B.Voc. RENEWABLE ENERGY

Course Duration:

4 Years– 8 Semesters - Multiple Entry and Exit Option

Eligibility Criteria:

Admission to I Year:

A Pass in Higher Secondary Examination in any stream (or) its equivalent.

II Year Admission (Lateral Entry)

As the B.Voc. Porgramme has multiple entry and exit options, students who have passed Diploma in any Engineering discipline are eligible for direct admission to II Year leading to Advanced Diploma in Renewable Energy and B.Voc. Renewable Energy.

IV Year Admission (Lateral Entry)

A candidate with 3 year B.Voc. or Bsc in approporiate domain with NHEQF level 7/UCF level 5.5 completed.

Exit Options

I Semester	-	Certificate Course in Renewable Energy
I Year	-	Diploma in Renewable Energy
II Year	-	Advanced Diploma in Renewable Energy
III Year	-	B.Voc in Renewable Energy
IV Year	-	B.Voc (Hons.) in Renewable Energy

Maximum number of Seats: 50

Semester- I

Course Code	Course Title	No. of Credits	L	T	P	Max. Marks		
						MSE	ESE	TOTAL
24REVC1101	Energy Sources	2	2	0	0	20	30	50
24REVC1102	Basic Mathematics	4	4	0	0	40	60	100
24REVC1103	Fluid and Heat Transfer Physics	3	3	0	0	40	60	100
24ENVA1101	Essential English : Basic	3	3	0	0	40	60	100
Skill Component	**Clean Cookstove Sales and Maintenance Executive**							
24REVC1104	Clean Cook Stoves : Design, Fabrication and Maintenance	4	2	1	1	40	60	100
24REVC1105	Sustainable Marketing Approaches for clean cook stoves	4	2	1	1	60	40	100
24REVC1106	Solar Thermal Laboratory	4	0	0	4	60	40	100
24REVC1107	Physics Practical	2	0	0	2	30	20	50
24REVC1108	Workshop Practice	3	0	0	3	60	40	100
24PEUV1101	Health and Fitness / Fine Arts / NSS / Shanti Sena	1	0	0	1	50	0	50
	Total	**30**						

Semester- II

Course Code	Course Title	No. of Credits	L	T	P	Max. Marks		
						MSE	ESE	Total
24REVC1201	Wind Energy	4	4	0	0	40	60	100
24REVC1202	Sustainable Chemistry	3	3	0	0	40	60	100
24REVC1203	Basic Electrical and Electronics	2	0	2	0	20	30	50
24ENVA1201	Essential English : Intermediate	3	3	0	0	40	60	100
Skill Component	Wind Resource Assessor and Site Surveyor-Wind Power Plant							
	Digital Marketing	3	2	0	1	48	52	100
24REVC1204	Site survey and Installation of Wind Power Plants	4	2	1	1	60	40	100
24REVC1205	Wind Energy Laboratory	4	0	0	4	60	40	100
24REVC1206	Electrical and Electronics Laboratory	4	0	0	4	60	40	100
24REVC1207	Engineering Drawing	3	0	0	3	30	20	50
	Total	**30**						

NCRF / UCF Credit Level:

S.No.	Year	NCRF / UCF Credit Level
1	**I Year**	**4.5**

Semester- III

Course Code	Course Title	No. of Credits	L	T	P	Max. Marks		
						MSE	ESE	Total
	Soft Skills	2	1	1	0	50	0	0
24REVC2101	Environmental Science	4	3	0	1	40	60	100
24REVC2102	Electrical Generation and Distribution	3	3	0	0	40	60	100
24REVC2103	Instrumentation for Renewable Energy Power Plants	3	2	1	0	40	60	100
Skill Component	**Solar PV Engineer (Option: Solar Water Pumping System)**							
24REVC2104	Solar Energy	4	4	0	0	40	60	100
24REVC2105	Site survey and installation of Solar PV Power Plants	4	2	1	1	60	40	100
24REVC2106	Solar PhotoVoltaic Laboratory	4	0	0	4	60	40	100
	Web Designing	3	0	0	3	40	60	100
24REVC2107	Solar Photovoltaic Power Plant Field Visit	2	0	0	2	50	0	50
24YOUV2101	Hatha Yoga Education	1	0	0	1	50	0	50
	Total	**30**						

Semester- IV

Course Code	Course Title	No. of Credits	L	T	P	Max. Marks		
						MSE	ESE	Total
24REVC2201	Grid issues in Renewable Energy Sources	3	3	0	0	40	60	100
24REVC2202	Waste To Energy Conversion Technologies	3	3	0	0	40	60	100
24REVC2203	Energy Auditing and Conservation	3	2	1	0	40	60	100
24REVC2204	Advanced Renewable Energy Technologies	3	3	0	0	40	60	100
Skill Component	**Manager- Waste Management**							
24REVC2205	Electrical Maintenance Laboratory	4	0	0	4	60	40	100
24REVC2206	Site survey and installation of Waste to Energy Power Plants	3	2	0	1	60	40	100
24REVC2207	Waste to Energy Laboratory	3	0	0	3	60	40	100
24REVC2208	Safety Practices in Renewable Energy Project Site	2	0	2	0	30	20	50
24REVC2209	In-plant Training (Solar/Wind/Bio energy Power Plant O&M)	6	0	0	6	60	40	100
	Total	**30**						

NCRF / UCF Credit Level:

S.No.	Year	NCRF / UCF Credit Level
1	II Year	5

Semester - V

Course Code	Course Title	No. of Credits	L	T	P	Max. Marks		
						MSE	ESE	Total
24REVC3101	Smart Grid	3	3	0	0	40	60	100
24REVC3102	Small Hydro Power Plants	2	2	0	0	20	30	50
24REVC3103	Project Planning and Cost Estimation	2	2	0	0	20	30	50
24REVC3104	Energy Economics	3	3	0	0	40	60	100
	Gandhi's Life, Thought and Work	2	2	0	0	20	30	50
24REVC3105	Entrepreneurial Pathways in Renewable Energy Sector	3	0	0	3	60	40	100
24REVC3106	Fundamentals of Green Hydrogen	3	2	0	1	40	60	100
24REVC3107	Mini Project	4	0	0	4	60	40	100
24REVC3108	Software simulation laboratory	2	0	0	2	30	20	50
24REVC3109	In Plant Training [Renewable Energy business development strategies]	6	0	0	6	60	40	100
	Total	**30**						

Semester- VI

Course Code	Course Title	No. of Credits	L	T	P	Max. Marks		
						MSE	ESE	Total
24REVC3201	Environmental Impact Assessment	3	3	0	0	40	60	100
24REVC3202	Green Buildings	3	3	0	0	40	60	100
24REVC3203	Energy Storage	3	3	0	0	40	60	100
24REVC3204	Universal Human Values and Professional Ethics	3	3	0	0	40	60	100
Skill Component	**Solar PV Project Manager (E&C)**							
24REVC3205	Renewable Energy Product Development	10	0	0	10	125	75	200
24REVC3206	Industrial Training	8	0	0	8	125	75	200
	Total	**30**						

NCRF / UCF Credit Level:

S.No.	Year	NCRF / UCF Credit Level
1	**III Year**	**5.5**

Semester -VII

Course Code	Course Title	No. of Credits	L	T	P	Max. Marks		
						MSE	ESE	Total
24REVC4101	Thermal Engineering	3	3	0	0	40	60	100
24REVC4102	Power Electronics	3	3	0	0	40	60	100
24REVC4103	Engineering Mathematics	3	3	0	0	40	60	100
24REVC4104	Electrical Machines	3	3	0	0	40	60	100
Skill Component	**Solar PV Designer**							
24REVC4105	Electrical Vehicle Operation and Maintenance	4	2	0	2	60	40	100
24REVC4106	Transmission and Distribution for Electrical Networks	4	2	0	2	60	40	100
24REVC4107	PLC and Programming	4	0	2	2	60	40	100
24REVC4108	Computer Aided Designing	3	2	0	1	60	40	100
24REVC4109	Advances in PV System Design	3	0	0	3	60	40	100
	Total	**30**						

Semester- VIII

Course Code	Course Title	No. of Credits	L	T	P	Max. Marks		
						MSE	ESE	Total
24REVC4201	Control System Engineering	3	3	0	0	40	60	100
24REVC4202	Structural Design for Renewable Energy Systems	3	3	0	0	40	60	100
24REVC4203	High Voltage Engineering	3	3	0	0	40	60	100
24REVC4204	Strength of Materials	3	3	0	0	40	60	100
Skill Component	**Advances in Renewable Energy Systems**							
24REVC4205	Advances in Wind Energy Conversion System	2	0	0	2	60	40	100
24REVC4206	Advances in Biomass Energy Conversion System	2	0	0	2	60	40	100
24REVC4207	Advances in Green Hydrogen	2	0	0	2	60	40	100
24REVC4208	Advances in Electrical Vehicles	2	0	0	2	60	40	100
24REVC4209	Dissertation	10	0	0	10	125	75	200
	Total	**30**						

NCRF / UCF Credit Level:

S.No.	Year	NCRF / UCF Credit Level
1	**IV Year**	**6**

Semester- I

24REVC1101 ENERGY SOURCES L 2 T 0 P 0

OBJECTIVE:

To help students to get a better knowledge about the various forms energy sources available.

