COURSE CONTENTS

1. BASIC PROPERTIES OF FLUIDS

1.1 Fluid properties-Density, Specific volume, Specific gravity, Viscosity
1.2 Pascal's law
1.3 Newton's law of Viscosity
1.4 Dynamic and kinematic viscosity
1.5 Types of fluid

2. PRESSURE MEASURING DEVICES

2.1 Concept of pressure
2.2 Manometers
  2.2.1 Simple manometers
  2.2.2 Differential manometers
2.3 Pressure gauges (Bourdon gauge)

3. FLUIDFLOW

3.1 Types of flow
  3.1.1 Steady-Non steady
  3.1.2 Uniform -Nonuniform
  3.1.3 Laminar-Turbulent
  3.1.4 One, Two, Three-dimensional flow
3.2 Continuity equation
  3.2.1 Assumption
  3.2.2 Rate of discharge for one dimensional flow

4. HYDRODYNAMICS AND MEASUREMENT OF FLOW

4.1 Energy of fluid-pressure, kinetic and potential
4.2 Bernoulli's theorem (no proof)
4.3 Applications of Bernoulli's theorem for flow measurements
  4.3.1 Venturi meter
  4.3.2 Orifice meter
4.4 Simple Numerical problems

5. FLOW THROUGH PIPES

- 5.1 Types of flow in pipes (Reynold's experiment)
  - 5.1.1 Laminar flow
  - 5.1.2 Turbulent flow
  - 5.1.3 Transient flow
- 5.2 Loss of head due to friction (No proof)
  - 5.2.1 Darcy's Weisbach equations
  - 5.2.2 Chezy's formula
  - 5.2.3 Manning formula
- 5.3 Other energy losses in pipe (only expressions)
- 5.4 Pipe arrangement (series and parallel)
- 5.5 Transmission of power through pipes

REFERENCES:

1. Hydraulics and fluid mechanics including Hydraulic machines- Modi P. N. and Seth S. M.
2. Fluid Mechanics & Machines- Dr. R. K. Bansal
3. Fluid Mechanics &Machines- R. S. Khurmi.
4. Hydraulics, fluid mechanics and fluid machines – Ramamrutham S
5. Fluid Machines-S. S. Ratan

SOLAR ENERGY

Course Code	RE3005
Course Title	Solar Energy
Number of Credits	3(L-2, T-1, P-0)
Prerequisites	None
Course Category	PC

COURSE OBJECTIVES

1. To know the solar cell fundamentals & its characteristics.
2. To generate electricity from solar PV system.
3. To learn different types of PV systems and their specific applications.
4. To understand the concept of smart grid and apply it in renewable energy power plant.

COURSE OUTCOMES

After completing the course, the student will be able to:

1. Identify different types of solar cell, its components & materials.
2. Use solar cell in PV system applications.
3. Know about the components of solar PV Systems and control action of PV system.
4. Generate electricity from solar PV system after assembling PV system components.
5. To learn different types of solar PV systems and their applications.

COURSE CONTENTS

1. **SOLAR CELL FUNDAMENTALS**
   - 1.1 Current conduction in semiconductor
   - 1.2 Atomic structure of silicon, Energy band formation in semiconductor, P-Type and N-type material with silicon, Formation of P-N junction of semiconductor
   - 1.3 Principles for Electron-Hole Pair generation by photon absorption, Photo-electric effect, Photo-conductive effect and Photo-voltaic effect
   - 1.4 Materials for Opto-Electronic applications
   - 1.5 Concept of solar cell, Main elements of silicon solar cell

2. **SOLAR CELL CHARACTERISTICS**
   - 2.1 Current-Voltage (I-V) characteristics of a Photovoltaic cell
   - 2.2 Power-Voltage (P-V) characteristics of a Photovoltaic cell
   - 2.3 Equivalent circuit of a solar cell, Maximum power point (MPP)
   - 2.4 Design considerations of Solar cells - short circuit current (Isc), Open circuit voltage (Voc), Fill factor (FF), Energy losses and factors for loss, Efficiency
   - 2.5 Factors limiting the efficiency of solar cell
   - 2.6 Impact of external parameters on solar cell performances-(i) Radiation, (ii) Temperature, (iii) Wind velocity

3. **SOLAR PHOTOVOLTAIC SYSTEMS**
   - 3.1 Components of PV Systems
   - 3.2 Maximum power condition of PV system
   - 3.3 Formation of PV Panel, Cell, Module, Array
   - 3.4 Balance of System (BOS)
   - 3.5 Mounting structures and installation of PV system
   - 3.6 Solar tracking systems

4. **CLASSIFICATION OF PV SYSTEM**
   - 4.1 Stand-Alone Solar PV System

4.2 Grid Interactive Solar PV System
4.3 Hybrid Solar PV System
4.4 Centralized and De-Centralized Systems

5. **EVOLUTION ON ELECTRIC GRID**
   5.1 Concept of Smart Grid- Definition of Smart Grid, Need of Smart Grid, Functions Smart Grid, Opportunities and barriers of Smart Grid
   5.2 Difference between Conventional Grid and Smart Grid
   5.3 Concept of Resilient Grid and Smart Grid
   5.4 Role of Smart Meter in Smart Grid

REFERENCES/SUGGESTED LEARNING RESOURCES

1. B. H. Khan, "Non-Conventional Energy Resources", The McGraw Hill Publications.
2. G.D. Rai, "Non-Conventional Energy Resources", Khanna Publications.
3. Prakash Garg, "Solar Energy, Fundamentals and Applications", Tata McGraw Hill, New Delhi.
4. Shobh Nath Singh, "Non-Conventional Energy Resources", Pearson Publications.
5. S. H. Saeed, D. K. Sharma, "Non-Conventional Energy Resources", S. K. Kataria and Sons.
6. A. M. Rehman, "Solar Energy", Scitech Publications.
7. Thomas E. Kissell, "Introduction to Solar Principles", Pearson Publications.

BASIC ELECTRICAL ENGINEERING LAB

Course Code	RE3006
Course Title	Basic Electrical Engineering Lab
Number of Credits	1(L-0, T-0, P-2)
Prerequisites	None
Course Category	PC

COURSE OBJECTIVES

1. To know the fundamentals related to electrical engineering.
2. Covers basics of D.C. circuits, magnetic circuits, A. C. circuits, and polyphase system.

COURSE OUTCOMES

After completing the course, the student will be able to:

1. Understand the basics of both D.C. circuits and A.C. circuits.
2. Identify different types of magnetic circuits and their behaviour.
3. Know about the concepts related to polyphase system.

PRACTICLES

1. Verification of Kirchhoff's laws in D.C. circuits.
2. Verification of Kirchhoff's laws in A.C. circuits.
3. Determination of B-H curve of a D.C. machine.
4. Measurement of power and power factor of single-phase R-L-C series circuit.
5. Determination of R and L of a choke coil using 3-voltmeter and an ammeter.
6. Determination of R and C of a capacitor using 3-ammeter and a voltmeter.
7. Measurement of power in 3-phase circuit (for balanced load).

Basic Civil Engg Lab-1

Course Code	RE 3007
Course Title	Basic Civil Engg. Lab-1
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	NIL
Course Category	PC

Course Objectives:

Following are the objectives of this course:

-To have the knowledge about to forecast the quantity of materials required for each item ofwork from the available drawings.

- To prepare estimates and prepare drawings for residential buildings, small workshop, distribution substation, overhead and underground systems
- To know the use windmills, solar plant, hydro plants, biomass plants.

Course outcomes:

After completing this course, student will be able to:

- Develop understanding of various components of costs and making cost estimation.
- Learn installation design, estimating and costing principles

1. General Principle of Estimating and Costing

1.1Purpose and essential of estimating and costing
1.2Preparation of list of materials
1.3Market survey, price list and net prices
1.4Calculation of material and labour cost, contingencies, supervision, overhead charges, profit and total cost.
1.5Purchase process: quotations, comparative statement, purchase order, tender order, security

2. **Wiring Materials and Accessories**

2.1Different electrical symbols
2.2Brief description, general specification and approximate cost of
2.2.1Different types of wire and cable
2.2.2Switches, socket outlets, ceiling roses, lamp holders, plugs2.2.3Conduits and it accessories
2.2.4Distribution boards and boxes
2.2.5Fuses, MCB, isolators, E.L.C.B. and energy meters
2.2.6Incandescent, Fluorescent and discharge lamps
2.2.7D.C. and A.C. motors and starters

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3. **Earthing**

3.1Schedule of material and accessories, costing and estimates of earthing.
3.2Pipe and plate earthing

4. **Writing units for various items of work involved in construction**

4.1 Recording measurement in M.B.
4.2Writing detailed specifications and rate analysis schedules for
4.2.1Earth work in excavation.
4.2.2. Concrete in foundation.
4.2.3. Brick work in sub and super structure.
4.2.4. Random rubble and Ashler masonry.
4.2.5.RCC in beams and slabs.
4.2.6Plastering

4.2.7. Pointing
4.2.8White washing, colour washing and distempering

5. Estimation of Wind Energy Potential

5.1 Wind **power assessment**
- 5.1.1 Wind energy flow rate
- 5.1.2 kinetic energy flux
- 5.1.3 wind power density
- 5.1.4 power coefficient
- 5.1.5 Betz Limit
- 5.1.6 capacity factor

5.2 wind energy
5.3 forecasting wind power
5.4 site selection
5.5 micro siting

6.Estimation of hydro power plants

6.1General Layout of a dam based hydroelectric plant

6.2 Power Estimation

7.Biomass plants
7.1. Forecast availability of its supply for next five years
7.2. Estimate pricing of biomass for the next five years
7.3. Streamline biomass supply chain for next five years
8. **Estimation of solar energy**
8.1caculation of LCOE (Levelized cost of energy)
8.2 Calculate Solar System Capacity
8.3 determine the number of panels

SUGGESTED LEARNING RESOURCES

1. Electrical Estimating & Costing S. L. Uppal.
2. Electrical Estimating & Costing J. B. Gupta.
4. Estimating & Costing Chakerborty
5. Estimating & Costing B.N. Dutta
6. Varshney, R.S., Hydro Power Structures, Nem Chand & Brothers.
7. BIOMASS ESTIMATION AND METHODOLOGY, Dr. Ajay Sharma, Rashi Verma, TARA

ENERGY CONSERVATION AND AUDIT LAB

Course Code	RE3008
Course Title	**ENERGY CONSERVATION And AUDIT LAB**
Number of Credits	1(L-0, T-0, P-2)
Prerequisites	None
Course Category	PC

COURSE OBJECTIVES

1. Identification of energy losses and opportunities of energy conservation.
2. Apply energy conservation techniques in electrical installations.
3. Use Co-generation and relevant tariff for reducing losses in facilities.
4. Implementation of energy conservation technique.
5. Carryout energy audit for electrical system

COURSE OUTCOMES

After completing the course, the student will be able to:

1. Interpret energy conservation policies in India.
2. Implement energy conservation techniques in electrical machines.
3. Apply energy conservation techniques in electrical installations.
4. Use Co-generation and relevant tariff for reducing losses in facilities.
5. Carryout energy audit for electrical system

PRACTICLES

1. Analyse star labelled electrical apparatus and compare the data sheet (Pamphlet) of various star ratings.
2. Determine the '% loading' and the related efficiency of given Induction motor at different loading
3. Determine the reduction in power consumption in star mode operation of Induction motor compared to delta mode at no load/ light loads.
4. Use APFC / PFC unit for improvement of p. f. of electrical load.
5. Determine Energy conservation in Fan by using Electronic Regulator
6. Analysis of electric bill based on tariff of Industrial consumer to reduce energy usage and electric bill
7. To interpret the energy bill of a residential consumer, suggest suitable tariff to achieve energy conservation and reduction in energy bill.
8. Experiment to compare lighting energy consumption of a model room using only artificial lighting and artificial lighting integrated with natural daylighting.
9. Identify different equipment required for energy audit of your Institute (Classroom, Workshop & Laboratory).
10. Prepare an energy audit report of your Institute (Classroom, Workshop & Laboratory
11. To Collect the Standard tariff rates of RSEB and suggest suitable tariff for given industry/Lab/Institute/Commercial establishment.

FLUID MECHANICS LAB

Course Code	*RE 3009
Course Title	FLUIDMECHANICSLAB
Number of Credits	1 (L:0, T:0, P:2)
Prerequisites	Nil
CourseCategory	PC

COURSE OBJECTIVES:

- To calibrate the given flow measuring device.
- To apply the knowledge and concepts acquired in fluid mechanics theory course.

COURSEOUTCOMES:

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

1. Understand and analyze the concept of various types of flow.
2. Measure various properties such as pressure, velocity, flow rate using various instruments.
3. Understand the need and importance of calibration of pressure gauges.
4. Understand the concept of flow meters.

COURSECONTENT:

1. Study of constructional features and working of different types of manometers and pressure gauges.
2. Verification of Bernoulli's theorem.
3. Determination of Coefficient of Discharge of Venturimeter.
4. Determination of Coefficient of Discharge of Orificemeter.
5. Determination of coefficient of friction of flow through pipes.
6. Determination of minor losses of flow through pipes.
7. To study Reynold's apparatus to determine laminar, transition and turbulent flow.

REFERENCES:

1. N. Kumara Swamy, Fluid Mechanics and Machinery Laboratory Manual, Charotar Publishing House Pvt. Ltd.,ANAND388001, Ed.2008.
2. Lab manual

SOLAR PHOTOVOLTAIC LAB

Course Code	RE3010
Course Title	Solar Photovoltaic Lab
Number of Credits	1(L-0, T-0, P-2)
Prerequisites	None
Course Category	PC

COURSE OBJECTIVES

1. To know the solar cell fundamentals & its characteristics.
2. To learn solar PV technology & its application in renewable energy power plant.

COURSE OUTCOMES

After completing the course, the student will be able to:

1. Identify different types of solar cell, its components and materials.
2. Use solar cell in PV system applications.
3. Test solar cell characteristic parameters.
4. Assemble photovoltaic array, module, and panel components.

PRACTICLES

1. Perform experiment to plot the current - voltage (I-V) characteristics of single crystalline silicon solar cell and find out the solar cell parameters (O.C. voltage, short circuit current, Voltage-current-power at Maximum Power point, Fill factor, Efficiency).
2. Perform experiment to plot the current - voltage (I-V) characteristics of poly crystalline silicon solar cell and find out the solar cell parameters (Voc, Vmp, Isc, Imp,Mpp, Fill factor, Efficiency).
3. Study the dependency of current- voltage characteristics of a solar cell on -(i) Light intensity and (ii) Temperature of solar cell.
4. Perform experiment to study the effect of tilt angle on solar cell parameters (Voc, Vmp, Isc, Imp, Mpp, Fill factor, Efficiency).
5. Perform experiment to plot current -voltage (I-V) characteristics of a solar cell module and find out the cell parameters (Voc, Vmp, Isc, Imp, Mpp, Fill factor, Efficiency).
6. Troubleshoot solar PV MPPT system and identify its remedy.
7. Troubleshoot solar PV panel and arrays and identify its remedy.

GOVERNMENT OF RAJASTHAN

BOARD OF TECHNICAL EDUCATION RAJASTHAN JODHPUR

SEMESTER SCHEME-2020-21

IV SEMESTER

(SESSION 2021-2022 & ONWARDS)

WIND ENERGY

Course Code	RE4001
Course Title	**Wind Energy**
Number of Credits	3(L-2, T-1, P-0)
Prerequisites	None
Course Category	PC

COURSE OBJECTIVES

1. To learn the nature of different types wind for wind energy conversion.
2. To know the component details& features of a wind turbine required for a wind mill.
3. To learn wind power conversion technology and the economics relating to it.
4. To generate electricity from a wind mill.
5. To interpret the troubleshooting of a wind turbine.

COURSE OUTCOMES

After completing the course, the student will be able to:

1. Know about the components of a wind turbine and their functions.
2. Know the principle & components of wind energy conversion system.
3. Know different hybrid models associated with wind energy.
4. Generate electricity from a SWT system & measure the machine parameters.
5. Know the economics relating to wind power generation.
6. Interpret faults in a wind turbine and its remedy.

COURSE CONTENTS

1. Wind Energy and Wind Power Plants

1.1 Wind Power Scenario in the World and India.

1.2 **Characteristics of Wind Energy**: Wind Movement, Wind Profile, Roughness, Effects of Obstacles in Wind Path.

1.3 **Types of Wind Power Plant:** - Small and Large Wind Turbines Horizontal and Vertical Axis; Upwind and Downwind, One Two and Three Blades; Constant and Variable Speed, Geared, Direct-Drive and Semi-Geared (Hybrid) WPPs; WECs, WEGs, WTs, WPPs.

1.4 **Wind Power Plant Tower Types:** Lettice; Tubular Steel, Concrete, Hybrid, Ladders, Cables.

1.5 **WPP Substation**: Switchgear, Transformers, Inside Layouts of Electric Electronic Panel at Block Level.

2. Construction and Working of Large Wind Power Plants

2.1 **Wind Turbine Terminology**: Cut-In, Cut-Out and Survival Wind Speeds, Threshold Wind Speed Rated Power Nominal Power Wind Power Curve

2.2 **Major Parts and Function of Wind Power Plant:** Rotor Blades, Hub, Nacelle, Tower, Electric Sub-Station, Nacelle Layouts of Geared Direct Drive and Semi- Geared Wind Power Plant, Main Shaft, Gearbox, Electric Generator, Electronic Control Panels**.**

2.3 **Rotation Principles**: Drag and Lift Principle, Thrust and Torque of Wind Turbine Rotor.

2.4 **Different Types of Sensors**: Anemometer, Wind Vane, Rpm Sensors of Main Shaft and Generator, Temperature Sensors of Nacelle, Gear Box and Generator; Cable Untwisting and Vibration Sensors.

2.5 **Different Type of Actuators**: Electric and Hydraulic Pitching and Yawing Mechanisms, Cable Untwisting and Breaking Mechanism

3. Aerodynamic Control, Electric Generators and Grid Connection

3.1 Aerodynamic Control of Wind Power Plants: Stall, Pitch and Active Stall

3.2 Braking Mechanism of Large Wind Power Plants

3.3 **Electric Generator Types**: Working of Squirrel-Cage Rotor Induction Generator (Scig), Wound Rotor Induction Generator (Wrig), Doubly-Fed Induction Generator (Dfig), Wound Rotor and Permanent Magnet Synchronous Generator.

4. General Maintenance of Wind Power Plant.

4.1 Preventive Maintenance Schedule of Actuators Such as Yaw Control, Pitch Control, Braking Mechanisms and Sensors; Oiling and Greasing; Electric and Electronic Equipment Related; Tower Related; Minor Repairs, Some Tips

4.2 **Scheduled Maintenance: of** Stall and Pitch and Active Pitch Controlled Wind Power Plants

4.3 Unscheduled Maintenance: Operational Factors Design Faults, Wear and Tear of Components

5. Construction and Working of Small Wind Turbines

5.1 Types and Working of Different Type of Small Wind Turbines

5.2 Classification: Horizontal and Vertical Axis, Upwind and Downwind, One, Two and Three Blades; Constant and Variable Speed; Direct Drive and Geared Breaking of Small Wind Turbines

5.3 Parts of Small Wind Turbine**:** Rotor, Generator, Gearbox, Tower, Electric Control Panel, Tale Vane, Anemometer, Wind Vane, Temperature and Rpm Sensor

5.4 Working SWTs: Direct Drive and Geared

5.5 Electric Generators in SWTs**:** Permanent Magnet Synchronous Generators and Induction Generators

5.6 SWT Towers: Lattice Tubular Type, Hydraulic Towers, Ladders, Cables.

6. Maintenance of Small Wind Turbines:

6.1 Small Wind Turbine Assembly

6.2 Installation of Different Types of Small Wind Turbines (SWTs): Tubular and Lattice Types,

6.3 SWTs Routine Maintenance: Tips; Preventive Maintenance Schedule of Braking Mechanisms, Sensors; Oiling and Greasing Related.

6.4 Power Electronics Devices and Converters in Different Types of SWTs: Thyristors, Power Transistors

6.5 Common Mechanical Faults in SWTs

6.6 Common Electrical Faults in SWTs

REFERENCES/SUGGESTED LEARNING RESOURCES

1. Wind Power Technology, “Earnest Joshua”, PHI Learning New Delhi, ISBN:978-8120351660
2. Wind Turbines, “Hau Erich”, Springer- Verlag, Berlin Heidelberg, Germany, 2013 ISBN: 978-3-642-27150-2
3. Wind Power Plants and Project Development, “Earnest Joshua” PHI learning, New Delhi, 2015, ISBN: 978-812035171
4. Wind Electrical System, “Bhadra, S. N., Kastha, D. Banerjee, S”, Oxford University Press, New Delhi,2013, ISBN:9780195670936
5. Wind Energy, “Siraj Ahmed”, PHI Learning New Delhi, 2015, ISBN: 978-8120351639

BASIC CIVIL ENGINEERING-2

Course Code	RE 4002
Course Title	Basic Civil Engineering-2
Number of Credits	L: 2, T: 1, P: 0
Prerequisites	NIL
Course Category	PC

COURSE OBJECTIVES

This subject covers design of structures. The student will also learn to use the latest relevant Indian Standard codes in the design practice of structures.

COURSE OUTCOMES

After completing the course, the student will be able to

1. Analyse the simple structures.
2. Understand basics of design of R.C.C.
3. Understand basics of design of steel.
4. Understand basics of pre stressed concrete.

CONTENTS OF COURSE

1. Theory of Structure

1.1 Different types of frames

1.2 Calculation of forces in the members of determinate frames

- 1.2.1 Method of Joints
- 1.2.2 Method of section

1.3 Calculation of slope and deflection in simply supported and cantilever beams, loaded with point and uniformly distributed load by

- 1.3.1 Double integration method
- 1.3.2 Macaulay's method
- 1.3.3 Area moment method

2.Concrete and Reinforcement:

2.1 concrete: its definition, Requirement of good concrete, Ingredients of concrete, their function and requirement as per Indian standards, Grades of concrete

2.2 Permissible stresses

2.3 Methods of mixing, transportation, placing and compaction of concrete

2.4 Curing of concrete

2.5 Sampling and test strength of concrete

2.6 Joints in concrete structures

2.7 Requirement of form work for beams, slabs and columns

2.8 Types, grades of reinforcement bars

2.9 Permissible stresses in steel as per IS-456

2.10 Standard sizes of reinforcement bars and their weight and perimeters

3. R.C.C.:

3.1 Concept of R.C.C.

3.2 Assumption in the theory of simple bending in R.C.C. beam

3.3 Flexural strength of reinforced beams

3.4 Position of neutral axis
3.5 Concept of balanced, under reinforced and over reinforced section
3.6 Shear and bond, concept of diagonal tension, shear reinforced, vertical stirrups, inclined bars
3.7 Bond length, anchorage hooks splices as per I.S. 456
3.8 Load and Loading standards for R.C.C. structures
3.9 Concept of one-way slab, two-way slab
3.10 Doubly reinforced beams
3.11 Elements of T- Beams and columns

4. Pre stressed Concrete Structures:
4.1 Concept of pre - stressing
4.2 Advantage / disadvantage of pre stress system of pre stressing
4.3 Losses in pre stressing

5. Steel Structures:
5.1 Load types: live, dead and wind loads
5.2 Rolled section types: angle, Y- channel, tubes, flats, sheets and plates
5.3 As per I.S. 800 permissible stress in bending, shear, bearing and tension
5.4 Use of steel tables / tubes

REFERENCE BOOKS:

1. Strength of Material & Theory of Structures. Vol – I & II, B.C. Punmia
2. Mechanics of Structure, S.B. Junarkar.
3. Strength of Material, S. Ramamurtham
4. Strength of Material & Theory of Structures. Vol – I & II, R.S. Khurmi
5. Limit state Design of Steel Structure, Subramanian
6. IS 800-2007
7. Design of R.C.C. Structures, B.C. Punmia
8. Design of R.C.C. Structures, H.J. Shah
9. IS 456-2000

Thermal Engineering & Heat Transfer

Course Code	RE4003
Course Title	**Thermal Engineering & Heat Transfer**
Number of Credits	3(L-2, T-1, P-0)
Prerequisites	None
Course Category	PC

COURSE OBJECTIVES

1. To know the fundamentals related to Mechanical engineering.
2. Covers basics of Thermal engineering fundamentals and heat transfer concepts.

COURSE OUTCOMES

After completing the course, the student will be able to:

1. Understand the basics of both Thermal engineering and Heat transfer.
2. Know about modes of Heat Transfer and understand the concepts related to Conduction, Convection and Radiation.
3. Understand the fundamental laws of thermodynamics and various thermal and thermodynamic processes.

COURSE CONTENTS

1. Introduction to Thermodynamics:
   1.1 Role of Thermodynamics in Engineering and Science.
   1.2 Basic Concept of thermodynamic laws
      1.2.1 Types of system, Thermodynamic Equilibrium, properties (basic Concept only)
      1.2.2 Elementary introduction to Zeroth Law, First Law, Heat and work
      1.2.3 Second laws of thermodynamics Kelvin-Planck and Clausius Statements
      1.2.4 Concept of Heat Engine, Heat Pump & Refrigerator, Efficiency/COP
      1.2.5 Carnot Cycle, Carnot Efficiency, T-S and P-V Diagram**.**

2. Heat Transfer:
2.1 Importance of Heat Transfer
2.2 Mode of Heat transfer
   2.2.1 Conduction
   2.2.2 Convection
   2.2.3 Radiation

3.Conduction:
3.1 Fourier's law
3.2 Heat transfer by conduction through a plane & composite wall
3.3 Radial Heat transfer by conduction through a cylinder & sphere
3.4 Overall Heat transfer coefficient
3.5 Critical insulation

4. Convection:
4.1 Natural convection
4.2 Forced convection
4.3 Heat exchangers
   4.3.1 Direct contact type
   4.3.2 Regenerator & Storage type
   4.3.3 Recuperator & Transfer type

5. Radiation:
5.1 Absorption, Reflection and transmission
5.2 Radiant energy distribution curve
5.3 Emissive power
5.4 Black body & white body
5.5 Grey body
5.6 Kirchhoff 's law

5.7 Wien's displacement law
5.8 Planks law &Stefan Boltzmann's law

REFERENCES/SUGGESTED LEARNING RESOURCES

1. Thermal Engineering Vol. I & Vol. II	Mathur & Mehta
2. Thermal Engineering	R.K. Rajput
3. Thermal Engineering	P.K. Nag
4. Elements of Heat Engineering (Vol I & II)	Patel & Karamchandani
5. Heat Transfer	Arora &Domkundwar

POWER ELECTRONICS

Course Code	RE40041
Course Title	Power Electronics
Number of Credits	3(L-2, T-1, P-0)
Prerequisites	None
Course Category	PC

COURSE OBJECTIVES

1. To follow the industry identified competency through learning of various industrial circuits and devices.
2. To maintain the proper functioning of power electronic devices.

COURSE OUTCOMES

After completing the course, the student will be able to:

1. Select power electronic devices for specific applications.
2. Maintain the performance of Thyristors.
3. Troubleshoot turn-on and turn-off circuits of Thyristors.
4. Maintain phase-controlled rectifiers.
5. Maintain industrial control circuits.