UNIT I- INTRODUCTION

Forms of energy – Advantages and disadvantages – Traditional energy systems – Applications: transport, agriculture, human power – conventional and non-conventional energy sources

UNIT II- NON-RENEWABLE ENERGY

Non-renewable energy sources – Fossil Fuels, coal, petroleum, natural gas – Thermal power generation – Nuclear power generation – Advantages and disadvantages

UNIT III- RENEWABLE ENERGY

Renewable energy sources – Solar – Wind – Hydro – Geothermal energy – Ocean thermal energy – Advantages and disadvantages

UNIT IV- POWER PLANT ENGINEERING

Load Duration Curve – Load factor – Capacity factor – Reserve factor – Demand Factor – Diversity factor –Plant use factor – Location of power plants – Problems

UNIT V- POWER GENERATION

Decentralized power generation –Concept – Cogeneration – Definition – Need – Application – Advantages – Classifications

TEXT BOOK:

- Rai, G.D., "Non-Conventional Sources of Energy", Khanna Publishers, Delhi 1995.

REFERENCES:

1. Rao S, Parulekar B.B, “Energy Technology – Non conventional, Renewable and Conventional” Khanna Publishers, 1999
2. D.P.Kothari “Renewable energy sources and emerging technologies” second edition
3. H.G. Stoll, “Least Cost Electrical Utility / Planning”, John Wiley & Sons, 1989
4. N.K.Bansal “Decentralised energy, options and technology” omega scientific publisher, 1993

LEARNING OUTCOMES:

- At the end of this course students will get gain knowledge about the various energy sources

24REVC1102 BASIC MATHEMATICS L 4 T 0 P 0

OBJECTIVE

To learn the fundamentals of Set theory, Matrices, Central Tendencies, Transportation problem and Assignment problem.

Specific outcome of learning:

- The learner will gain basic knowledge on fundamentals of set theory
- The learner will gain knowledge of Matrices
- The learner will become proficient in measures in central tendencies
- The learner will acquire skills of transportation problems
- The learner will gain the concepts of the assignment problem and travelling sales man problem

Unit 1: **Set Theory:** Types of Sets – Operations on sets – Laws of set operation – Simple Problems

Unit 2: **Logics:** Introduction – Connectives - Truth tables - Tautology implication and equivalence of formulae

Unit 3: **Limits:** Limits of a function – Evaluation of limits – standard results - Properties of limits –Simple problems.

Unit 4: **Measures of Central Tendencies:** Arithmetic Mean - Geometric Mean - Harmonic Mean - Median and Mode.

Unit 5: **Games and Strategies:** Introduction, Two-Person Zero-Sum Games- Some Basic Terms, MaxMin- MiniMax Principle- Games without Saddle Points – Mixed Strategies-- Graphic Solution of 2xn and mx2Games- Dominance Property.

Text Books:

- M. K. Venkataraman, N. Sridharan, N. Chadrasekaran, Discrete Mathematics, The National Publishing Company, 2012
  Unit 1: Chapter I, Sec: 1 -6
  Unit 2: Chapter IX, Sec: 1-8
- Rangaraj G, Mallieswari R & Rema B, Business Mathematics, Cengage, 2020
  Unit 3: Chapter 16, Sec: 16.1 – 16.5
- RSN Pillai & Bhagavathi, Statistics, S.Chand & Company Ltd, New Delhi 2013.
  Unit 3: Chapter 9, Pg.No: 124 -240
- Kanti Swarup, P.K. Gupta, Man Mohan, Operations Research, Sultan Chand & Sons, 2017
  Unit 5: Chapter 17, Sec: 17.1 – 17.7

Reference Books:

- P. K. Gupta & D. S. Hira, **Operations Research**, S. Chand & Company Ltd., New Delhi, 2013.
- J. K. Sharma, **Operations Research theory and its applications**, 2nd Edition, Macmillan,

New Delhi, 2006.
- R. Panneerselvam, **Operations Research**, Prentice Hall of India Pvt. Ltd., New Delhi, 2002.

24REVC1103 FLUID AND HEAT TRANSFER PHYSICS L 3 T 0 P 0

OBJECTIVES:

To impart basic knowledge on properties of fluids which are used in the solar appliances and to give them enough information about basic heat principles and heat transfer mechanisms which are also vital for the study of solar collectors/water heater and other thermal applications.

The students will be imparted knowledge of

CO 1: the flowing properties of fluids and energy of fluid when flowing
CO 2: applying the Bernoulli's principle on the fluids used for study
CO 3: viscous properties and measuring viscosity as well as comparing the viscosities of Fluids
CO 4: surface tension of liquids and determination of its values experimentally
CO 5: basic concepts of heat, thermometry and calorimetry
CO 6: the measuring techniques of temperature and specific heat
CO 7: the calorific value of fuels and its measurement
CO 8: the heat transfer mechanisms such as conduction, convection and radiation
CO 9: the measurement and applications of the different heat transfer mechanisms
CO10: the working of pyrometers and pyrheliometers
CO11: measuring the solar constant and the temperature of the Sun

UNIT I : FLOW OF LIQUIDS-VISCOSITY: Rate of flow of fluid- Stream lined and turbulent motion-Equation of continuity of flow-Energy of a liquid in flow-Bernoulli's Theorem-Proof-Applications of Bernoulli's theorem: Velocity of efflux-Torricelli's Theorem. **Viscosity**: – Coefficient of viscosity – critical velocity – Reynolds number and its significance – Poiseuille's equation – experimental determination of viscosity: Poiseuille's method, Stokes method, Ostwald's viscometer, Rankine's method for air (**10 Lectures**)

UNIT II:SURFACE TENSION:– Molecular range- Explanation – surface film and surface energy – Free energy of a surface – Excess of pressure inside the drops and bubbles – Rise of a liquid in a capillary tube – Experimental determination of surface tension – Jaeger's method, Drop weight method and capillary rise method. **(10 Lectures)**

UNIT III: Concept of heat and temperature-**Thermometry:** types of thermometers-Centigrade, Farenheit and Rankine scales-relation between the scales of temperature-Platinum resistance thermometer-Callender and Griffith's bridge-low temperature and high temperature measurement. **Calorimetry**: specific heat -method of mixture for determination of specific heat of solids and liquids-Newton's law of cooling-Calorific value of fuels-Bomb calorimeter. (**10 Lectures)**

UNIT IV : Transmission of Heat- **Conduction:** coefficient of thermal conductivity 'K'-Searle's method, Forbe's method for good conductors-Lee's disc method for a bad conductor-radial flow of heat-cylindrical flow of heat-Wiedmann-Franz law. (**9 Lectures)**

UNIT V :Convection: Applications-central heating systems-**Thermal radiation:** properties-emissive power-absorptive power-transmitting power-relation between the three-Kirchoff's law-proof-experimental verification-Ritchie's experiment-Pyrometers-disappearing filament pyrometer-solar constant-Pyrheliometer-water flow Pyrheliometer -temperature of Sun

(**9 Lectures)**

Total Lectures 48

Text books:

1. Elements of Properties of Matter by D.S.Mathur, S.Chand and Company Ltd.

2. Properties of Matter by Brijlal and N.Subramanyam, S.Chand and Company Ltd.

3. Heat and Thermodynamics by D.S. Mathur, Sultan Chand & Sons Educational publishers, NewDelhi.

4. Heat, Thermodynamics and Statistical Physics by Brijlal, N.Subramanyam and P.S. Hemne, S.Chand & Company PVT Ltd Reprint on 2014.