COURSE CONTENTS

1. **POWER ELECTRONIC DEVICES**
   - 1.1 Power Transistors: Construction, working principle, V-I characteristics and uses
   - 1.2 IGBT: Construction, working principle, V-I characteristics and uses

2. THYRISTOR FAMILY DEVICES

- 2.1 SCR:
  - 2.1.1 Construction
  - 2.1.2 Two transistor analogy
  - 2.1.3 Types, working and characteristics
  - 2.1.4 SCR mounting and cooling
- 2.2 Types of Thyristors, Thyristor family devices: Symbol, construction, operating principle, and V-I characteristics
  - 2.2.1 SCR
  - 2.2.2 SCS
  - 2.2.3 GTO
  - 2.2.4 UJT
  - 2.2.5 PUT
  - 2.2.6 DIAC
  - 2.2.7 TRIAC
- 2.3 Protection Circuits:
  - 2.3.1 Over-voltage
  - 2.3.2 Over-current
  - 2.3.3 Snubber
  - 2.3.4 Crowbar

2. **TURN-ON AND TURN-OFF METHODS OF THYRISTORS**

3.1 SCR:
- 3.1.1 Construction
- 3.1.2 Two transistor analogy
- 3.1.3 Types, working and characteristics
- 3.1.4 SCR mounting and cooling

3.2 Types of Thyristors, Thyristor family devices: Symbol, construction, operating principle, and V-I characteristics:
- 3.2.1 SCR
- 3.2.2 SCS
- 3.2.3 GTO
- 3.2.4 UJT
- 3.2.5 PUT
- 3.2.6 DIAC
- 3.2.7 TRIAC

3.3 Protection Circuits:
- 3.3.1 Over-voltage
- 3.3.2 Over-current
- 3.3.3 Snubber
- 3.3.4 Crowbar

3. **PHASE CONTROLLED RECTIFIERS**

4.1 Phase control: Firing angle, conduction angle

4.2 Circuit diagram, working, input- output waveforms, equations for DC output and effect of freewheeling diode. For
- 4.2.1 Single phase half controlled
- 4.2.2 Full Controlled
- 4.2.3 Midpoint controlled rectifier with R, RL Load

4. **INDUSTRIAL CONTROL CIRCUITS**

5.1 Applications:
- 5.1.1 Burglar's alarm system
- 5.1.2 Battery charger using SCR
- 5.1.3 Emergency light system
- 5.1.4 Temperature controller using SCR
- 5.1.5 Illumination control / fan speed control TRIAC
- 5.1.6 SMPS

REFERENCES/SUGGESTED LEARNING RESOURCES

1. M. Ramamoorty, "An Introduction to Thyristors and their applications", East-West Press Pvt. Ltd, New delhi.
2. Rajendra Kumar Sugandhi, and Krishna KumarSugandhi, "Thyristors: Theory and Applications", New Age International Ltd. Publishers, New Delhi.
3. S.K. Bhattacharys, "Fundamentals of Power Electronics", Vikas Publishing House Pvt Ltd, Noida.
4. AlokJain, "Power Electronics and its Applications", Penram International Publishing Pvt. Ltd, Mumbai.
5. MuhammadRashid, "Power Electronics Circuits Devices and Applications", Pearson Education India, Noida.
6. M.D. Singh, and K.B.Khanchandani, "Power Electronics", Tata McGraw Hill Publishers, New Delhi, 2008.
7. Paul BZbar, "Industrial Electronics: A Text-Lab Manual", McGraw Hill Publishing Co. Ltd., New Delhi.
8. D.R.Grafham, SCR Manual, General Electric Co.

Hydraulic Machines

Course Code	RE 40042
Course Title	**Hydraulic Machines**
Number of Credits	3(L-2, T-1, P-0)
Prerequisites	None
Course Category	PC

COURSE OBJECTIVES

- To understand fundamental concept of fluid flow.
- To understand and analyse the performance of pumps.
- To understand and analyse the performance of hydraulic turbines.
- To understand the functioning and characteristic curves of pumps.

COURSE OUTCOMES

After completing the course, the student will be able to:

1. Calculate different parameters such as co-efficient of friction, power, efficiency etc of various Systems.
2. Describe the construction and working of turbines and pumps.
3. Plot characteristics curves of turbines and pumps.
4. Estimate performance parameters of a given Centrifugal and Reciprocating pump.
5. Select and analyse an appropriate turbine with reference to given situation in power plants.

COURSE CONTENTS

1. BASICS OF TURBO MACHINERY& JETS

1.1 Impact of jet on fixed and vertical flat plates,
1.2 Impact of jet on curved vanes,
1.3 Simple Numericals on work done and efficiency.

2. CENTRIFUGAL PUMPS

2.1 Working principle and applications of centrifugal pump (with Derivation for work done and efficiency)
2.2 Manometric head – losses and efficiencies
2.3 Specific speed-pumps in series and parallel
2.4 Performance characteristic curves
2.5 Cavitation & NPSH
2.6 Numericals on calculations of overall efficiency and power required to drive pumps.

3. RECIPROCATING PUMPS

3.1 Working principle and applications of reciprocating pump
3.2 Concept of Slip
3.3 Cavitation and separation
3.4 Indicator diagrams

4. HYDRAULIC TURBINES

4.1 Layout of hydroelectric power plant (Basic Concept)
4.2 Classification and selection of hydraulic turbines,
4.3 Construction and working principle of Pelton wheel,
4.4 Francis and Kaplan turbines (Derivation for work and efficiency)
4.5 Draft tubes – types and construction,
4.6 Simple problem related to Calculation of Work done, Power, efficiency of turbines,
4.7 Unit quantities

5. PERFORMANCE OF HYDRAULIC TURBINES

5.1 Geometric similarity, Unit and specific quantities

5.2 characteristic curves, governing of turbines, cavitation, surge tank, water hammer

5.3 Basics of Hydraulic systems- hydraulic ram, hydraulic lift, hydraulic coupling.

REFERENCES:

1. Hydraulics and fluid mechanics including Hydraulic machines- Modi P. N. and Seth S. M.
2. Fluid Mechanics & Machines- Dr. R. K. Bansal
3. Hydraulic, fluid mechanics & fluid machines – Ramamrutham S
4. Fluid Mechanics & Hydraulic Machines- R.K. Rajput
5. Fluid Machines- S. S. Ratan
6. Fluid mechanics and Fluid Power Engineering- D.S. Kumar

ELECTRIC VEHICLE

Course Code	RE40051
Course Title	**Electric Vehicle**
Number of Credits	3(L-2, T-1, P-0)
Prerequisites	None
Course Category	PE

COURSE OBJECTIVES

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- Maintain electric vehicles

COURSE OUTCOMES:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry-oriented COs associated with the above-mentioned competency:

a) Interpret the salient features of Hybrid electric vehicles.
b) Interpret the Dynamics of hybrid and Electric vehicles
c) Maintain the DC-DC converters in EV applications.
d) Maintain the DC-AC converters in EV applications
e) Select the batteries for EV applications.

COURSE CONTENTS:

1. INTRODUCTION TO HYBRID ELECTRIC VEHICLES

1.1. Evolution of Electric Vehicles
1.2. Advanced Electric Drive Vehicle Technology Vehicles
1.2.1. Electric Vehicles (EV),
1.2.2. Hybrid Electric Drive (HEV),
1.2.3. Plug In Electric Vehicle (PIEV),
1.3. Components Used Hybrid Electric Vehicle
1.4. Economic and Environmental Impacts of Electric Hybrid Vehicle
1.5. Parameters Affecting Environmental and Economic Analysis
1.6. Comparative Study of Vehicles for Economic, Environmental Aspects

2. DYNAMICS OF HYBRID AND ELECTRIC VEHICLES

2.1. General Description of Vehicle Movement
2.2. Factors Affecting Vehicle Motion
2.2.1. Vehicle Resistance,
2.2.2. Tyre Ground Adhesion,
2.2.3. Rolling Resistance,
2.2.4. Aerodynamic Drag,
2.2.5. Equation of Grading Resistance,
2.2.6. Dynamic Equation
2.3. Drive Train Configuration,
2.4. Automobile Power Train,
2.5. Classification of Vehicle Power Plant
2.6. Classification of Motors Used In Electric Vehicles
2.7. Types of HEVs
2.8. HEV Configurations-Series, Parallel, Series-Parallel, Complex.

3. DC-DC CONVERTERS FOR EV AND HEV APPLICATIONS

3.1. EV and HEV configuration based on power converters
3.2. Classification of converters –unidirectional and bidirectional
3.3. Principle of step-down operation

3.4. Boost and Buck- Boost converters
3.5. Principle of Step-Up operation

4. DC-AC INVERTER & MOTORS FOR EV AND HEVS

4.1. DC-AC Converters
4.2. Principle of operation of half bridge DC-AC inverter (R load, R-L load)
4.3. Single phase Bridge DC-AC inverter with R load, R-L load
4.4. Electric Machines used in EVs and HEVs,

5. BATTERIES

5.1. Overview of batteries
5.2. Battery Parameters,
5.3. types of batteries
5.4. Battery Charging,
5.5. alternative novel energy sources
  5.5.1. solar photovoltaic cells,
  5.5.2. fuel cells,
  5.5.3. super capacitors,
  5.5.4. flywheels
5.6. Regenerative braking in EVs

REFERENCES:

1. A.K. Babu, Electric & Hybrid Vehicles, Khanna Publishing House, New Delhi (Ed. 2018)
2. Fuhs, A. E. Hybrid Vehicles and the Future of Personal Transportation, CRC Press,
3. Gianfranco, Electric and Hybrid Vehicles: Power Sources, Models, Sustainability, Infrastructure And The Market, Pistoia Consultant, Rome, Italy,
4. Ehsani, M. Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press
5. Husain, I. Electric and Hybrid Electric Vehicles, CRC Press
6. Chan C. C. and K. T. Chau, Modern Electric Vehicle Technology, Oxford Science Publication,
7. Lechner G. and H. Naunheimer, Automotive Transmissions: Fundamentals, Selection, Design and Application, Springer
8. Rashid, M. H. Power Electronics: Circuits, Devices and Applications, 3rd edition, Pearson,
9. Moorthi, V. R. Power Electronics: Devices, Circuits and Industrial Applications, Oxford University Press
10. Krishnan, R. Electric motor drives: modelling, analysis, and control, Prentice Hall
11. Krause, O. P.; C. Wasynczuk, S. D. Sudhoff, Analysis of electric machinery, IEEE Press

SOLAR THERMAL

Course Code	RE40052
Course Title	Solar Thermal
Number of Credits	3(L-2, T-1, P-0)
Prerequisites	None
Course Category	PC

COURSE OBJECTIVES

1. To learn about solar radiation, its measurement procedure and solar geometry.
2. To learn about the characteristics of different types of solar collectors.
3. To understand the heating effects of solar energy in different applications.

COURSE OUTCOMES

After completing the course, the student will be able to:

1. Get concept on amount of solar radiation on earth and its measurement technique.
2. Learn different modes of solar energy collection.
3. Learn about characteristics of different types of solar collectors.
4. Apply the heating effect of solar energy in practical applications.
5. Know about different types of solar water heating systems.

COURSE CONTENTS

1. **SOLAR RADIATION**
   - 1.1 The Sun as the source of radiation
   - 1.2 Spectral Distribution of Extra-terrestrial Radiation, Variation of Extra-terrestrial Radiation
   - 1.3 Beam, Diffuse and Global Radiation
   - 1.4 Solar geometry, Basic Earth-Sun angles and their relationship (Numerical)
   - 1.5 The Solar Constant, Solar time and Equation of time, Angles for Tracking Surfaces

2. **MEASUREMENT OF SOLAR RADIATION**
   - 2.1 Measurement of solar radiation using Pyranometers, Measurement of Direct, Diffuse and Global solar radiation
   - 2.2 Measurement of duration of Sunshine hours
   - 2.3 Average Solar Radiation, Clear Sky Radiation, Clear and Cloudy days and its distribution
   - 2.4 Measurement of Radiation on inclined surfaces
   - 2.5 Ratio of Beam radiation on Tilted surface to that on Horizontal surface

3. **SOLAR COLLECTORS**

3.1 Liquid Flat-Plate Collectors - Materials required, Collector efficiency, Overall heat loss coefficient, Bottom loss coefficient, Top loss coefficient, Side loss coefficient, Sky temperature
3.2 Basic Flat-Plate Energy Balance Equation
3.3 Temperature distribution in Flat-Plate Collectors, Collector Heat removal Factor and Flow Factor, Improvement of collector efficiency
3.4 Evacuated tube collector - Basic principle, construction
3.5 Testing of solar collectors
3.6 Solar Concentrating Collector - Classification, Parameters of solar concentrators, Concentration Ratio, Thermal Performance of Concentrating Collectors
3.7 Cylindrical Parabolic Collector
3.8 Compound Parabolic Collector (CPC)
3.9 Paraboloid Dish Collector
3.10 Central Receiver Collector

4. **SOLAR AIR HEATING AND SOLAR WATER HEATING**
4.1 Solar Air Heater - Types of Air Heaters
4.2 Testing Procedure of Solar Air Heater, Performance Analysis of Solar Air Heater
4.3 Solar Water Heating System, Forced-Circulation and Natural circulation
4.4 Swimming Pool Heating
4.5 Testing and Rating of Solar Water Heaters

5. **SOLAR THERMAL DEVICES**
5.1 Solar Cooker - Types, Basic principle
5.2 Box type solar cooker - Design, Construction and Performance
5.3 Paraboloid type solar cooker
5.4 Testing of solar cooker
5.5 Solar Dryers- Types, Basic principle, Cabinet type Dryer and Indirect Dryer, Applications

REFERENCES/SUGGESTED LEARNING RESOURCES

1. John A. Duffieand William A. Beckman, “Solar Engineering of Thermal Processes”, JOHN WILEY and SONS.
2. H.P. Garg, J. Prakash, “Solar Energy Fundamentals & Applications”, McGraw Hill Education.
3. Dom Kundwar, Kothandaraman, “Thermal Engineering”, Dhanpat Rai& Co.
4. D. Yogi, Goswami, “Principles of Solar Engineering”, CRC Press, Taylor & Francis Group.
5. B.H. Khan, “Non-Conventional Energy Resources”, McGraw-Hill.
6. David Buchila, Thomas E. Kissell, Thomas Floyd, “Renewable Energy System”, Pearson.
7. D.P Kothari, K.C Singal, Rakesh Ranjan, “Renewable Energy Sources”, PHI Learning Private Limited.
8. Shobh Nath Singh, “Non-Conventional Energy Resources”, Pearson.
9. S. H. Saeed, D. K. Sharma, “Non-Conventional Energy Resources”, S. K. Kataria & Sons

WIND ENERGY LAB

Course Code	RE4006
Course Title	**Wind Energy Lab**
Number of Credits	1(L-0, T-0, P-2)
Prerequisites	None
Course Category	PC

COURSE OBJECTIVES

1. To learn the nature of different types wind for wind energy conversion.
2. To know the component details & features of a wind turbine required for a wind mill.
3. To learn wind power conversion technology and the economics relating to it.
4. To generate electricity from a wind mill.
5. To interpret the troubleshooting of a wind turbine.

COURSE OUTCOMES

After completing the course, the student will be able to:

1. Know about the components of a wind turbine and their functions.
2. Know the principle & components of wind energy conversion system.
3. Know different hybrid models associated with wind energy.
4. Generate electricity from a SWT system & measure the machine parameters.
5. Know the economics relating to wind power generation.
6. Interpret faults in a wind turbine and its remedy.

COURSE CONTENTS

1. Identify the specified components of a 1 KW Small Wind Turbine (SWT) system.
2. Set up a 1KW Small Wind Turbine (SWT) system.
3. Experiment to test the performance of Squirrel Cage Induction Generator (SCIG) – measurement of active and reactive power with respect to speed of SCIG and its analysis.
4. Experiment to test the performance of Permanent Magnet Synchronous Generator (PMSG) –
   a) No load test, b) Load test.
5. Check the performance of Direct Drive SWT.
6. Check the performance of Gear Drive SWT.
7. Assemble and dismantle the SWT system.
8. Simulate faults and its remedy in SWT system.

Thermal Engineering Lab

Course Code	RE4007
Course Title	**Thermal Engineering Lab**
Number of Credits	3(L-0, T-0, P-2)
Prerequisites	None
Course Category	PC

COURSE OBJECTIVES

To know the fundamentals related to Thermal engineering.
Covers basic study of steam turbine, condenser, air pump, cooling towers and heat transfer equipment.

COURSE OUTCOMES

1. After completing the course, the student will be able to:
2. Understand the basics of both Thermal engineering and Heat transfer.
3. Know about concept and calculations of thermal conductivity and heat flow through material with different shapes.
4. Understand the working of cooling towers, C.O.P of Refrigerator and heat transfer equipment.

COURSE CONTENTS

1. Study of steam turbine
2. Study of steam condensers.
3. Study of cooling towers.
4. Study of heat transfer equipment available in the laboratory
5.Conduct performance test on VCR test rig to determine COP of the refrigerator.
6.Thermal conductivity test on
1) Thick slab 2) Composite wall 3) Thick cylinder

REFERENCES/SUGGESTED LEARNING RESOURCES

1. Thermal Engineering Vol. I & Vol. II — Mathur & Mehta
2. Thermal Engineering — R.K. Rajput
3. Thermal Engineering — P.K. Nag
4. Elements of Heat Engineering (Vol I & II) — Patel & Karamchandani
5. Heat Transfer — Arora & Domkundwar

POWER ELECTRONICS LAB

Course Code	RE40081
Course Title	Power Electronics Lab
Number of Credits	1(L-0, T-0, P-2)
Prerequisites	None
Course Category	PC

COURSE OBJECTIVES

1. To follow the industry identified competency through learning of various industrial circuits and devices.
2. To maintain the proper functioning of power electronic devices.

COURSE OUTCOMES

After completing the course, the student will be able to:

1. Select power electronic devices for specific applications.
2. Maintain the performance of Thyristors.
3. Troubleshoot turn-on and turn-off circuits of Thyristors.
4. Maintain phase-controlled rectifiers.
5. Maintain industrial control circuits.

PRACTICLES

1. Test the proper functioning of power transistor, IGBT, and DIAC.
2. Determine the latching current and holding current using V-I characteristics of SCR.
3. Test the variation of R, C in R and RC triggering circuits on firing angle of SCR.
4. Test the effect of variation of R, C in UJT triggering technique.
5. Perform the operation of Class – A, B, C turn off circuits.
6. Perform the operation of Class –D, E, F turn off circuits.
7. Use CRO to observe the output waveform of half wave-controlled rectifier with resistive load and determine the load voltage.
8. Draw the output waveform of Full wave-controlled rectifier with R load, RL load, and freewheeling diode and determine the load voltage.
9. Test the performance of given SMPS, UPS.

Troubleshoot the Burglar's alarm, Emergency light system, Speed control system, Temperature control system.

Hydraulic Machines Lab

Course Code	RE40082
Course Title	**Hydraulic Machines Lab**
Number of Credits	3(L-0, T-0, P-2)
Prerequisites	None
Course Category	PC

COURSE OBJECTIVES

1. To know the fundamentals related to Hydraulic machines.
2. Covers basics and working of pumps and turbines.

COURSE OUTCOMES

After completing the course, the student will be able to:

3. Understand the basics of Hydraulic machines.
4. Know about construction and working of Centrifugal and reciprocating Pumps.
5. Understand the fundamental model and working of Pelton wheel, Francis and Kaplan turbine.

COURSE CONTENTS

1. Determination of slip, coefficient of Discharge for a reciprocating pump
2. Study of construction and working of Centrifugal pump
3. Study of construction and working of Pelton wheel turbine
4. Study of construction and working of Francis turbine
5. Study of model of Kaplan turbine
6. Study of submersible pump, jet pump, deep well pump.

REFERENCES/SUGGESTED LEARNING RESOURCES

1.Fluid Mechanics & Machines Dr. Jagdish Lal
2. Fluid Mechanics & Machines Dr. R. K. Bansal
3. Fluid Mechanics & Machines R. S. Khurmi.
4. Hydraulics & Pneumatics H.L. Stewart.
5. Fluid Machines S.S. Ratan

ELECTRIC VEHICLE LAB

Course Code	RE40091
Course Title	**Electric Vehicle Lab**
Number of Credits	1(L-0, T-0, P-2)
Prerequisites	None
Course Category	PE

COURSE OBJECTIVES:

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- Maintain electric vehicles

COURSE OUTCOMES:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry-oriented COs associated with the above-mentioned competency:

a) Interpret the salient features of Hybrid electric vehicles.
b) Interpret the Dynamics of hybrid and Electric vehicles
c) Maintain the DC-DC converters in EV applications.
d) Maintain the DC-AC converters in EV applications
e) Select the batteries for EV applications.

PRACTICALS:

1. Develop block diagram of Electric vehicle and identify parts
2. Case study- Compare minimum four vehicles for economic and environmental analysis
3. Develop schematic diagram of hybrid electric vehicle and identify the components fluorescent lamp.
4. Prepare report on Plug in Electric vehicle by visiting a charging station
5. Inspect and install inverter of given lead acid battery
6. Prepare a report on batteries used from market survey
7. Collect specifications of converters and inverters used for Electric vehicles a single lamp control by two switches
8. Diagnose, repair and maintain battery used in electric vehicle
9. Prepare test procedure for equipment used in Electric vehicle
10. List safety procedures and schedule for handling HEVs and EVs.

SOALR THERMAL LAB

Course Code	RE40092
Course Title	Solar Thermal Lab
Number of Credits	1(L-0, T-0, P-2)
Prerequisites	None
Course Category	PC

COURSE OBJECTIVES

1. To learn about solar radiation, its measurement procedure and solar geometry.
2. To learn about the characteristics of different types of solar collectors.
3. To understand the heating effects of solar energy in different applications.

COURSE OUTCOMES

After completing the course, the student will be able to:

1. Get concept on amount of solar radiation on earth and its measurement technique.
2. Learn different modes of solar energy collection.
3. Learn about characteristics of different types of solar collectors.
4. Apply the heating effect of solar energy in practical applications.
5. Know about different types of solar water heating systems.

PRACTICLES

1. Experiment to measure beam, diffuse and global radiation on horizontal surface using Pyranometer and plot radiation vs. time characteristics for certain duration.
2. Experiment to measure beam, diffuse and global radiation on tilted surface at different angles of inclination and plot radiation vs. time characteristics for certain duration.
3. Study the different parts of a solar flat plate collector.
4. Study of different parts of an evacuated tube collector.
5. Study of different parts of a solar concentrating collector.
6. Experiment to measure thermal performance of a solar cooker with varying reflector.
7. Experiment to measure the parameters of a Solar cooling system.
8. Experiment to measure the parameters of a Solar dryer.

GOVERNMENT OF RAJASTHAN

BOARD OF TECHNICAL EDUCATION RAJASTHAN JODHPUR

SEMESTER SCHEME-2020-21

V SEMESTER

(SESSION 2021-2022 & ONWARDS)

Engineering Material

Course Code	RE 5001
Course Title	Engineering Material
Number of Credits	1 (L:3, T: 0, P: 0)
Prerequisites	NIL
Course Category	PC

Course Objectives:

Following are the objectives of this course:

- To learn about various construction materials, and understand their relevant characteristics.
- To be able to identify suitability of various materials for different construction purposes.

Course outcomes:

After completing this course, student will be able to:

- Identify relevant natural construction materials.
- . Select relevant artificial construction materials.
- . Select relevant special type of construction materials

COURSE CONTENTS

1. **Natural Construction Materials**
1.1 Stones
  1.1.1 Requirements of good building stone
  1.1.2 General characteristics of stone
1.2 Timber
  1.2.1 Structure of timber
  1.2.2 General properties and uses of good timber
  1.2.3 Use of bamboo in construction
1.3 Asphalt, bitumen and tar used in construction, their properties and uses
1.4 Properties of lime, its types and uses
1.5 Properties of sand and uses
1.6 Classification of coarse aggregate according to size

2. **Artificial Construction Materials**
2.1 Bricks
  2.1.1 Constituents of brick earth
  2.1.2 Conventional / Traditional bricks
  2.1.3 Modular and Standard bricks
  2.1.4 Special bricks –fly ash bricks
  2.1.5 Characteristics of good brick
  2.1.6 Field tests on Bricks
2.2 Flooring tiles – types and uses
2.3 Cement
  2.2.1 Types of cement and its uses
  2.2.2 Field tests on cement
2.4 Precast concrete blocks- hollow, solid, pavement blocks, and their uses

2.5 Plywood, Particle board, Veneers, laminated board and their uses
2.6 Types of glass: Soda lime glass, lead glass and borosilicate glass and their uses
2.7 Ferrous and non-ferrous metals and their uses

3. Special Construction Materials
3.1Types of material and suitability in construction works of following materials:
3.1.1Water proofing
3.1.2Termite proofing
3.1.3Thermal and sound insulating materials
3.2Fibers – Types –Jute, Glass, Plastic Asbestos Fibers, (only uses)

4. Classification of Electrical Engineering Materials:
4.1 General requirement of electrical engineering materials,
4.2 Classification of materials into conducting, semi-conducting and insulating materials through a brief reference to atomic structure
5. **Conducting Materials**:
5.1 Resistivity
5.2 Factors affecting resistivity such as
5.2.1 Temperature
5.2.2 Alloying
5.2.3 Aging effect
5.3 General Properties of following materials
5.3.1 Low Resistivity Materials
5.3.2 High resistivity materials
5.3.3 Bruch materials
5.3.4 Contact materials

6. Insulating Materials:
6.1 Electrical properties
6.1.1 Volume resistivity
6.1.2 Surface resistance
6.1.3 Dielectric strength
6.1.4 Dielectric constant
6.2 Physical, Thermal, Chemical properties
6.3 Classification of insulating materials on the basis of temperature limit
6.4 Composition, properties and applications of - Fibrous materials, Ceramics, Mica and mica products, Asbestos and asbestos products, Glass and glass products, Natural and synthetic rubber, PVC, Bakelite
6.5 Properties of liquid insulating materials such as - Transformer oils, Mineral insulating oils
6.6 Properties of gaseous insulating materials such as- Hydrogen, Air, SF6

7. **Magnetic Materials:**
7.1 Terminology and classification
7.1.1 Diamagnetic material
7.1.2 Paramagnetic material
7.1.3 Ferromagnetic material
7.2 Effect of Curie temperature
7.3 Soft and hard magnetic materials
7.4 Different magnetic materials such as- soft ferrites, Silicon steel, Nickel Iron alloys, Cobalt steel, Tungsten steel, ALNICO, ALNI

8. Special Purpose Materials:
8.1 Metals/ alloys for fuses with their properties composition & uses

8.2 Composition and properties of soldering materials
8.3 Materials for thermocouple
8.4 Materials for bimetal
8.5 Super conductivity and super conducting materials application and recent trend in this field.

References:

1. Sood H., Laboratory Manual on Testing of Engineering Materials, New Age Publishers, New Delhi.
2. Sharma C. P., Engineering Materials, PHI Learning, New Delhi.
3. Duggal, S. K, Building Materials, New International, New Delhi.
4. Electrical Engineering Materials, T.T.T.I. Madras
5. Electrical Engineering Materials, Raina, Bhattacharya
6. Electrical Engg. Materials B.R. Sharma
7. Electrical Engg. Materials P.L. Kapoor
8.विधुत इंजीनियरिंग पदार्थ, के डी शर्मा
9. विधुत इंजीनियरिंग पदार्थ, डी आर नागपाल

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BIOMASS AND HYDRO POWER PLANTS

Course Code	RE5002
Course Title	Biomass and Hydro Power Plants
Number of Credits	3(L-3, T-0, P-0)
Prerequisites	None
Course Category	PC

COURSE OBJECTIVES:

1. To learn about biomass resources in our surroundings and conversion of electrical energy from those resources.
2. To know about bio-gas production technology.
3. To learn how to produce electricity from a biogas plant.
4. To learn socio-economic aspects of Biogas usages.

COURSE OUTCOMES:

After completing the course, the student will be able to:

1. Know various sources of biomass, their fuel value & applications in biomass energy conversion.
2. Learn the design parameters and applications of different gasifiers.
3. Know about the components of a bio-gas plant and their functions.
4. Get concept on bio-gas production technology.
5. Produce biogas from a small biogas plant and generate electricity there from.

COURSE CONTENTS:

1. Fundamentals of Bio-Mass:

1.1 Biomass resources.
1.2 Energy farming.
1.3 Different forms of Biomass, their composition & fuel properties.
1.4 Indian scenario for Biomass resources.
1.5 Advantages of biomass energy.

2. Bio mass Conversion Technology Methods:

2.1 Physical method.
2.2 Incineration.
2.3 Thermo-chemical method.
2.4 Bio-chemical method.
2.5 Urban waste to energy conversion – Municipal solid waste incineration plant, Sewage to energy conversion.

3. Bio-Mass Gasification:

3.1 Theory of Gasification.
3.2 Pre-Treatment methods of Biomass.
3.3 Physical Treatment – Mechanically Grinding & Chipping, Moisture Removing or Adding, Application of Binding Agent, Steaming, Torrefaction.
3.4 Low temperature & High temperature Gasification.
3.5 Chemistry of Gasification & its products.
3.6 Classification of Gasifier
- 3.6.1 Updraft Gasifier – Principles, Design & Application.
- 3.6.2 Downdraft Gasifier – Principles, Design & Application.
- 3.6.3 Cross Draft Gasifier – Principles, Design & Applications.
- 3.6.4 Open core Gasifier – Principles, Design & Applications.
- 3.6.5 Fluidized Bed Gasifier – Principles, Design & Applications.
- 3.6.6 Gasifier Biomass feed parameters.

3.7 Different Models of Gasifiers.

4. **Bio-Gas Production**:

4.1 Biogas & its composition.
4.2 Anaerobic digestion – Basic process, advantages.
4.3 Types of Biogas plant –
- 4.3.1 Fixed dome type.