24ENVA1101 **Essential English : Basic** **L 3 T 0 P 0**

OBJECTIVES:

- To improve the English language skills of students with very limited abilities to use the language; and
- To focus on the language skills of the learners in a graded manner.

UNIT I GRAMMAR

- What is Grammar?
- The Capital Letter
- Nouns & Pronouns

UNIT II LISTENING

- Teacher Narrations

UNIT III SPEAKING SKILLS

- Self-Introduction
- Descriptions of persons, objects, places

UNIT IV READING & VOCABULARY

- Graded reading comprehension passages

UNIT V WRITING SKILLS

- Sentence Construction
- Descriptive Paragraph writing

TEXTBOOK:

General English I Textbook/Course Material - Prepared by the School.

REFERENCE BOOK:

Seaton, Anne & Y.H. Mew. *Basic English Grammar Book 1.* Irvine: Saddleback, 2007. Print.

24REVC1104 Clean Cook Stoves : Design, Fabrication and Maintenance L 2 T 1 P 1

Objective:

The objectives of this course are in summary, to:

1. Equip participants with knowledge to understand the principles and concepts of cookstoves, fuels and fire
2. Enable participants to learn and understand the parameters relevant for testing and evaluation of cookstoves and how they relate to each other
3. Build the skills of the participants on the use of hand tools and equipment for cookstove design, development and manufacture and the risk associated with them.
4. Guide participants to identify the appropriate materials for cookstoves development and manufacture
5. Equip participants to understand and apply the design process and support them to prepare technical and business plan for solving a challenge.

Unit-I Understanding Theoretical Concepts of Cookstoves

History cookstoves and how different types of cookstoves have evolved over the years, Cookstoves concepts and definitions , Principles of cookstove design and development (heat enclosure, heat transfer, fuels, fire, etc.) , Environmental, health, social and economic factors associated with the use of cookstoves.

Unit- II Parameters for identifying a good stove

Power output ,Thermal efficiency ,Ease of starting fire ,Energy consumption ,Fire power , Emission (CO, CO2, PM 2.5) ,Global warming impact, energy content and heat capacity.

Unit- III Materials for stove building

Identification of materials (metals, insulators, wood, clay etc.) , Application of materials in the development of the stove.

Unit- IV Design Process

Gather information, Framing the problem, Set design requirements, Generate ideas.

Unit- V Evaluating Stage

Analyse and experiment, Evaluate concept and choose the best idea,Work out the details, Build prototype,Test and evaluate.

Text Books:

1. Clean Cooking Stoves: How to Innovate and Change the World by "Sai Bhaskar N. Reddy".

E-sources:

1. Cleancookstoves.org/technology-and-fuels
2. Aprovecho.org
3. Stoves.bioenergylists.org
4. Oregonlive.com

24REVC1105 Sustainable Marketing Approaches for clean cook stoves L 2 T 1 P1

Objective:

The objectives of this course are in summary, to:

1. Equip participants with knowledge to understand the principles and concepts of cookstoves, fuels and fire
2. Enable participants to learn and understand the parameters relevant for testing and evaluation of cookstoves and how they relate to each other
3. Build the marketing skills of the participants on the use of hand tools and equipment for cookstove design, development and manufacture and the risk associated with them.

Unit I: Introduction to Portable Improved Cookstoves

Definition of Terms: Portable improved cookstove, efficiency, emission. Types of Cookstoves: Different types of portable improved cookstoves. Features and Benefits: Product features and benefits. Warranty and Repair: Applicable warranty, replacement/repair policies

Unit II: Comparative Analysis and Fuel Optimization

Cooking Methods Comparison: Comparison of portable improved cookstoves with other cooking methods. Fuel Types and Usage: Different types of fuels and their required amounts. Fuel Optimization: Proper firing techniques and emission optimization. Cookstove Use: Proper placement of pots on pot rests

Unit III: Customer Interaction and Sales Strategies

Customer Identification: Identifying and interacting with customers. Demonstration: Demonstrating the function of portable improved cookstoves. Sales Strategy: Developing sales strategies based on area demographics, income, biomass usage, and priorities. Communication Skills: Communicating advantages, warranty details, working principles, and health/environmental impacts

Unit IV: Financial Options and Customer Service

Financial Solutions: Exploring financial options for purchase, sales, and resale. Customer Service: Handling maintenance requests and complaints. Problem Resolution: Resolving customer requests and addressing repeated service problems.

Unit V: Safety Practices and Procedures

Personal Protective Equipment (PPE): Proper use of PPE. Hygiene and Safety: Maintaining proper hygiene, handling hot pots, safe removal of ash. Post-Use Instructions: Cooling instructions and other safety practices after use

Reference Books:

- Jacquelyn A. Ottman. 2011. The New Rules of Green Marketing: Strategies, Tools, and Inspiration for Sustainable Branding. Berrett-Koehler Publishers
- Amit Kumar Singh, Priyanka Mahanta. 2021. Green Marketing and Sustainable Development. Mittal Publications.
- Sapna Sugandha, Mr. Chandan Veer, Prof. (Dr.) Pavnesh Kumar. GREEN MARKETING Concept & Cases. ISBN: 9789390640737
- Mike Clifford. 2015. Case Studies on Marketing Sustainable Portable Cook Stoves: Best Practices and Strategies. Global Dimension in engineering Education, Barcelona.
- Gerald Foley. 1985. Improved Cooking Stoves in Developing Countries. Earthscan

LEARNING OUTCOME:

Students will gain knowledge about the marketing approaches for clean cook stoves.

24REVC1106 SOLAR THERMAL LABORATORY L 0 T 0 P 4

OBJECTIVE:

- To carry out the performance evaluation of solar thermal systems

1. Study on greenhouse effect on solar flat plate collector
2. Estimation of instantaneous efficiency of a solar liquid flat plate collector
3. Performance evaluation of solar cooker
4. Performance evaluation of a series flat plate collector
5. Performance evaluation of a solar flat plate collector in parallel
6. Study of solar air heater
7. Estimation of efficiency of solar still
8. Performance evaluation of concentric solar collector
9. Performance estimation of solar box type cooker
10. Efficiency estimation of solar concentrating collector

LEARNING OUTCOME:

At the end of the course learner, will able to evaluate the performance of solar Thermal systems

24REVC1107 PHYSICS PRACTICAL L 0 T 0 P 2

Course Objective

To understand the physics of fluid flow, heat transfer

1. Determination of the acceleration due to gravity
2. Surface tension – Interfacial tension.
3. Coefficient of viscosity.
4. Verification of Kirchhoff's laws and Thevenin's theorem.
5. Measurement of resistance and temperature Coefficient of resistance – Carey Foster's bridge
6. Potentiometer – measurement of low voltage – EMF of Thermocouple, calibration of low range voltmeter
7. Potentiometer – measurement of medium and high voltages – calibration of medium and high range voltmeters
8. Potentiometer – measurement of current, calibration of ammeter.
9. Measurement of temperature using various principles expansion of solids, liquids and gases, resistance thermocouple-Selection of thermometer for different purposes.
10. Measurement of heat energy-method of mixtures-Specific heat capacity of solids, liquids – Latent heat of fusion of ice and latent heat of vaporization of water – Barton's correction.
11. Cooling curve for wax / naphthalene – Melting point.
12. Measurement of heat energy – Electrical method – specific heat capacity of solids and liquids Barton's correction.
13. Study and Measurement of Calorific value of fuels, - Bomb Calorimeter 6. Thermal conductivity of a good conductor – Lee's Disc method
14. Thermal conductivity of a good conductor – Forbe's method

Outcome

At the end of the course, the student will able to measure the fluid and heat transfer properties of substances.

24REVC1108 WORKSHOP PRACTICE L 0 T 0 P 3

OBJECTIVES:

To impart knowledge and skill to use tools, machines, equipment, and measuring instruments. Educate students of Safe handling of machines and tools.

UNIT-I

Demonstration on use of Hand Tools:V-block, Marking Gauge, Files, Hack Saw, Drills, Taps. Minimum 3 models involving Dove tail joint, Triangular joint and Semicircular joint

UNIT-II

Wood Working (Carpentry Section):Carpentry Practice Use of hand tools for holding drilling, cutting, marking and mixed tools such as vice, clamps, saw, hammers, mallet, screwdriver, etc.

UNIT-III

Different carpenter joints and their application (Mortish and Tanon, Dovetail, Half Lap, etc. Identification of joint in a particular job articles of furniture items. Jobs to be made: Wall Hanger, Pulse Mixer.

UNIT IV

Welding: Study of electric arc welding tools &equipments, Models: Butt Joint, Lap Joint, T joint & L-joint.

UNIT V

Sheet Metal & Soldering Work: Development & Soldering of the models: Tray, Frustum of cone, Prism(Hexagon & Pentagon),Truncated Square Pyramid, Funnel.

COURSE OUTCOMES:

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

- Demonstrate and produce different types of fitting models.
- Gain knowledge of development of sheet metal models with an understanding of their applications.
- Perform soldering and welding of different sheet metal & welded joints.
- Understand the Basics of Workshop practices

REFERENCES

1. Shop Theory Anderson Tata McGraw Hill 1975
2. Elements of Workshop Technology: Vol I: Media Promoters &Publishers Pvt Ltd., Mumbai.

3. Manufacturing Processes, S K Hajra. Choudhury, A K. Hajra Choudhury, 15th Edition Reprinted 2013.

24PEUV1101 Health and Fitness (1 Credit)

OBJECTIVES

- To acquire basic knowledge of Physical Education
- To know the rules and regulations of sports and games
- To acquire knowledge about recreation
- To spread the message of positive health as taught in Yoga to people in a systematic and scientific manner
- To provide a proper perspective and insight into various aspects of Yoga education to the trainees

UNIT – I : Concept and meaning of Physical Education- Definition of Physical Education- Aims and Objectives of Physical Education- Scope of Physical Education

UNIT-II : Origin of games(basketball, ball badminton, cricket, football, hockey, kabaddi, khokho, Tennikoit, Volley ball)- Basic skills of anyone of the major games (basketball, Volley ball, kabaddi and football etc.,) and two events Track and Field events Intramural and Extramural tournaments- Recreational activities

UNIT- III : Common athletic injuries and their treatment- personal hygiene- safety education with special reference to play field- modern trends in Physical Education- Counselling against doping, drug addiction, smoking, alcoholism- nutrition and sports diet

UNIT- IV: Meaning of Yoga- Definition of Yoga- Aims and Objectives of Yoga- Scope of yoga Need and Importance of Yoga in the modern era

UNIT- V: The wheel of Yoga-Eight limbs of yoga – Gandhi's contribution of Yoga – Meaning and Objectives of Meditation – various types of meditation – Difference between yoga and Physical Exercises – Therapeutically aspects of yoga and its applications

REFERENCES

1. Essential of Physical Education by Dr. Ajmeer Singh, Xpress Grafics, Delhi-28, 2003
2. The Official Rules book of Basketball, Football, Hockey, Volleyball, Kabaddi Federation of India, 2015
3. Competition Rules Book by Amateur Athletics Federation of India, New Delhi, 2003
4. Officiating Techniques in Track and Field by Brar T.S. Gwalior, 2002

LEARNING OUTCOME

Students able to acquire basic knowledge of Physical Education, know the rules and regulations of sports and games, acquire knowledge about recreation, spread the message of positive health as taught in Yoga to people in a systematic and scientific manner, provide a proper perspective and insight into various aspects of Yoga education to the trainees

FINE ARTS (1 Credits)

OBJECTIVES

- A general survey course to introduce the students to Indian Art.
- To understand the basics of Art History, Aesthetics and Art Appreciation.
- Theoretical, social and cultural dimensions of the production of art and architecture

UNIT- I: ART HISTORY AND AESTHETICS:

What is art and what is art History? What constitutes art and how do we define it? The Classical Concept of art -Theory of Art as Expression -Aesthetic theories of Art

UNIT- II:INDIAN ART:

Do art and architecture perform functions and have a role to play in society? The role and importance of the museum as a site for cataloguing and preserving art, and projecting certain defined notions that have a bearing on the study of art and architecture will also be focused upon

UNIT- III:INDIAN ARCHITECTURE:

Prescriptive texts and the making of early Indian art and architecture. Was the 'science' of art and architecture developed as a concomitant of the artistic and architectural developments in early India?

UNIT- IV:TYPES OF ARCHITECTURE:

Domestic (dwellings), public institutional (step-wells, rest houses, hospitals) and religious institutional (temples, stūpas/ caityavihāra, maṭhas) will be focused upon. The focus will be on the material sources at particular monument sites such as Sanchi, Amaravati, Ajanta, Ellora, Khajuraho, Tanjavur, Mahabalipuram, Sravana Belagola, Bhubaneshwar and Mount Abu. (There may be other sites added or dropped from this list depending on the newer literature available.)

UNIT- V:TRENDS AND DEVELOPMENTS:

How do we understand the different structures that emerge over a long period of time within a monument or when a monument no longer has a living significance for the people in its vicinity? Are symbols remnants of the primitive mentality or do they also evolve over time? How do we understand ornamentation? Finally, is there an Indian art and architecture?

REFERENCES

1. Brancaccio, Pia (2011) the Buddhist Caves at Aurangabad: Transformations in Art and Religion. Leiden & Boston: Brill.
2. Brockman, Norbert C. (2011) Encyclopaedia of Sacred Places. Vol. 1: A-M. Second Edition, California: ABC-CLIO, LLC.
3. Burton-Page, John (2008) Indian Islamic Architecture. Forms and Typologies, Sites and Monuments. Ed. George Michell. Leiden & Boston: Brill.
4. Elgood, Heather (2000) Hinduism and the Religious Arts. London & New York: Cassell.
5. Tillotson, GHR, Paradigms of Indian Architecture: Space and Time in Representation and Design, Curzon, 1997.
6. Vatsyayan, Kapila, the Square and the Circle of the Indian Arts, Abhinav, Delhi, 1997.
7. Wagoner, Philip B., 'Ananda K. Coomaraswamy and the Practice of Architectural History', Journal of the Society of Architectural Historians, vol. 58, no. 1, 1999.

LEARNING OUTCOME:

Student will acquire knowledge and skill on Indian art, history and aesthetics, Indian architecture and Trends and development of Indian architecture

NSS **L 1 T 0 P 0**

Objectives:

- ✓ To know the history, philosophy, principles of NSS and working with people
- ✓ To know the role and responsibility of volunteers

UNIT – I:
NSS – History, Philosophy, Principles and Objectives
UNIT – II
Working with people – Methods and Techniques
UNIT – III
NSS – Regular Programme: Objectives, activities – role and responsibilities of volunteers
UNIT – IV
NSS Special Camping Programme: Objectives, activities - role and responsibilities of volunteers
UNIT – V
Evaluation of the NSS activities – Tools and Techniques

REFERENCES

1. National Service Scheme Manual, 1997. Department of Youth Affairs and Sports, Ministry of Human Resource Development, Government of India.
2. Supe, S.V. 1995, Extension Education, Sterling Publications, Madras
3. Advi Reddy, 1996, Extension Education Babatal Publications, Hyderabad
4. Narayanasamy, N, M.P.Boraian and R. Ramesh, 1997, Participatory Rural Appraisal, GRU, Gandhigram.