4.3.2 Floating type.
4.4 Maintenance of Biogas plant.

5. Large and Micro-Hydro Power Plants

5.1 Energy conversion process of hydro power plant.
5.2 Classification of hydro power plant: High, medium and low head.
5.3 Construction and working of hydro turbines used in different types of hydro power plant;
5.4 High head – Pelton turbine.
5.5 Medium head – Francis turbine.
5.6 Low head – Kaplan turbine.
5.7 Safe practices for hydro power plants.
5.8Different types of micro-hydro turbines for different heads.
5.9 Locations of these different types of large and micro-hydro power plants in India and Rajasthan.

Text / Reference Books:

1. Non-Conventional Energy Resources, B. H. Khan, The McGraw Hill Publications.
2. Non-Conventional Energy Sources, G.D. Rai, Khanna Publications
3. Non-Conventional Energy Resources Shobh Nath Singh Pearson
4. Non-Conventional Energy S. H. Saeed, S. K. Kataria & Sons Resources D. K. Sharma
5. Understanding Clean Energy and fuels from biomass, Mukunda, HS. Wiley-India Pvt. Ltd, 2011
6. Hand book of plant-based biofuel, Pandey A., CRC Press, Taylor & Francis, 2008
7. Biogas Systems, Principle and Applications Mital, KM. New Age International Ltd. 1996
8. Biomass, Energy and Environment, A developing country perspective from India. Ravindranath NH. Hall DO. Oxford University Press, 1995

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ECONOMIC POLICIES IN INDIA

Course Code	RE- 51001(Common in all branches of Engg.)
Course Title	Economic Policies in India
Number of Credits	3 (L:3, T:0, P:0)
Prerequisites	NIL
Course Category	OE

COURSE LEARNING OBJECTIVES:

The objective of this course is to familiarize the students of different streams with the basic concepts, structure, problems and issues concerning Indian economy.

CO1	Understand Indian economics policy, planning strategies
CO2	It will enable to students to comprehend theoretical and empirical development across countries and region for policy purposes
CO3	Development Economics as a discipline encompasses different approach es to the problems of unemployment, poverty, income generation, industrialization from different perspectives.
CO4	Able to identify the problems and capable to decide the application for future development.
CO5	Analyze economic issues and find solutions to complex economic problems and take correct economic judgment.

COURSE CONTENTS:

1. BASIC FEATURES AND PROBLEMS OF INDIAN ECONOMY:

- 1.1. Economic History of India;
- 1.2. Nature of Indian Economy
- 1.3. Demographic features and Human Development Index,
- 1.4. Problems of Poverty, Unemploy-ment, Inflation, income inequality, Blackmoney in India.

2. SECTORAL COMPOSITION OF INDIAN ECONOMY:

- 2.1. Issues in Agriculture sector in India,
- 2.2. land reforms
- 2.3. Green Revolution
- 2.4. agriculture policies of India,
- 2.5.

3. INDUSTRIAL DEVELOPMENT,

- 3.1. Small scale and cottage industries,
- 3.2. Industrial Policy,
- 3.3. Public sector in India,
- 3.4. Service sector in India.

4. ECONOMIC POLICIES:

- 4.1. Economic Planning in India,
- 4.2. Planning commission v/s NITI Aayog,
- 4.3. Five Year Plans,
- 4.4. Monetary policy in India,
- 4.5. Fiscal Policy in India,
- 4.6. Centre state Finance Relations,
- 4.7. Finance commission in India
- 4.8. LPG policy in India

5. EXTERNAL SECTOR IN INDIA

- 5.1. India's foreign trade value composition and direction,
- 5.2. India Balance of payment since 1991,
- 5.3. FDI in India,
- 5.4. Impact of Globalization on Indian Economy,
- 5.5. WTO and India.

REFERENCE BOOKS:

1. Dutt Rudder and K.P.M Sunderam (2017). Indian Economy .S Chand &Co.Ltd. New Delhi.
2. Mishra S. K &V. K Puri (2017). Indian Economy and Its Development Experience. Himalaya Publishing House.
3. Singh, Ramesh, (2016): Indian Economy, Tata-McGraw Hill Publications, New Delhi.
4. Dhingra, I.C., (2017): March of the Indian Economy, Heed Publications Pvt. Ltd.
5. Karam Singh Gill, (1978): Evolution of the Indian Economy, NCERT, NewDelhi
6. Kaushik Basu (2007): The Oxford Companion to Economics of India ,Oxford University Press.

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ENGINEERING ECONOMICS & ACCOUNTANCY

Course Code	RE51002(Common in all branches of Engg.)
Course Title	Engineering Economics & Accountancy
Number of Credits	3 (L:3, T:0, P:0)
Prerequisites	NIL
Course Category	OE

COURSE OBJECTIVES

•To acquire knowledge of basic economics of a ciliate the process of economic decision making.
•To acquire knowledge on basic financial management aspects.
•To develop the basic skills to analyse financial statements.

COURSE OUTCOMES:

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

CO1	Understand the macro-economic environment of the business and its impact on enterprise
CO2	Understand cost elements of the product and its effect on decision making
CO3	Prepare accounting records and summarize and interpret the accounting datafor managerial decisions
CO4	Understand accounting systems and analyze financial statements using ratio analysis
CO5	Understand the concepts of financial management and investment

COURSE CONTENTS

1. INTRODUCTION:

1.1. Managerial Economics;
1.2. Relationship with other disciplines;
1.3. Firms: Types, objectives and goals;
1.4. Managerial decisions;
1.5. Decision analysis.

2. DEMAND & SUPPLY ANALYSIS:

2.1. Demand;
  2.1.1. Types of demand;
  2.1.2. Determinants of demand;
  2.1.3. Demand function;
  2.1.4. Demand elasticity;
  2.1.5. Demand forecasting;
2.2. Supply;
  2.2.1. Determinants of supply;
  2.2.2. Supply function;
  2.2.3. Supply elasticity.

3. PRODUCTION AND COST ANALYSIS:

3.1. Production function;
3.2. Returns to scale;
3.3. Production optimization;
3.4. Least cost input; Iso quants;
3.5. Managerial uses of production function;
3.6. Cost Concepts;
  3.6.1. Cost function;
  3.6.2. Types of Cost;
  3.6.3. Determinants of cost;
  3.6.4. Short run and long run cost curves;
  3.6.5. Cost Output Decision;
  3.6.6. Estimation of Cost.

4. PRICING:

4.1. Determinants of Price;
4.2. Pricing under different objectives and different market structures;
4.3. Price discrimination;
4.4. Pricing methods in practice;
4.5. Role of Government in pricing control.

5. FINANCIAL ACCOUNTING (ELEMENTARY TREATMENT):

5.1. Balance sheet and related concepts;
5.2. Profit & Loss Statement and related concepts;
5.3. Financial Ratio Analysis;
5.4. Cash flow analysis;
5.5. Funds flow analysis;
5.6. Comparative financial statements;
5.7. Analysis & Interpretation of financial statements;
5.8. Investments;
5.9. Risks and return evaluation of investment decision;
5.10. Average rate of return;
5.11. Payback Period;
5.12. Net Present Value;
5.13. Internal rate of return,

REFERENCE BOOKS:

1.McGuigan, Moyer and Harris, 'Managerial Economics; Applications, Strategy and Tactics', Thomson South Western, 10th Edition, 2005.
2.Prasanna Chandra. 'Fundamentals of Financial Management', Tata McGraw Hill Publishing Ltd., 4th edition,2005.
3.Samuelson. Paul A and Nordhaus W. D., 'Economics', Tata McGraw Hill Publishing Company Limited, New Delhi, 2004.
4.Paresh Shah, 'Basic Financial Accounting for Management', Oxford University Press, New Delhi, 2007.
5.Salvatore Dominick, 'Managerial Economics in a global economy'. Thomson South Western, 4th Edition, 2001.

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MACHINE DESIGN

Course Code	RE50031
Course Title	MACHINE DESIGN
Number of Credits	3(L-2, T-1, P-0)
Prerequisites	None
Course Category	PE

COURSE OBJECTIVES

1. To know the fundamentals related to Machine Design
2. Covers basics of design of welded joints, screw, bolts, keys, coupling and shafts

COURSE OUTCOMES

After completing the course, the student will be able to:

1. Understand the basics of Machine design methods.
2. Identify different types of design criteria of general machine components.
3. Apply various design methods to design machine components like shafts, keys, couplings, screw, bolt and welded joints.

COURSE CONTENTS

1. INTRODUCTION:

1.1 General consideration in machine design
1.2 General procedure in machine design
1.3 Selection of material
1.4 Working stress and factor of safety, selection of factor of safety
1.5 Stress concentration, stress concentration factor and methods of reducing stress concentration
1.6 Fatigue and endurance limit

2. Design of Welding Joints:

2.1 Types of welded joint and Design of lap joint and butt joint
2.2 Strength of transverse and parallel fillet welded joints in axial loading
2.3 Basic welding symbols
2.4 Welded joint subjected to twisting moment and bending moment

3. Design of Screw and Bolts:

3.1 Initial stresses due to screwing up
3.2 Stress due to external forces
3.3 Stress due to combined forces
3.4 Bolt of uniform strength
3.5 Screw thread, designations and its dimensions.
3.6 Design of Power screw

4. Design of Keys and Couplings:

4.1 Design of sunk key
4.2 Design of rigid flange coupling
4.3 Design of pin type flexible couplings

5. Design of Shaft:

5.1 Shaft subjected to twisting moment
5.2 Shaft subjected to bending moment
5.3 Shaft subjected to combined twisting and bending moment

REFERENCES/SUGGESTED LEARNING RESOURCES

1. Machine Design Pandya & shah
2. Machine Design R. S. Khurmi
3. Machine Design Sharma & Aggarwal
4. Machine Design V. B. Bhandari
5. Engineering Design J. E. Shieglay (McGraw-Hill)

RENEWABLE ENERGY INSTRUMENTATION APPLICATION

Course Code	RE50032
Course Title	Renewable Energy Instrumentation Application
Number of Credits	3(L-3, T-0, P-0)
Prerequisites	None
Course Category	PE

Course Objectives:

1. To learn efficient operation of various types of instruments utilized for renewable power applications.
2. To know the characteristics, measurement procedure and applications of different instruments.

Course Outcomes:

After completing the course, the student will be able to:

1. Know the characteristics and specification of different instruments.
2. Know the principle of operation, advantages, disadvantages of different process parameter like displacement, force, pressure, Temperature, Level, Flow etc
3. Identify different measuring instruments related to specific plant.
4. Use instruments for specific applications.
5. Operate various types of instruments in renewable power applications.

COURSE CONTENT

1. Characteristics of Measurement System:

1.1 Concept of Static characteristics,
1.2 Definition of different static characteristic – Accuracy, Precision, Sensitivity, Linearity, Repeatability, Reproducibility, Hysteresis, Resolution.
1.3 Dynamic characteristics concept only.

2. Measurement of Displacement and Force:

2.1 Measurement of displacement: (i) Strain gauge, (ii) LVDT.
2.2 Measurement of force: Load cell (column type).

3. Measurement of Level & Flow:

3.1 Level measurement by Gauge glass, Displacer, Ultrasonic, D/p transmitter.
3.2 Bernoulli's theorem.
3.3 Principle of operation, advantages and disadvantages of different flow measuring instruments: (i) Orifice, (ii) Rotameter, (iii) Differential Pressure Transmitter.

4. Measurement of Temperature:

4.1 RTD: Basic principle of operation, Equation, Construction, Types, Range, Specification.
4.2 Thermocouple: Basic principle of operation, Equation, Construction, Types, Range, Specification.

5. Measurement of Pressure:

5.1 Units of pressure, Concept of Absolute pressure, gauge pressure and vacuum.
5.2 Basic principle of operation of different pressure measuring instruments – (i) U tube manometer, (ii) C type bourdon tube.
5.3 Concept of pressure transmitter.
5.4 Dead weight tester.

6. Miscellaneous Measurements:

6.1 Instruments for radiation measurements –
  6.1.1 Geiger Counter with Geiger-Mueller (GM) Tube or Probe.
  6.1.2 Proportional Counter.
  6.1.3 Scintillation Counters.
6.2 Pyranometer – Design & construction for solar radiation measurement.
6.3 Data logger – Operation, Measurement technique and Application.
6.4 Different instruments used in – Hydroelectric power plant, Solar thermal plant, Wind power plant, Biogas plant (name of instruments and where to use in that plant).

Text / Reference Books:

1. Introduction to Measurement & Instrumentation, Ghosh, PHI
2. Industrial Instrumentation and Control, S. K. Singh, TMH
3. Sensor & Transducers, D. V. S. Murty, PHI
4. A Course in Electrical & Electronics Measurement & Instrumentation, J. B. Gupta, S. K. Kataria
5. Principle of Industrial Instrumentation, D. Patranabis, TMH
6. Measurement System Application & Design, E. O. Doeblin, McGraw Hill
7. Instrumentation & Control Systems, K. N. Reddy, P. S. R. Krisnudu, Scitech Publications (India) Pvt. Ltd
8. Instrument Transducer, H. K. P. Neubert, Oxford University Press.

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ELECTRICAL MACHINE AND MEASUREMENT

Course Code	RE50041
Course Title	Electrical Machine and Measurement
Number of Credits	3(L-2, T-1, P-0)
Prerequisites	None
Course Category	PE

COURSE OBJECTIVES

1. To understand the fundamental concepts of Electrical machines used in renewable power generation and transmission technology.
2. To know the operations of some basic instruments essential for use in power system.

COURSE OUTCOMES

After completing the course, the student will be able to:

1. Describe the constructional details and working principles of DC machines, AC machines, and Transformers.
2. Test DC and AC machines, power transformers, and instrument transformers.
3. Evaluate the performance of DC and AC machines and Transformers by conducting different tests.
4. Decide the suitability of DC and AC machines for use in renewable power plants.
5. Write specifications of DC machines, AC machines, and Transformers as required.
6. Maintain electrical machines in industry and captive plants.