Learning Outcome

- ✓ Student able to know To know the history, philosophy, principles of NSS and working with people, role and responsibility of volunteers

FOUNDATION COURSE IN SHANTI SENA L 1 T 0 P 0

Objectives:

- ✓ To introduce the Concept of Shanti Sena (Peace Brigades) to the students.
- ✓ To give exposure and training to students in the skills needed for Shanti Sena

UNIT – I

Shanti Sena- Meaning and conceptual frame work – historical development

UNIT– II

Shanti Sena in India and abroad- Contributions of Mahatma Gandhiji, Khan Abdul Ghaffar Khan, Vinoba Bhave and Jeyaprakash Narayan

UNIT– III

Organisation and functions of Shanti Sena- Shanti Kendras, All India Shanti Sena Mandal; Peaceful resolution of conflicts, Peace Making, Alternative to Defense and Violence

UNIT –IV

Experiments in Modern times- World Peace Brigade, Peace Brigade International, U.N. Peace Keeping Force, Truth and Reconciliation Commission and Experiments of Gandhigram Rural Institute

UNIT – V

Skills and Training for Shanti Sena- Skills of First Aid and Skills for disaster management, Peace Making Skills(Conflict Resolution and Counseling) and Transforming oneself into a Shanti Saink

References

1. K.Arunachalam (1985), Gandhi - The Peace Maker, Gandhi Smarak Nidhi, Madurai.
2. Dr.N.Radhakrishnan, (1997), Gandhian Nonviolence: A Trainer's Manual, Gandhi Smiriti and Darshan Samiti, New Delhi.

Learning Outcome

- ✓ Student will learn concept of Santhi Sena and acquire skill on santhi sena

Semester – 2

24REVC1201 **WIND ENERGY** **L 4 T 0 P 0**

OBJECTIVE:

To describe the fundamentals and main characteristics of wind power energy conversion techniques

UNIT-I

Introduction – Wind– The nature of wind – power in wind – Wind to electricity generation principle – lift, drag basis for wind energy conversion - Wind data and energy estimation – site selection criteria

UNIT-II

Types and classification of WECs; power, torque, and speed characteristics – Advantages-limitations – wind rise diagram – mini wind turbine, micro wind turbine – Indian energy data, Organisations like NIWE

UNIT-III

Wind energy conversion system design – Aerodynamic design principles – aerodynamic theories; Axial momentum, blade element and combine theory; Rotor characteristics, Maximum power coefficient; Prandlt's tip loss correction.

UNIT-IV

Design of wind turbine – Wind turbine design consideration; Methodology; Theoretical simulation of wind turbine characteristics; Test methods of Wind energy applications – wind pumps: Performance analysis, design concept and testing; Principle of WEG; stand alone, grid connected and hybrid applications of WECs; Economics of wind energy utilization

UNIT-V

Introduction to Induction machines; Principle of operation, construction, classification, expression for induced EMF, Torque/slip characteristics, Vector diagram – losses and efficiency of machine, related problem – Induction generator: Grid connected, Self-excited, Doubly fed induction generator – Estimation of capacitance requirement for self-excited IGs, problems on Igs.

Text Books:1. Wind Energy Explained: Theory, Design and Application *2010 by James F. Manwell, Jon G. McGowan, Anthony L. Rogers.*

2. WIND ENERGY: THEORY AND PRACTICE- Siraj Ahamed.

24REVC1202 SUSTAINABLE CHEMISTRY L 3 T 0 P 0

OBJECTIVES:

The objective of the course is to emphasize the importance of chemistry in terms of

sustainable world,togiveanoverviewof water purification,varioustypesof non-renewable energy sources includingenergy storage,tocomprehendtheimportanceofcorrosionofmetals, to make the students to understand the need of polymers and the effects of pollution.

Specific learning outcomes: Upon completion of the course, the students will be able to

- Describe the water treatment methods for industrialapplications.
- Categorize various types and sources ofnon-conventional energy sources.
- Demonstrate the corrosion and protection of metallic materials.
- Describethebasic concepts ofpolymersandaware of environmental pollution.

Unit-I Water

Sources and impurities - hardness of water - expression and estimation by EDTA - Requirement of water for boilers and its uses - Zeolite and demineralization processes - internal treatment of boiler water - calgon, carbonate and phosphate conditioning- domestic water treatment - Desalination - reverse osmosis.

Unit-II Energy Storage

Solar cells - Types Batteries-Primary batteries- Electrodes - Electrolyte - Secondary batteries- Dry cell- Lead acid battery and H_2-O_2 fuel cell - Hydrogen as Fuel.

Unit-III Corrosion and its prevention

Corrosion - chemical and electrochemical - sacrificial anode - impressed current cathodic protection. Paints- constituents and its function –special paints- heat resistant paints –fire retardant paints-luminous paints.

Unit-IV Polymers

Polymers, Basic concepts- monomers- polymers – polymerization- types - Addition and condensation- Degree of polymerization- functionality - thermoplastics and thermosetting plastics - preparation and uses of polythene, PVC, Teflon, Nylon, and bakelite - Elastomers – synthetic and natural rubbers –vulcanization-Buna-S and Buna-R

Unit-V Pollution

Causes of air and water pollution - primary and secondary pollutants - assessment of water pollution - definition and significance of BOD and COD.-Treatment of sewage - air pollution - environmental impact - acid rain, greenhouse effect and ozone depletion

REFERENCES

1. P. C. Jain and Monika Jain, Engineering Chemistry, Dhanpat Raj and sons, Delhi,2008
2. Ravikrishnan, Environmental studies, Sri Krishna publications, 2016.
3. M. R. Balasubramanium, S. Krishnamoorthy and V. Murugesan, Engineering Chemistry, Allied Publisher Limited. Chennai, 1993
4. M. Karunanidhi, N. Ayyaswami, T. Ramachandran and H. Venkatraman, Applied Chemistry, Anuradha Agencies,1994.

LEARNING OUTCOMES:

- Students will get gain knowledge in Basics and Application of Chemistry for Renewable Energy system

24REVC1203 BASIC ELECTRICAL AND ELECTRONICS L 0 T 2 P 0

OBJECTIVES

- Basics of DC and AC Circuits
- Electric circuit laws, single and three phase circuits and wiring
- Basics of Various electronic devices

UNIT I - INTRODUCTION

Electrical Energy – Electron Theory (Molecules, Atom, Protons, neutrons and Electrons) – Basic circuit components- Active and Passive components- voltage-current - Resistance – Power – Active – Reactive – Apparent – Measurement Units

UNIT II - DC CIRCUITS

Introduction to DC circuits - Series DC Circuits - Parallel DC Circuits – Series-Parallel DC Circuits - Voltage Dividers and Current dividers – DC Power Measuring Instruments.

UNIT III - AC CIRCUITS

Introduction to AC circuits – waveforms and RMS value – power and power factor, single phase and three-phase balanced circuits - housing wiring, industrial wiring, materials of wiring.

UNIT IV - ELECTRICAL CIRCUITS AND THEOREMS

Ohms Law - Kirchhoff's Law – Instantaneous Power – Inductors - Capacitors – Independent and Dependent Sources -Thevinin's Theorem, Norton's Theorem, Maximum Power transfer theorem-Linearity and Superposition Theorem.

UNIT V - ELECTRONIC DEVICES & CIRCUITS

Types of Materials – N type and P type materials – PN Junction –Forward and Reverse Bias – Semiconductor Diodes –Bipolar Junction Transistor – Field Effect Transistors – Characteristics - Power Electronics - Digital Electronics - GATE - DAC – ADC .

TEXT BOOK:

1. Thereja .B.L., "Fundamentals of Electrical Engineering and Electronics", S. Chand & Co. Ltd., 2008

REFERENCES:

1. A.E.Fitzgerald, David E Higginbotham and Arvin Grabel, “Basic Electrical Engineering”, McGraw Hill Education(India) Private Limited, 2009
2. 6. N K De, Dipu Sarkar, “Basic Electrical Engineering”, Universities Press (India)Private Limited 2016
3. D P Kothari and I.J Nagarath, ”Electrical Machines “Basic Electrical and Electronics Engineering”, McGraw Hill Education(India) Private Limited, Third Reprint ,2016
4. Rajendra Prasad, “Fundamentals of Electrical Engineering”, Prentice Hall of India, 2006

LEARNING OUTCOMES:

- Students will get gain knowledge in Basics of AC, DC Circuit and various electronic components.

24ENVA1201 Essential English : Intermediate L 3 T 0 P 0

(Language II Course – 3 Credits/3 Hours/wk.)

OBJECTIVES:

- To build on the English language skills of students initiated in the previous semester.
- To focus on the language skills of the learners in a graded manner.

UNIT I-GRAMMAR

- Adjectives
- Determiners
- Verbs & Tenses
- Subject-Verb Agreement

UNIT II-LISTENING

- Teacher/Peer Readings
- Story Narrations

UNIT III-SPEAKING SKILLS

- Basic conversation
- Narration of events

UNIT IV-READING & VOCABULARY

- Graded reading comprehension passages

UNIT V-WRITING SKILLS

- Narrative paragraphs
- Note Making

TEXTBOOK:

General English II Textbook/Course Material - Prepared by the School.

REFERENCE BOOK:

Seaton, Anne & Y.H. Mew. *Basic English Grammar Book 1.* Irvine: Saddleback, 2007. Print.

Digital Marketing							
Course	**Depart**	**Semest**	**Credits**	**Hours**	**Theory**	**Practical**	**Total**

Code	ment	er		T	P	CFA	ESE	CFA	ESE	
	B.Com(Co-op), B.B.A.,M.A. M.B.A., B.Voc.(MMPT), B.Voc.(FTQE), B.Voc(RE), B.Voc.(FP)	IV, IV,I,I,II,II,II	3	2	1	30	45	10	15	100
Cognitive Level	**K-1** Recall the basic definitions and terminologies of computer **K-2** Summarize the knowledge in digital marketing **K-3** Ready to deal with online business									
Course Objectives	**The Course aims to** • Introduce the concepts of digital marketing • Provide the knowledge in Digital marketing sites • Give experience to the students to sale their products in Digital medias									
UNIT	**CONTENT**									
I	**Introduction to Digital Marketing** • Evolution of Digital Marketing from traditional to modern era • Role of Internet; Current trends, Info-graphics, • Inference for business & society • Emergence of digital marketing • Drivers of the new marketing environment • Digital marketing strategy • P.O.E.M. framework, Digital landscape, Digital marketing plan, Digital marketing models.									
II	**Internet Marketing and Digital Marketing** • Internet Marketing, opportunities and challenges • Digital marketing framework • Digital Marketing mix, Impact of digital channels on IMC • Search Engine Advertising: - Pay for Search Advertisements, Ad Placement, Ad Ranks, Creating Ad Campaigns, Campaign Report Generation Display marketing • Buying Models • Programmable Digital Marketing • Analytical Tools • YouTube marketing									
III	**Social Media Marketing – Role of Influencer Marketing, Tools & Plan** • Facebook Marketing • LinkedIn Marketing • Twitter Marketing • Instagram and Snapchat Marketing • Mobile Marketing									

	• Social media metrics
IV	**Marketing and Trends in Digital Advertising**
	• Need for SEO • Use of Search engines and its working patterns • On-page and off-page optimization • SEO tactics • Introduction to SEM • Web Analytics – Google analytics • Data collection for web analytics • Universal analytics • Tracking code
V	**Trends in Digital Advertising and Case Study**
	• Trends in digital advertising • Impact of digital advertising • Case study: Students generate advertisement and sale it in Mobile marketing, twitter Marketing, Facebook Marketing, LinkedIn Marketing, Instagram or Snapchat Marketing. • Ask them to report
Reference Books	Seema Gupta Digital Marketing Mc-Graw Hill 1 st Edition - 2017 Ian Dodson The Art of Digital Marketing Wiley Latest Edition Puneet Singh Bhatia Fundamentals of Digital Marketing Pearson 1 st Edition - 2017 Vandana Ahuja Digital Marketing Oxford University Press Latest Edition Philip Kotler Marketing 4.0: – Moving from Traditional to Digital Wiley 2017
Course Outcomes	**On completion of the course, students should be able to** CO1: Students gain an overall understanding of Digital Marketing Develop insight on Current Trends – Digital and Social Statistics (Infographics) CO2 : Provide an introduction to Digital Marketing Platforms like Facebook, Twitter, YouTube CO3: Pinterest, etc. Introduction to the basics of Search Engine Optimization (SEO) and Mobile Marketing CO4: Introduction to various strategies involved in Marketing products and Services Digitally.

24REVC1204 **L 2 T 1 P 1**

SITE SURVEY AND INSTALLATION OF WIND POWER PLANTS

OBJECTIVE:

To understand the site survey methodology and installation of wind power plants from the point of renewable energy site surveyor by incorporating the underlying concepts of aerodynamics and mechanical considerations.

UNIT-I INTRODUCTION TO WIND ENERGY

Wind energy conversion principles - General introduction -Types and classification of WECS; Power, torque and speed characteristics – Site Selection Criteria– Advantages – Limitations – Indian Wind Energy Data

UNIT-II WIND RESOURCE ASSESMENT:

Analyse detailed site information - analyse the daily, monthly and annual wind resource data of site to evaluate the potential for wind energy generation -ensure the collection of data on local weather conditions such as temperature range, flooding (in case of onshore), wind speed, humidity, rainfall and assess its impact on wind energy generation. -Assess the ground water availability and quality, load bearing capacities, pH levels and seismic risk -analyse the pre-site selection baseline data for project execution suitability -identify location for Power Curve test -ensure installation of meteorological mast (met mast) at site - analyse wind data collected from met mast for wind potential

UNIT- III PRELIMINARY ANALYSIS

Identify accessibility of the site i.e., its connectivity to various transport mechanisms including rail, road, connecting roads etc. -ensure conducting of route survey - identify soil type and its strength -identify state/central law of land leasing and purchase

UNIT-IV: TRANSMISSION LINE & GRID AVAILABILITY ANALYSIS:

Assess grid availability for power evacuation including nearest substation and transmission line capacity - identify the relevant grid authority -check the feasibility of point of power evacuation

UNIT- V EVALUATION AND MONITORING FOR WINDPOWER PLANT

Establish suitable project management technics and prepare necessary formats – organize tasks concurrently to make optimal use of workforce during project execution – Prepare consolidation relevant report and presentations for project monitoring – Ensure following of industrial standers within the wind site – Ensure following contingency plan in case of unforeseen delays – carryout regular sit visits to ensure protocols are followed – Ensure restoration of site poste commissioning.

TEXT BOOK:

1. David A. Spera, (Editor) Wind Turbine Technology: Fundamental Concepts of Wind Turbine Engineering, American Society of Mechanical Engineers; (1994)
2. Mukund R. Patel, Wind and Solar Power Systems , CRC Press; (1999)
3. G.L.Johnson. Wind Energy Systems, Prentice Hall Inc, New Jersey, 1985.
4. David A. Spera, (Editor) Wind Turbine Technology: Fundamental Concepts of Wind Turbine Engineering, American Society of Mechanical Engineers; (1994)

REFERENCE BOOK:

1. G.L.Johnson. Wind Energy Systems, Prentice Hall Inc, New Jersey, 1985
2. Erich Hau,Wind Turbines: Fundamentals, Technologies, Application and Economics, Springer Verlag; (2000)
3. Paul Gipe , Karen Perez, Wind Energy Basics: A Guide to Small and Micro Wind Systems, Chelsea Green Publishing Company; (1999)
4. J. F. Manwell, J. G. McGowan, A. L. Rogers, Wind Energy Explained, John Wiley & Sons; 1st edition (2002)
5. Tony Burton, David Sharpe, Nick Jenkins, Ervin Bossanyi, Wind Energy Handbook , John Wiley & Sons; 1st edition (2001)
6. Mukund R. Patel, Wind and Solar Power Systems , CRC Press; (1999)

LEARNING OUTCOME:

Students will gain knowledge about the site survey and installation of wind power plant.

24REVC1205 WIND ENERGY LABORATORAY L 0 T 0 P 4

OBJECTIVE:

- To carry out the performance evaluation of wind energy system.
- To understand and optimize the overall wind conversion devices like pump, micro wind turbine etc.,

1. Estimation of cut in velocity of wind turbine generator
2. Evaluation of Tip Speed Ratio (TSR) with different wind velocities
3. Estimation of Coefficient of Performance of Wind Electric Generator
4. Evaluation of Power curve for wind turbine generator
5. Estimation of Charge controller of Wind Turbines
6. Performance evaluation of Wind turbine generator with various AC load condition
7. Performance evaluation of Wind turbine generator with various DC load condition
8. Performance Evaluation of Wind Water Pumping System
9. Study on Grid Integration of Wind Electric Generator
10. Studies on Micro Wind Turbine system.