COURSE CONTENTS

1. **ELECTRO-MECHANICAL ENERGY CONVERSION**
   - 1.1 Mechanism of Electro-Mechanical energy conversion for generator and motor mode
   - 1.2 D.C. Generator: Construction, Working principle, Types, E.M.F. equation, O.C. Characteristics (Numerical)
   - 1.3 D.C. Motor: Construction, Working principle, Types, Torque equation, Load Characteristics (Numerical)
   - 1.4 Commutation method in DC machine
   - 1.5 Applications of different types of D.C. generators and motors

2. **TRANSFORMER**
   - 2.1 Single phase Transformer:
     - 2.1.1 Working principle, E.M.F. equation, Transformation ratio, Specification
     - 2.1.2 Losses, Efficiency, Voltage Regulation (Numerical)

3. **AC GENERATOR**
   - 3.1 Three Phase Synchronous Generator (Alternator)
     - 3.1.1 Construction, Working principle
     - 3.1.2 Methods of excitation systems
     - 3.1.3 E.M.F. equation (no derivation)
     - 3.1.4 Terminal voltage at different power factor loads (no derivation), Voltage regulation, Load angle (Numerical)
     - 3.1.5 Synchronization and Parallel operation of an alternator with infinite bus or with another alternator
4. **THREE PHASE INDUCTION MACHINE**

4.1 **THREE PHASE INDUCTION MOTOR**

4.1.1 Construction, Types, Working principle

4.1.2 Synchronous Speed, Slip

4.1.3 Torque equation, Torque- Slip characteristics

4.1.4 Starting methods

4.1.5 Methods of Speed control

4.2 **INDUCTION GENERATOR (IG)**

4.2.1 Construction, Principle of operation

4.2.2 Excitation

4.2.3 Active power Off-grid IG, Capacitor Start IG

4.2.4 Torque-Slip characteristics, Torque-Speed characteristics

4.2.5 High efficiency IG

4.2.6 Applications in renewable power plant

5. **MEASUREMENT OF ELECTRICAL POWER AND ENERGY**

5.1 Measurements of 3-phase power for balanced and unbalanced load by wattmeter method

5.2 Electronic Energy Meter - Construction, Basic circuit diagram, Principle of operation

5.3 Measurements of electrical energy by 3-phase energy meter

6. **INSTRUMENT TRANSFORMER**

6.1 Current Transformer (CT): Working principle, Burden on CT, Phase angle error, Ratio error, Specifications

6.2 Potential Transformer (PT): Working principle, Phase angle error, Ratio error, Specifications

REFERENCES/SUGGESTED LEARNING RESOURCES

1. S.K. Bhattacharya, “Electrical Machines”, T.M.H Publishing Co. Ltd.
2. B. L. Thereja, “Electrical Technology- Vol-II”, S. Chand.
3. Ashfaq Hussain, “Electrical Machines”, Dhanpat Rai.
4. A.K. Sawhney, “Electric & Electronic Measurement and Instrumentation”, Dhanpat Rai and Sons.
5. J.B. Gupta, “Electrical & Electronic Measurements”, S. K. Kataria Publication.
6. S.K. Sen, “Electrical Machines”, Khanna Publisher.

ENERGY CONVERSION DEVICES AND METHODOLOGIES

Course Code	RE50042
Course Title	Energy Conversion Devices and Methodologies
Number of Credits	3(L-2, T-1, P-0)
Prerequisites	None
Course Category	PE

Course Objectives:

1. To learn about different conventional & non-conventional energy sources and their conversion to other systems.
2. To know about different parts of thermal, hydro, nuclear & other renewable power plants.

Course Outcomes:

After completing the course, the student will be able to:

1. Identify different sections of conventional & non-conventional energy power plants.
2. Learn energy conversion systems from conventional & non-conventional sources.
3. Compare merits & demerits of different conversion systems.
4. Compute economy of the different energy conversion process.

COURSE CONTENT

1. Thermal Science:

1.1 Thermal systems, Thermal circuit analysis and terminology.
1.2 Heat transfer methodologies – Conduction, Convection and Radiation.
1.3 Properties of heat transparent materials.
1.4 Heat transfer by mass transfer.
1.5 Electro-Mechanical Energy Conversion:
- 1.5.1 Introduction.
- 1.5.2 Salient aspects of conversions.
- 1.5.3 Energy – Balance, Magnetic-field System, Energy and Co-energy.
- 1.5.4 A Simple Electromechanical System.
- 1.5.5 Energy in Terms of Electrical Parameters, Rotary Motion, Dynamic Equations and system-model of a simple system.

2.Steam Power Unit:

2.1. Layout of the unit.
2.2 Coal burning methods, Disposal of ash and dust.
2.3 Combined cycle power plants, Integrated coal gasification.
2.4 Plant components: Condenser, Economiser, Cooling tower.
2.5 Boilers and Fired Systems:
- 2.5.1 Fundamentals of Boilers, Materials and construction of boilers.
- 2.5.2 Types of boilers, Firing systems.
- 2.5.3 Efficiency of boilers, Elements for maximum efficiency of boilers.
- 2.5.4 Excess air, Stack temperature control, Utilization of waste heat
- 2.5.5 Load balancing, Boiler blow down.
- 2.5.6 Condensate return methodologies.
- 2.5.7 Fuel consideration, Coal, Oil and Natural Gas.

2.6 Steam and Condensate Systems:
- 2.6.1 Thermal properties of steam.
- 2.6.2 Saturated steam, Super-heated steam.
- 2.6.3 Heat transfer characteristics of steam.
- 2.6.4 Estimating steam usage, Steam traps and their applications.

3. Hydro-electric Units:

3.1 Classification.
3.2 Layout of the unit.
3.3 Components and auxiliaries of hydro power plant.
3.4 Selection of turbines, Micro hydro plants, Pumped storage.
3.5 Hydro-Power:
- 3.5.1 Components for hydroelectric generators.

3.5.2 Ram pump, Impulse turbine, Reaction turbine, Hydroelectric Systems.
3.5.3 Small and large hydro-power plants.

4. Diesel and Gas Turbine Units:
4.1 General Layout, Components of Plant, Comparison with steam power plant.
4.2 Nuclear Power Plants:
4.2.1 Location of plant.
4.2.2 Components of nuclear plants, Types of reactors, Uranium enrichment, Safety factors, Disposal of nuclear waste.
4.2.3 Comparison with thermal power plant.

5. Other Conversion Units:
Renewable Power Plants – Solar power plant, Wind power plant, Biogas power plant, geothermal energy, Ocean thermal energy.

6. **Battery:**
6.1 Types of storage batteries
6.2 Construction and working of Lead acid batteries, Ni-Fe batteries and Lithium ion batteries
6.3 Discharging and recharging of Lead acid batteries
6.4 Ampere and watt-hour efficiencies

Text / Reference Books:
1. Non-Conventional Energy Resources, B. H. Khan, McGraw Hill Publications.
2. Non-Conventional Energy Sources, G.D. Ray, Khanna Publications
3. Power Plant Engineering, P. K. Nag, Tata McGraw-Hill Education
4. Solar Energy – Principles of Thermal Collection, and Storage, S. P. Sukhatme and J.K. Nayak Tata McGraw-Hill, New Delhi
5. Solar Energy, Fundamentals and Applications Garg, Prakash Tata McGraw Hill.
6. A Text Book on Power Plant Engineering, K.K. Ramalingam, Scitech Publications (India) Pvt. Ltd.
7. Power Plant Engineering R.K. Hegde Pearson

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MATERIAL LAB

Course Code	RE 5005
Course Title	MATERIAL LAB
Number of Credits	L: 0, T: 0, P: 2
Prerequisites	NIL
Course Category	PC

Course Objectives:

Following are the objectives of this course:

- To know the procedure for the conduct of tensile and compressive strength.
- To understand the concept of stress and strain through testing of different materials.
- To calculate shear force, bending moment and their corresponding stresses.

Course outcomes:

After competing this course, student will be able to:

- Test different engineering materials on Universal Testing Machine.
- Analyse structural behaviour of materials under various loading conditions.
- Interpret shear force and bending moment diagrams for various types of beam sections and different loading conditions.
- Determine bending and shear stresses in beams under different loading conditions

CONTENTS OF COURSE

1. Study and understand the use and components of Universal Testing Machine (UTM).

2. Perform Tension test on mild steel as per IS:432(1).

3. Perform tension test on Tor steel as per IS:1608, IS:1139.

4. Conduct compression test on sample test piece using Compression Testing Machine
.
5. Conduct Izod Impact test on three metals. e.g., mild steel/ brass/aluminium/ copper /cast iron etc as per IS:1598.
6. Conduct Charpy Impact test on three metals. e.g., mild steel/ brass/aluminium/ copper /cast iron etc as per IS:1757.

7. Determine Water Absorption on bricks per IS:3495 (part II), IS:1077 or tile IS:1237.

8. Determine Compressive strength of dry and wet bricks as per IS:3495(part I), IS:1077.

9. Perform Single Shear and double shear test on any two metals e.g., Mild steel/ brass/aluminium/copper / cast iron etc as per IS:5242.

10. Conduct Compression test on timber section along the grain and across the grain as per IS:2408.

11. Conduct Flexural test on timber beam on rectangular section in both orientations as per IS:1708, IS:2408.

Suggested learning resources:

1. Bedi D.S., Strength of Materials, Khanna Publishing House, New Delhi (Edition 2018) Civil Engineering III Semester Prepared: 2020-21 21
2. Timoshenko, S., Strength of Materials, Vol. I, CBS, New Delhi.
3.Khurmi, R.S., Strength of Materials, S Chand and Co. Ltd. New Delhi.
4. Ramamurtham, S, Strength of Materials, Dhanpat Rai and sons, New Delhi.
5. Punmia B C, Strength of Materials, Laxmi Publications (p) Ltd. New Delhi.
6. Rattan S.S., Strength of Materials, McGraw Hill Education; New Delhi.

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BIOMASS AND MICRO-HYDRO POWER PLANTS LAB

Course Code	RE5006
Course Title	**Biomass and Micro-Hydro Power Plants Lab**
Number of Credits	1(L-0, T-0, P-2)
Prerequisites	None
Course Category	PC

COURSE OBJECTIVES

1. To learn about biomass resources of our surroundings and conversion of electrical energy from those resources.
2. To know about bio-gas production technology.
3. To learn how to produce electricity from a biogas plant.
4. To learn socio-economic aspects of Biogas usages.

COURSE OUTCOMES

1. After completing the course, the student will be able to:
2. Know various sources of biomass, their fuel value &applications in biomass energy Conversion.
3. Learn the design parameters and applications of different gasify.
4. Know about the components of a bio-gas plant and their functions.
5. Get concept on bio-gas production technology.
6. Produce biogas from a small biogas plant and generate electricity there from.
7. Measure parameters of the biogas plant.
8. Apply biogas in gas engine applications.
9. Interpret the economic aspects of a biogas plant.

List of Practicals

1. Identify the components of Biogas and measure the quantity in percentage.
2. Set up a one cubic meter Anaerobic Digestion Biogas plant.
3. Measure the calorific value of the Biogas.
4. Measure the yield of the Biogas changing the input parameters e.g., temperature, input raw materials.
5. Set up a gas cleaning system with H_2S and H_2O filter.
6. Calculate the efficiency of the Biogas plant.
7. Set up a 1kW gas engine for power generation. And measure the efficiency of the gas engine with Biogas input.
8. Assemble a micro hydro power plant and then dismantle it.
9. Identify the routine maintenance parts of the large hydro power plant after watching a video programme
10. Identify the routine maintenance parts of the micro hydro power plant after watching a video programme.

DRAWING AND SURVEY LAB

Course Code	RE 50071
Course Title	Drawing And Survey lab
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	NIL
Course Category	PE

COURSE OBJECTIVES:
Following are the objectives of this course:

- To understand types of surveying works required
- To know the type of method and equipment to be used for different surveys
- To know the use and operational details of various surveying equipment.

COURSE OUTCOMES:
After completing this course, student will be able to:

1. Select the type of survey required for given situation.
2. Compute area of open field using chain, tape and cross staff.
3. Conduct traversing in the field using chain and compass.
4. To learn the basic principles of building planning and drawing.
5. To make graphical representation of various components of buildings.
6. To study complete plan and elevation of a building.

COURSE CONTENTS:

1. Measure distance between two survey stations using chain, tape and ranging rods when two stations are intervisible.
2. Undertake reciprocal ranging and measure the distance between two stations.
3. Undertake simple levelling using dumpy level/ Auto level and levelling staff.
4. Undertake differential levelling and determine Reduced Levels by Height of instrument method and Rise and fall method using dumpy level/Auto Level and levelling staff.
5. Draw various types of lines, graphical symbols for materials, doors and windows, symbols for sanitary, water supply and electrical installations and write abbreviations as per IS962.
6. Write summary of observations of all technical details from the given drawing (One/Two BHK) obtained from the professional architect or civil engineer (Group activity in four students).
   a) Measure the units of existing building (Load Bearing / Frame structure).
   b) Draw Line Plan of measured existing building at serial no 3a to the suitable scale.
7. Draw Line Plan to suitable scale (Minimum 1BHK, Staircase, WC and Bathroom) a) Residential Bungalows (Minimum three plans) b) Apartment (Minimum two plans).
8. Draw line plans to suitable scale for any Five Public Buildings from the following (School Building, Primary Health Centre, Bank, Post Office, Hostel, Restaurant, Community Hall and Library)
9. Draw the following plans for a Framed Structure (One/Two BHK) from given line plan.
10. Developed plan, Elevation Section for above developed plan.
11. Site plan for above drawings including area statement, schedule of opening and construction notes B. Full Imperial Size Sheet(A1)

SUGGESTED LEARNING RESOURCES

1. Shah. M.G. Kale, CM, Patki, S.Y., Building Drawing, McGraw Hill Publishing
2. Malik and Mayo, Civil Engineering Drawing, Computech Publication Ltd
3. M. G. Shah and C. M. Kale, Principles of Perspective Drawing, McGraw Hill
4. Swamy, Kumara; Rao, N, Kameshwara, A., Building Planning and Drawing, Charotar Publication, Anand.
5. Bhavikatti, S. S., Building Construction, Vikas Publication House Pvt. Ltd., Delhi.
6. Punmia, B.C, Jain, Ashok Kumar; Jain, Arun Kumar, Surveying I, Laxmi Publications., New Delhi.

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RENEWABLE ENERGY INSTRUMENTATION APPLICATION LAB

Course Code	RE50072
Course Title	Renewable Energy Instrumentation Application Lab
Number of Credits	1(L-0, T-0, P-2)
Prerequisites	None
Course Category	PE

COURSE OBJECTIVES:

1. To learn efficient operation of various types of instruments utilized for renewable power applications.
2. To know the characteristics of different instruments and their specific use.

COURSE OUTCOMES:

After completing the course, the student will be able to:

1. Know the characteristics and specification of different instruments.

2. Know the principle of operation, advantages, disadvantages of different process parameter like Displacement, Force, Pressure, Temperature, Level, Flow etc.

3. Identify different measuring instruments related to specific plant.

4. Use instruments for specific applications.

5. Operate various types of instruments in renewable power applications.

List of Practicals:

1. Study of different instruments specification for displacement, force, level, pressure, flow measuring system.
2. Experiment to plot and analyse the characteristics curve of strain gauge.
3. Experiment to plot and analyse the characteristics curve of LVDT with distance as input.
4. Experiment to plot the load cell characteristics using different load as input.
5. Experiment to measure level of a tank using Gauge glass, Rotameter and Differential Pressure Transmitter.
6. Experiment to measure level of a tank using Displacer, Ultrasonic level meter.
7. Experiment to measure the flow of liquid using Rotameter, and Differential Pressure Transmitter.
8. Experiment to measure the temperature using Pt100 and Thermocouple.
9. Identification of different parts of C type burdon tube pressure gauge.
10. Study of operation of dead weight tester and calibration of pressure gauge using it.

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ELECTRICAL MACHINE AND MEASUREMENTLAB

Course Code	RE50081
Course Title	Electrical Machine and Measurement Lab
Number of Credits	1.5(L-0, T-0, P-3)
Prerequisites	None
Course Category	PE

COURSE OBJECTIVES

1. To understand the fundamental concepts of Electrical machines used in renewable power generation and transmission technology.
2. To know the operations of some basic instruments essential for use in power system.

COURSE OUTCOMES

After completing the course, the student will be able to:

1. Describe the constructional details and working principles of DC machines, AC machines, and Transformers.
2. Test DC and AC machines, power transformers, and instrument transformers.
3. Evaluate the performance of DC and AC machines and Transformers by conducting different tests.
4. Decide the suitability of DC and AC machines for use in renewable power plants.
5. Write specifications of DC machines, AC machines, and Transformers as required.
6. Maintain electrical machines in industry and captive plants.

PRACTICLES

1. Identify the different parts of a DC machine and make a report on it.
2. Perform experiment for speed control of a DC shunt motor below and above its rated speed.
3. Identify the different parts of a single-phase transformer and make a report on it.
4. Identify the different parts of a 3-phase induction motor and make a report on it.
5. Perform experiment to plot the O.C.C. of an alternator and observe the effect of excitation and speed on induced e.m.f.
6. Perform experiment to synchronise two 3-phase alternators by – a) Three lamp method or b) Synchroscope and to study the sharing of load between the alternators.
7. Perform experiment to measure 3-phase power of balanced 3-phase load by 2-wattmeter method.

8.Perform experiment to measure current ratio, voltage ratio, and polarity test of CT and PT.

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ENERGY STORAGE LAB

Course Code	RE50082
Course Title	Energy Storage Lab
Number of Credits	1.5(L-0, T-0, P-3)
Prerequisites	None
Course Category	PE

Course Objectives:

1. To learn the characterization of different types of battery.
2. To know about thermal storage and pumped storage systems.
3. To maintain efficient use of battery & other solar power storage systems generating electrical power.

Course Outcomes:

After completing the course, the student will be able to:

1. Use different batteries knowing their electrical characteristics.
2. Apply thermal storage systems storing energy and to generate electrical power.
3. Apply pumped storage systems storing energy and to generate electrical power.
4. Apply compressed gas storage systems storing energy and to generate electrical power.
5. Compare the energy storage suitability between different storage methods.

List of Practicals:

1. Study the parts of a Lead-Acid battery, Ni-Cd battery and Li-ion battery.
2. Connect batteries in different connections to verify its Voltage & Ampere-hour.
3. Experiment for Charging & Discharging characterisation of a Lead-Acid battery and its parameters.
4. Experiment for Charging & Discharging characterisation of a Ni-Cd battery and its parameters.
5. Experiment for Charging & Discharging characterisation of a Li-ion battery and its parameters.
6. Experiment to study different parts of a thermal storage system.
7. Experiment to apply thermal storage principle for solar collector.
8. Experiment to apply thermal storage principle for solar water heater.
9. Experiment to study different parts of a pumped storage system.
10. Experiment to study different parts of a compressed gas storage system.

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GOVERNMENT OF RAJASTHAN

BOARD OF TECHNICAL EDUCATION RAJASTHAN JODHPUR

SEMESTER SCHEME-2020-21

VI SEMESTER

(SESSION 2021-2022 & ONWARDS)

ENTREPRENEURSHIP AND START-UPS

Course Code	RE- 6111(Common in all branches of Engg.)
Course Title	Entrepreneurship and Start-ups
Number of Credits	4 (L-3, T-1, P-0)
Prerequisites (Course code)	None
Course Category	HS

COURSE LEARNING OBJECTIVES:

1. Acquiring Entrepreneurial spirit and resourcefulness.
2. Familiarization with various uses of human resource for earning dignified means of living.
3. Understanding the concept and process of entrepreneurship-its contribution and role in the growth and development of individual and the nation.
4. Acquiring entrepreneurial quality, competency, and motivation.
5. Learning the process and skills of creation and management of entrepreneurial venture.

LEARNING OUTCOME:

Upon completion of the course, these students will be able to demonstrate knowledge of the following topics:

1. Understanding the dynamic role of entrepreneurship and small businesses
2. Organizing and Managing a Small Business
3. Financial Planning and Control
4. Forms of Ownership for Small Business
5. Strategic Marketing Planning
6. New Productor Service Development
7. Business Plan Creation

COURSE CONTENTS:

1. INTRODUCTION TO ENTREPRENEURSHIP AND START–UPS

- 1.1. Definitions, Traits of an entrepreneur, Intrapreneurship, Motivation
- 1.2. Types of Business Structures,
- 1.3. Similarities / differences between entrepreneurs and managers.

2. BUSINESS IDEAS AND THEIR IMPLEMENTATION

- 2.1. Discovering ideas and visualizing the business
- 2.2. Activity map
- 2.3. Business Plan

3. IDEA TO START-UP

- 3.1. Market Analysis– Identifying the target market,
- 3.2. Competition evaluation and Strategy Development,
- 3.3. Marketing and accounting,
- 3.4. Risk analysis

4. MANAGEMENT

- 4.1. Company's Organization Structure,
- 4.2. Recruitment and management of talent.
- 4.3. Financial organization and management

5. FINANCING AND PROTECTION OF IDEAS

- 5.1. Financing methods available for start-ups in India
- 5.2. Communication of Ideas to potential investors– Investor Pitch
- 5.3. Patenting and Licenses

6. EXIT STRATEGIES FOR ENTREPRENEURS, BANKRUPTCY, AND SUCCESSION ANDHARVESTING STRATEGY

SUGGESTED LEARNING RESOURCES:

S. No.	Title of Book	Author	Publication
1.	The Start-up Owner's Manual: The Step by-Step Guide for Building a Great Company	Steve Blank and Bob Dorf	K & S Ranch ISBN–978-0984999392
2.	The Lean Start-up: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses	Eric Ries	Penguin UK ISBN–978-0670921607
3.	Demand: Creating What People Love Before They Know They Want It	Adrian J. Slywotzky with Karl Weber	Headline Book Publishing ISBN–978-0755388974
4.	The Innovator's Dilemma: The Revolutionary Book That Will Change the Way You Do Business	Clayton M. Chris Tensen	Harvard business ISBN:978-142219602

SUGGESTEDSOFTWARE/LEARNINGWEBSITES:

a. https://www.fundable.com/learn/resources/guides/startup
b. https://corporatefinanceinstitute.com/resources/knowledge/finance/corporatehstructure/
c.https://www.finder.com/small-business-finance-tips
d. https://www.profitbooks.net/funding-options-to-raise-startup-capital-for-your-business/

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PROJECT MANAGEMENT

CourseCode	RA- 62001(Common in all branches of Engg.)
CourseTitle	Project Management
NumberofCredits	3(L:3,T:0,P:0)
Prerequisites	NIL
CourseCategory	OE

COURSE LEARNING OBJECTIVES

•To develop the idea of project plan, from defining and confirming the project goals and objectives, identifying tasks and how goals will be achieved.

•To develop an understanding of key project management skills and strategies.

COURSE OUTCOMES

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

CO1	Understand the importance of projects and its phases.
CO2	Analyze projects from marketing, operational and financial perspectives.
CO3	Evaluate projects based on discount and non-discount methods.
CO4	Develop network diagrams for planning and execution of a given project.
CO5	Apply crashing procedures for time and cost optimization.

COURSE CONTENTS

1. CONCEPT OF A PROJECT:

- 1.1. Classification of projects
- 1.2. Importance of project management
- 1.3. The project Life cycle
- 1.4. Establishing project priorities (scope-cost-time)
- 1.5. Project priority matrix
- 1.6. Work break down structure.

2. CAPITAL BUDGETING PROCESS:

- 2.1. Planning -Analysis-Selection-Financing-Implementation-Review.
- 2.2. Generation and screening of project ideas
- 2.3. Market and demand analysis
- 2.4. Demand forecasting techniques.
- 2.5. Market planning and marketing research process
- 2.6. Technical analysis

3. FINANCIAL ESTIMATES AND PROJECTIONS:

- 3.1. Cost of projects
- 3.2. Means of financing
- 3.3. Estimates of sales and production-cost of production
- 3.4. Working capital requirement and its financing
- 3.5. Profitability project, cash flow statement and balance sheet.
- 3.6. Breakeven analysis.

4. BASIC TECHNIQUES IN CAPITAL BUDGETING:

- 4.1. Non discounting and discounting methods
- 4.2. pay-back period
- 4.3. Accounting rate of return

4.4. Net present value
4.5. Benefit cost ratio
4.6. Internal rate of return.
4.7. Project risk.
4.8. Social cost benefit analysis and economic rate of return.
4.9. Non-financial justification of projects.

5. PROJECT ADMINISTRATION:

5.1. Progress payments,
5.2. Expenditure planning,
5.3. Project scheduling and network planning,
5.4. Use of Critical Path Method (CPM),
5.5. Schedule of payments and physical progress,
5.6. time-cost trade off.
5.7. Concepts and uses of PERT
5.8. Cost as a function of time,
5.9. Project Evaluation and Review Techniques
5.10. Cost mechanisms.
5.11. Determination of least cost duration.
5.12. Post project evaluation.
5.13. Introduction to various Project management software.

REFERENCE BOOKS

1.Project planning, analysis, selection, implementation and review –Prasannachandra–Tata McGraw Hill
2.Project Management – the Managerial Process– Clifford F. Gray& Erik W. Larson McGraw Hill
3.Project management- David I Cleland- McGraw Hill International Edition, 1999
4.Project Management– Gopalakrishnan– McMillan India Ltd.
5.Project Management- Harry – Maylor – Pearson Publication

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RENEWABLE ENERGY TECHNOLOGIES

Course Code	RA- 62002(Common in all branches of Engg.)
Course Title	Renewable Energy Technologies
Number of Credits	3 (L:3, T:0, P:0)
Prerequisites	NIL
Course Category	OE

COURSE LEARNING OBJECTIVES

•To understand present and future scenario of world energy use.
•To understand fundamentals of solar energy systems.
•To understand basics of wind energy.
•To understand bio energy and its usage in different ways.
•To identify different available non-conventional energy sources.

COURSE OUTCOMES

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

CO1	Understand present and future energy scenario of the world.
CO2	Understand various methods of solar energy harvesting.
CO3	Identify various wind energy systems.
CO4	Evaluate appropriate methods for Bio energy generations from various Bio wastes.
CO5	Identify suitable energy sources for a location.

COURSE CONTENTS

1. INTRODUCTION:

1.1. World Energy Use;
1.2. Reserves of Energy Resources;
1.3. Environmental Aspects OF Energy Utilisation;
1.4. Renewable Energy Scenario in India and around the World;
1.5. Potentials; Achievements/ Applications;
1.6. Economics of renewable energy systems.

2. SOLAR ENERGY:

2.1. Solar Radiation;
2.2. Measurements of Solar Radiation;
2.3. Flat Plate and Concentrating Collectors;
2.4. Solar direct Thermal Applications;
2.5. Solar thermal Power Generation
2.6. Fundamentals of Solar Photo Voltaic Conversion;
2.7. Solar Cells;
2.8. Solar PV Power Generation;
2.9. Solar PV Applications.

3. WIND ENERGY:

3.1. Wind Data and Energy Estimation;
3.2. Types of Wind Energy Systems;
3.3. Performance; Site Selection;

3.4. Details of Wind Turbine Generator;
3.5. Safety and Environmental Aspects.

4. BIO-ENERGY:

4.1. Bio mass direct combustion;
4.2. Bio mass gasifiers;
4.3. Bio gas plants;
4.4. Digesters;
4.5. Ethanol production;
4.6. Bio diesel;
4.7. Cogeneration;
4.8. Bio mass Applications.

5. OTHER RENEWABLE ENERGY SOURCES:

5.1. Tidal energy;
5.2. Wave Energy;
5.3. Open and Closed OTEC Cycles;
5.4. Small Hydro Geothermal Energy;
5.5. Hydrogen and Storage;
5.6. Fuel Cell Systems;
5.7. Hybrid Systems.

REFERENCE BOOKS

1. Non-Conventional Energy Sources, Rai. G. D., Khanna Publishers, New Delhi, 2011.
2. Renewable Energy Sources, Twidell, J.W. & Weir, A., EFN Spon Ltd., UK,2 006.
3. Solar Energy, Sukhatme. S. P., Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.
4. Renewable Energy, Power for a Sustainable Future, Godfrey Boyle, Oxford University Press, U.K., 1996.
5. Fundamental of Renewable Energy Sources, G N Tiwari and M K Ghoshal, Narosa, New Delhi, 2007.
6. Renewable Energy and Environment A Policy Analysis for India, N H Ravindranath, U K Rao, B Natarajan, P Monga, Tata McGraw Hill.
7. Energy and The Environment, R A Ristinen and J J Kraushaar, second edition, John Willey & Sons, New York, 2006.
8. Renewable Energy Resources, J W T Widell and A D Weir, ELBS, 2006.