LEARNING OUTCOME:

At the end of the course learner, will able to evaluate the performance of Wind electric and mechanical systems.

24REVC1206 ELECTRICAL AND ELECTRONICS LABORATORY L 0 T 0 P 4

OBJECTIVE:

- To understand the basic concepts of electrical and electronics engineering

1. Introduction of tools, electrical materials, symbols and devices
2. Residential House wiring
3. Florescent lamp wiring
4. Single lamp controlled by Two switches – Staircase Wiring
5. Measurement of Energy using Energy meter
6. Measurement of voltage, current , power and power factor using Resistive loading
7. To study fuses, MCB and important of earthing
8. Study of electronics components
9. Study on logic gates
10. Identification of Resistance using color coding
11. Measurement of Ripple factor using Half wave and full wave rectifier
12. Exercise on soldering

LEARNING OUTCOME:

At the end of the course learner, will able to understand the basic electrical and electronics engineering concepts.

24REVC1207 ENGINEERING DRAWING L 0 T 0 P 3

OBJECTIVES

- Comprehend the importance of drawing
- Identify and use the drawing instruments with proper Rules and guidelines
- Acquire knowledge about geometric construction
- Understanding the projection of points and straight lines

UNIT I - BASICS CONCEPTS OF ENGINEERING DRAWING

Importance of graphics in engineering applications – Use of drafting instruments- drawing board, mini drafter, compass, divider, protractor, drawing sheets, drawing pencils, set squares etc.,-title block – folding of drawing sheets – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning.

UNIT II - GEOMETRIC CONSTRUCTIONS

Geometric constructions: Bisect a line – bisect an arc – bisect given angle – divide straight line into number of equal parts – divide the circle into number of equal divisions – draw an arc touching two lines at any angle –draw an arc touching two arcs.

UNIT III - FREEHAND SKETCHING

Visualization concepts and Free Hand sketching: Visualization principles –Representation of Three Dimensional objects – Layout of views- Freehand sketching of multiple views from pictorial views of objects

UNIT IV - PROJECTION OF STRAIGHT LINES

Projection of straight lines – Line in the first quadrant and on the reference planes -perpendicular to one plane and parallel to other plane – inclined to one plane and parallel to the other plane – parallel to both the planes – inclined to both the planes – Exercises.

UNIT V - PLANE CURVES, POINTS AND SOLIDS

Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of square and circle - Projection of points – points on the different quadrants and on the reference planes. Projection of simple solids like prisms, pyramids, cylinder, cone

TEXT BOOK:

1. K V Nataraajan “A Text Book of Engineering Drawing”.

REFERENCES:

1. Venugopal.K, Sreekanjana G, “Engineering Graphics” New Age International Publishers
2. Gopalakrishnan.K.R., "Engineering Drawing", (Vol.I and Vol.II), Dhanalakshmi publishers, edition 2, 1970
3. Besant Agrawal, C M Agrawal “Engineering drawing”, Tata McGraw Hill Education Private limited.
4. Barkinson & Sinha, "First Year Engineering Drawing", Pitman Publishers. Bhatt N.D. and Panchal V.M., “Engineering Drawing”, Charotar Publishing House, 50th Edition, 2010

5. Gill P.S., “Engineering drawing”, S.K.Kataria & Sons

LEARNING OUTCOME:

Students will gain knowledge about the basics of engineering drawing with the importance of drawing, projections, lines and curves.

SEMESTER 3

SOFT SKILLS
(Course – 2 Credits – 2 Hours/wk.)

OBJECTIVES:

- To help the students improve their communication skills; and
- To enhance their holistic development and improve their employability skills.

UNIT I

- Introducing Soft Skills
- Effective Communication for Success

UNIT II

- Influencing Skills
- Lateral Thinking Skills

UNIT III

- Time Management
- Presentation Skills

UNIT IV

- Effective Team Work Skills
- Inter-personal Skills

UNIT V

- Interviewing Skills
- Negotiation Skills

TEXTBOOK:

Antonysamy and Chandra. *Soft Skills and Personality Development: A Handbook of Employability Skills.* Chennai: Vijay Nicole, 2012.

ASSESSMENT: There is no ESE. Assessment is totally internal and is performance-based.

24REVC2101 ENVIRONMENTAL SCIENCE L 3 T 0 P 1

OBJECTIVES:

- To learn the importance in conservation of environment and natural resources.
- To learn causes, effects and control measures of environmental pollution.

- To understand the concepts of disaster management and preparedness to overcome.

UNIT– I: NATURAL RESOURCES

Introduction to Environment and natural resources (Definition, scope and important) – Forest Resources: Use and over-exploitation of forest resources and its impact on forest and tribal people – Water Resources: Use and over exploitation of water and impact – Land Resources: Land degradation and soil – erosion, desertification – Food Resources: Effects of modern agriculture, fertilizer pesticide problems – Energy Resources: Growing energy needs renewable and non-renewable energy source-use of alternative energy sources.

UNIT– II: ECOSYSTEM AND BIODIVERSITY

Concept of an ecosystem – Structure and function of an ecosystem – Energy flow in the ecosystem - Food chains, food webs and ecological pyramids – Types of ecosystem – Biodiversity: genetic, species and ecosystem diversity, India as a mega – diversity nation – Treats to biodiversity: habit loss, poaching of wild life, man-wildlife conflicts; Endangered and endemic species of India – Conservation of Biodiversity: In-situ and Ex-situ conservation of biodiversity.

UNIT– III: ENVIRONMENTAL POLLUTION:

Causes, effects and control measure of: Air pollution, Water pollution, Soil pollution, Noise pollution and nuclear hazards, Solid waste management, Global environmental problems.

UNIT– IV: SOCIAL ISSUES AND THE ENVIRONMENT:

Sustainable development, Rural Urban problems related to environment, Water management and rain water harvesting – Environment ethics: Issues and possible solutions, Environmental Protection Policy, Acts and Legislation, Population and the Environment – Environmental and Population concern: Environment and human health, Environment education at various levels – HIV/AIDS, Women and child welfare, gender issues, gender equity, institutions for gender studies / research.

UNIT– V: DISASTER MANAGEMENT: DISASTER:

Meaning and concepts, types, causes and management – Effects of disaster on community, economy, and environment – Disaster management cycle: early response, rehabilitation, reconstruction and preparedness – Vulnerability Analysis and role of community in Disaster Mitigation – The Disaster Management Act 2005 – Disaster Management Authority: National, State and District level – Ill effects of fireworks.

REFERENCES

1. A textbook of Environmental Studies, 2006, Asthana, D.K., Meera Asthana, S.Chand & Company Ltd., New Delhi.

2. Environmental Studies, 2005, Benny Joseph, Tata McGraw – Hill Publishing Company, New Delhi

3. A textbook of Environmental Studies, 2005, Erach Bharueha, UGC, University Press, New Delhi

4. Panchayats in Disaster: Preparedness and Management, 2009, Palanithurai, G., Concepts Publishing Company

5. A textbook of Environmental Studies, 2003, Thangamani and Shyamala, Pranav Syndicate, Publication Division, Sivakasi

LEARNING OUTCOME

Students acquire the knowledge in environmental studies particularly in resources, pollutions and disaster management

24REVC2102 ELECTRICAL GENERATION AND DISTRIBUTION L 3 T 0 P 0

OBJECTIVES

- To study the structure of electric power system and to develop expressions for the computation of transmission line parameters

- To develop the knowledge in various generation of power from both renewable and non-conventional energy sources
- To transfer the power system distribution technologies

UNIT I - INTRODUCTION TO STRUCTURE POWER SYSTEM

Structure of electric power system: generation, transmission and distribution; Types of AC and DC distributors – distributed and concentrated loads – interconnection – EHVAC and HVDC transmission

UNIT II - THERMAL POWER STATION

Introduction, selection of site, main parts and working principle, i.e. (boiler - Economizer), Air pre-heater, super heater, Re-heater, Steam prime Mover, condenser, spray pond cooling Tower, fuels solid, and gaseous Fuels.