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PRODUCT DESIGN

Course Code	RA- 63001(Common in all branches of Engg.)
Course Title	Product Design
Number of Credits	3 (L:3, T:0, P:0)
Prerequisites	NIL
Course Category	OE

COURSE LEARNING OBJECTIVES

•To acquire the basic concepts of product design and development process
•To understand the engineering and scientific process in executing a design from concept to finished product
•To study the key reasons for design or redesign.

COURSE OUTCOMES

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

CO1	Understand the basic concepts of product design and development process.
CO2	Illustrate the methods to define thecustomer needs.
CO3	Describe an engineering design and development process.
CO4	Understand the intuitive and advanced methods used to develop and evaluate a concept.
CO5	Apply modelling and embodiment principles in product design and development process.

COURSE CONTENTS

1. DEFINITION OF A PRODUCT

- 1.1. Types of products;
- 1.2. Levels of product;
- 1.3. Product-market mix;
- 1.4. New product development (NPD) process;
- 1.5. Idea generation methods;
- 1.6. Creativity;
  - 1.6.1. Creative attitude;
  - 1.6.2. Creative design process;
- 1.7. Morpho logical analysis;
- 1.8. Analysis of inter-connected decision areas;
- 1.9. Brain storming.

2. PRODUCT LIFECYCLE;

- 2.1. The challenges of Product development;
- 2.2. Product analysis;
- 2.3. Product characteristics;
- 2.4. Economic considerations;
- 2.5. Production and Marketing aspects;
- 2.6. Characteristics of successful Product development;
- 2.7. Phases of a generic product development process;
- 2.8. Customer need identification;
- 2.9. Product development practices and industry-product strategies.

3. PRODUCT DESIGN

3.1. Design by evolution;
3.2. Design by innovation;
3.3. Design by imitation;
3.4. Factors affecting product design;
3.5. Standards of performance and environmental factors;
3.6. Decision making and iteration;
3.7. Morphology of design (different phases);
3.8. Role of aesthetics in design.

4. INTRODUCTION TO OPTIMIZATION IN DESIGN

4.1. Economic factors in design;
4.2. Design for safety and reliability;
4.3. Role of computers in design;
4.4. Modelling and Simulation;
4.5. The role of models in engineering design;
4.6. Mathematical modelling;
4.7. Similitude and scale models;
4.8. Concurrent design;
4.9. Six sigma and design for six sigma;
4.10. Introduction to optimization in design;
4.11. Economic factors and financial feasibility in design;
4.12. Design for manufacturing;
4.13. Rapid Proto typing (RP);
4.14. Application of RP in product design;
4.15. Product Development versus Design.

5. DESIGN OF SIMPLE PRODUCTS DEALING WITH VARIOUS ASPECTS OF PRODUCT DEVELOPMENT;

5.1. Design Starting from need till the manufacture of the product

REFERENCE BOOKS

1.Product Design and Development, Karl T. Ulrichand Steven D. Eppinger, Tata McGraw Hill edition.
2.Engineering Design– George E. Dieter.
3.An Introduction to Engineering Design methods Vijay Gupta.
4.Merie Crawford: New Product management, McGraw-Hill Irwin.
5.Chitale A K and Gupta R C, “Product Design and Manufacturing”, Prentice Hall of India, 2005.
6.Kevin Otto and Kristin Wood, Product Design, Techniques in Reverse Engineering and New Product Development, Pears on education.

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DISASTER MANAGEMENT

Course Code	RA- 63002(Common in all branches of Engg.)
Course Title	Disaster Management
Number of Credits	3 (L: 3, T: 0, P :0)
Prerequisites	NIL
Course Category	OE

COURSE LEARNING OBJECTIVES

Following are the objectives of this course:

•To learn about various types of natural and man-made disasters.
•To know pre and post-disaster management for some of the disasters.
•To know about various information and organizations in disaster management in India.
•To get exposed to technological tools and their role in disaster management.

COURSE OUTCOMES:

1.1. After competing this course, student will be:
1.2. Acquainted with basic information on various types of disasters
1.3. Knowing the precautions and awareness regarding various disasters
1.4. Decide first action to be taken under various disasters
1.5. Familiarised with organization in India which are dealing with disasters
1.6. Able to select IT tools to help in disaster management

COURSE CONTENTS

1. UNDERSTANDING DISASTER

1.1. Understanding the Concepts and definitions of Disaster,
1.2. Hazard,
1.3. Vulnerability,
1.4. Risk,
1.5. Capacity–Disaster and Development,
1.6. Disaster management.

2. TYPES, TRENDS, CAUSES, CONSEQUENCES AND CONTROL OF DISASTERS

2.1. Geological Disasters (earth quakes, landslides, tsunami, mining);
2.2. Hydro-Meteorological Disasters (floods, cyclones, lightning, thunder-storms, hailstorms, avalanches, droughts, cold and heat waves)
2.3. Biological Disasters (epidemics, pest attacks, forest fire);
2.4. Technological Disasters (chemical, industrial, radiological, nuclear)
2.5. Manmade Disasters (building collapse, rural and urban fire, road and rail accidents, nuclear, radiological, chemicals and biological disasters)
2.6. Global Disaster Trends
2.7. Emerging Risks of Disasters
2.8. Climate Change and Urban Disasters.

3. DISASTER MANAGEMENT CYCLE AND FRAME WORK

3.1. Disaster Management Cycle
3.2. Paradigm Shift in Disaster Management.
3.3. Pre-Disaster
3.4. Risk Assessment and Analysis,
3.5. Risk Mapping,
3.6. Zonation and Micro zonation,
3.7. Prevention and Mitigation of Disasters,
3.8. Early Warning System
3.8.1. Preparedness,
3.8.2. Capacity Development;
3.8.3. Awareness.

3.9. During Disaster
- 3.9.1. Evacuation
- 3.9.2. Disaster Communication
- 3.9.3. Search and Rescue
- 3.9.4. Emergency Operation Centre
- 3.9.5. Incident Comm and System
- 3.9.6. Relief and Rehabilitation

3.10. Post-disaster
- 3.10.1. Damage and Needs Assessment,
- 3.10.2. Restoration of Critical Infra structure
- 3.10.3. Early Recovery Reconstruction and Redevelopment;
- 3.10.4. IDNDR, Yokohama Strategy, Hyogo Frame-work of Action.

4. DISASTER MANAGEMENT IN INDIA

4.1. Disaster Profile of India
4.2. Mega Disasters of India and Lessons Learnt.
4.3. Disaster Management Act 2005
4.4. Institutional and Financial Mechanism,
4.5. National Policy on Disaster Management,
4.6. National Guidelines and Plans on Disaster Management;
4.7. Role of Government (local, state and national),
4.8. Non-Government and Inter Governmental Agencies

5. APPLICATIONS OF SCIENCE AND TECHNOLOGY FOR DISASTER MANAGEMENT

5.1. Geo informatics in Disaster Management (RS, GIS, GPS and RS).
5.2. Disaster Communication System (Early Warning and Its Dissemination).
5.3. Land Use Planning and Development Regulations,
5.4. Disaster Safe Designs and Constructions,
5.5. Structural and Non-Structural Mitigation of Disasters
5.6. S & T Institutions for Disaster Management in India

REFERENCES

1.Publications of National Disaster Management Authority (NDMA) on Various Templates and Guide lines for Disaster Management
2.Bhandani, R. K., An over view on natural & man-made disasters and their reduction, CSIR, New Delhi
3.Srivastava, H. N., and Gupta G. D., Management of Natural Disasters in developing countries, Daya Publishers, Delhi
4.Alexander, David, Natural Disasters, Kluwer Academic London
5.Ghosh, G.K., Disaster Management, APH Publishing Corporation
6.Murthy, D. B. N., Disaster Management: Text & Case Studies, Deep & Deep Pvt. Ltd.

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INDIAN CONSTITUTION

CourseCode	RA- 6333(Common in all branches of Engg.)
CourseTitle	Indian Constitution
NumberofCredits	0 (L:2,T:0;P:0)
Prerequisites(Coursecode)	None
CourseCategory	AU

COURSE CONTENT

1. THE CONSTITUTION –

1.1. Introduction
1.2. The History of the Making of the Indian Constitution
1.3. Preamble and the Basic Structure, and its interpretation
1.4. Fundamental Rights and Duties and their interpretation
1.5. State Policy Principles

2. UNION GOVERNMENT

2.1. Structure of the Indian Union
2.2. President– Role and Power
2.3. Prime Minister and Council of Ministers
2.4. Lok Sabha and Rajya Sabha

3. STATE GOVERNMENT

3.1. Governor– Role and Power
3.2. Chief Minister and Council of Ministers
3.3. State Secretariat

4. LOCAL ADMINISTRATION

4.1. District Administration
4.2. Municipal Corporation
4.3. Zila Panchayat

5. ELECTION COMMISSION

5.1. Role and Functioning
5.2. Chief Election Commissioner
5.3. State Election Commission

SUGGESTED LEARNING RESOURCES:

S. No.	Title of Book	Author	Publication
1.	Ethics and Politics of the Indian Constitution	Rajeev Bhargava	Oxford University Press, New Delhi, 2008
2.	The Constitution of India	B. L. Fadia	Sahitya Bhawan; New edition (2017)
3.	Introduction to the Constitution of India	D D Basu	Lexis Nexis; Twenty-Third 2018 edition

SUGGESTED SOFTWARE / LEARNING WEBSITES:

1. https://www.constitution.org/cons/india/const.html
2. http://www.legislative.gov.in/constitution-of-india
3. https://www.sci.gov.in/constitution
4. https://www.toppr.com/guides/civics/the-indian-constitution/the-constitution-of-india/

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DISTRIBUTED GENERATION SYSTEMS

Course Code	RE6001
Course Title	Distributed Generation Systems
Number of Credits	3(L-3, T-0, P-0)
Prerequisites	None
Course Category	PC

COURSE OBJECTIVES

1. To get the concept of distributed generation.
2. To learn concept of Microgrid for power distribution.
3. To know the distributed energy sources and their integration to Microgrid.

COURSE OUTCOMES

After completing the course, the student will be able to:

1. Explain the concept of distributed generation systems.
2. Understand the Microgrid system and their control schemes.
3. Identify distributed energy sources and their monitoring in Microgrid.
4. Learn the way of efficient use of distributed sources and power.

COURSE CONTENTS

1. **DISTRIBUTED GENERATION AND MICROGRID**
   - 1.1 Introduction
   - 1.2 Integration of distributed generation to Grid
   - 1.3 Concepts of Micro Grid
   - 1.4 Typical Microgrid configurations, AC and DC micro grids
   - 1.5 Interconnection of Microgrids
   - 1.6 Technical and Economic advantages of Microgrid
   - 1.7 Concept of Electric Grid
2. **DISTRIBUTED ENERGY RESOURCES**
   - 2.1 Introduction
   - 2.2 Combined heat and power (CHP) generation
   - 2.3 Solar photovoltaic (PV) systems
   - 2.4 Wind energy conversion systems (WECS)
   - 2.5 Small-scale hydroelectric power generation
   - 2.6 Storage devices - Batteries, Ultra capacitors, Flywheel energy storage system in Microgrids
   - 2.7 Functions of Central Controller (CC) and Micro source Controllers (MCs)
   - 2.8 Active and reactive power control, Voltage control
   - 2.9 Load sharing through power-frequency control
3. **PROTECTION ISSUES FOR MICROGRIDS**

3.1 Introduction
3.2 Islanding, Different islanding scenarios
3.3 Major protection issues of standalone Microgrid
3.4 Adaptive protection for Microgrid
3.5 Impact of DG integration on electricity market, environment and distribution system
3.6 Communication standards and protocols

4. **ELECTRICITY PRICING**
4.1 Electricity tariff - one part tariff, two-part tariff, maximum demand tariff, power factor tariff
4.2 Concept of Dynamic pricing, Time of-use (TOU) pricing, Critical-peak pricing (CPP), Real Time Pricing
4.3 Automatic Meter Reading (AMR)
4.4 Plug in Hybrid Electric Vehicles (PHEV)
4.5 Intelligent Electronic Devices (IED) and their application for monitoring & protection

5. **POWER QUALITY ISSUES**
5.1 Energy efficient end use devices
5.2 Load Curves, Load Shaping Objectives, Load Shaping methodologies
5.3 Types of power quality disturbances - Voltage sag (or dip), Transients, Short and Long duration voltage variation, Voltage imbalance, Waveform distortion, Harmonic sources (Numerical Problems)

REFERENCES/SUGGESTED LEARNING RESOURCES

1. Ali Keyhani, “Design of Smart Power Grid Renewable Energy Systems”, Wiley.
2. James Momoh, “Smart Grid: Fundamentals of Design and Analysis”, Wiley.
3. R. C. Durgan, M. F. Me Granaghen, H. W. Beaty, “Electrical Power System Quality”, McGraw-Hill.
4. Remus Teodorescu, Marco Liserre, Pedro Rodriguez, “Grid Converters for Photovoltaic and Wind Power Systems”, Wiley.
5. S. Chowdhury, S.P. Chowdhury and P. Crossley, “Microgrids and Active Distribution Networks”, ISBN 978-1-84919- 014-5, IET, 2009.
6. J. B. Gupta, “Power System”, S. K. Kataria & Sons.

EMERGING RENEWABLE ENERGY TCHNOLOGIES

Course Code	RE6002
Course Title	**EMERGING RENEWABLE ENERGY TCHNOLOGIES**
Number of Credits	1(L-0, T-0, P-2)
Prerequisites	None
Course Category	**PC**

COURSE OBJECTIVES

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences.

 Maintain the efficient operation of various renewable energy power plants.

COURSE OUTCOME

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry-oriented COs associated with the above-mentioned competency:

a) Maintain the optimized working of solar PV and CS power plants.

b) Maintain the optimized working of large wind power plants

c) Maintain the optimized working of small wind turbines.

d) Maintain the optimized working of biomass-based power plants

List of Practicals:

1. Identify the components of Flat plate collector, Evacuated tube collector, and solar dryer
2. Use pyrometer for measurement of solar radiation flux density.
3. Assemble solar PV system with and without battery connection.
4. Measure heat output, Maximum power, power output efficiency of solar PV panel
5. Use vane Anemometer for measurement of different locations for site selection for wind mill.
6. Assembly / Dismantle a horizontal axis small wind turbine
7. Assembly / Dismantle a biogas power system
8. Assembly / Dismantle a biomass gassifier power system
9. Assembly / Dismantle a wind solar hybrid system