UNIT III - HYDROELECTRIC STATION

Introduction, selection of site, classification based on quality of water, head and load, General lay out and operation. Construction and operation of different components i.e. Dam, spillways- Gates, Canal, penstocks, Water Hammer, surge tank, types of Turbine.

UNIT IV - SOLAR AND WIND POWER GENERATION

Introduction, selection of site of solar and wind, Elements of solar and wind power plant- Types of solar Power plants (SECS) – ON grid – OFF grid, types of Wind power Conversion system (WECS)generation.

UNIT V - DISTRIBUTION OF ELECTRICAL ENERGY

Introduction to Distribution system in India – Distribution Methods - Overhead Sub Station – Circuit breakers - Underground cable system–Cable constructions- cable trench

TEXT BOOK:

1. B.R.Gupta, 'Power System Analysis and Design' S. Chand, New Delhi, Fifth Edition, 2008
2. S.Sivanagaraju , M.Balasubba Reddy and D.Srilatha " Electric Energy – Generation, Utilization and conservation" Pearson Publications 2012

REFERENCES:

1. S.N. Singh, 'Electric Power Generation, Transmission and Distribution', Prentice Hall of India Pvt. Ltd, New Delhi, Second Edition, 2011
2. C.L.Wadhwa, 'Electrical Power Systems', New Academic Science Ltd, 2009
3. D.P.Kothari, I.J. Nagarath, 'Power System Engineering', and McGraw-Hill Publishing Company limited, New Delhi, Second Edition, 2008.

LEARNING OUTCOME

Students will gain knowledge about the electrical generation and distribution of renewable and other distributed energy resources

24REVC2103 INSTRUMENTATION FOR RENEWABLE ENERGY POWER PLANTS L 2 T 1 P 0

OBJECTIVE

To help students to expertise and increase skills related to various instruments and learn the basics of control system

UNIT I-INTRODUCTION

Fundamentals and importance of instrumentation – Types, selection, and performance of instruments – Error in measurement – Calibration and standard of instruments

UNIT II-TRANSDUCERS

Introduction to transducer and types – Process instrumentation, Indicating and recording instrumentation – Measurement of temperature, pressure, relative humidity, moisture content and velocity and flow

UNIT III-MISCELLANEOUS MEASUREMENT

Miscellaneous measurement: force and torque – Level – pH – Gas analyser – Emissivity – Refractive index – Viscosity – Surface tension – Spectrophotometry – Chromatography

UNIT IV-CONTROL SYSTEM

Basic elements of control system – open loop and closed loop systems – Differential equations – Transfer function – Modelling of electric systems – Translational and rotational mechanical systems – Block diagram reduction techniques – Signal flow graph

UNIT V-TIME AND FREQUENCY RESPONSE ANALYSIS

Time response analysis – First order systems – Impulse and step response analysis of second order system – Steady state error – P, PI, PD and PID compensation – Frequency response bode plot.

TEXT BOOK:

1. Anderson N.A., Instrumentation for Process Measurement and Control, Chilton company, 1980
2. A.Nagoor Kani "Control systems" RBA publication 2006.

REFERENCES:

1. Deoblin E.O., Measurement System Application and Design, McGraw Hill, 1990
2. Neubert HKP, Instrument Transducers, Oxford University Press, 1999.
3. B.G.Liptak, "Instrumentation Engineers Handbook (Process Measurement & Analysis)", Fourth Edition, Chilton Book Co, CRC Press, 2005
4. Al.Sutko,Jerry.D.Faulk, "Industrial Instrumentation", Delmar publishers, 1996
5. Paul Gruhn, P.E., CFSE and Harry Cheddie, P.E., "Safety Instrumented Systems: Design, Analysis, and Justification", 2nd Edition, ISA, 2006
6. I.J.Nagrath, Plam W.J.,M.Gopal "Control system engineering" John Wiley 1986

LEARNING OUTCOME

Students will gain knowledge about the instrumentation and basics of control systems

24REVC2104 SOLAR ENERGY L 4 T 0 P 0

OBJECTIVE: To understand the installation of solar power plants by the underlying concepts of solar physics, solar Radiation measuermenrs and PV systems

UNIT-I INTRODUCTION TO SOLAR ENERGY

Introduction – solar energy – solar constant – electricity from solar energy – beam and diffused radiation – angles of solar radiation – sun path diagram

UNIT-II RADIATION MEASUREMENTS

Radiation measurements – pyranometer – pyroheliometer – Sunshine recorder – Lux meter – Day length – Effect of earth atmosphere – Measurement and estimation on horizontal and tilted surface – Shadow determination

UNIT-III SEMICONDUCTOR MATERIAL

Semiconductor material – Manufacturing process of solar PV – Principle of PV power generation – VI Characteristics of solar PV – Applications of solar PV: Pump, Standalone PV system

UNIT-IV SOLAR PV MODULE

Series parallel connection of cells – Batteries for PV system – PV system design – Rating of PV systems – Sizing of wires in PV system – MPPT – Charge controllers – DC to AC converters – AC to DC converters- Life cycle analysis – solar hybrid system – issues in solar hybrid system.

UNIT-V TROUBLE SHOOTING OF PV MODULES

Quality assessment of the PV modules delivered at the site - Methods/Techniques in identifying various defects in a PV module - Measurement of various parameters in a PV module/PV string - Interpretation of performance data, and troubleshooting of possible defects in PV module.

TEXT BOOKS:

1. H.P.Garg., Prakash J., Solar Energy: Fundamentals & Applications, Tata McGraw Hill, New Delhi, 1997
2. S P Sukhatme, Solar Energy, Tata McGraw Hill, 2008

REFERENCES:

1. D Y Goswami, Frank Kreith and J F Kreider, Principles of Solar Engineering, Taylor & Francis, 1998
2. Tiwari G.N., Suneja S., Solar Thermal Engineering System, Narosa Publishing House, New Delhi, 1997.
3. Alan L Fahrenbruch and Richard H Bube , Fundamentals of Solar Cells: PV Solar
4. Energy Conversion, Academic Press, New York , 1983
5. Richard H Bube, Photovoltaic Materials, Imperial College Press, 1998

LEARNING OUTCOME:

Students will gain knowledge about the solar energy utilization of PV systems

24REVC2105 **L 2 T 1 P 1**

SITE SURVEY AND INSTALLATION OF SOLAR PV POWER PLANTS

OBJECTIVE:

To understand the site survey methodology and installation of solar power plants from the point of renewable energy site surveyor with the underlying concepts of solar physics

UNIT-I: IRRADIATION AND CLIMATE ANALYSIS

Analyze the daily, monthly and annual solar resource data including – GHI – DNI- Albedo etc. for site to evaluate the potential for solar energy generation at the site in consideration - ensure collection of data on local weather conditions such as - temperature range - flooding - wind speed- humidity - pollution levels -snow and other climatic conditions. Assessment of its impact on solar energy generation - assess the ground water availability and quality, load bearing capacities, pH levels and seismic risk.

UNIT-II: CONTOUR MAPPING AND SHADOW ANALYSIS

A. Prepare a detailed survey plan of the land proposed for installation of solar power plant with elevations and topography – contour mapping B. Calculate the exact land area of the proposed site where installation is to be commenced. - Carry out far shading and near shading analysis and map the usable area for solar installation - Check for any shading obstacles – Carry out on-site and off-site shadow analysis

UNIT-III: ROOFTOP SOLAR PV POWER PLANT

Identify the location of installation and optimize the route plan - Assess the site level pre-requisites for solar panel installation - Decide on the type of mounting to be constructed - civil construction to be undertaken for installing the panels- Prepare a site map of the location where installation has to be carried out.

UNIT-IV: ELECTRICAL DESIGN ASPECTS OF SOLAR PV ROOFTOP

Assess the load to be run on Solar Power Plant -Prepare a load profile - Prepare plant layout including component locations, cable routing, and interconnection point and metering point- Identify limitations- incentives according to relevant applicable policies, regulations and procedures.

UNIT-V: COMMISSSIONING OF POWER PLANT

Single line diagram of PV plant- grid interconnecting technical parameters (IEC 1547)/ (CEA-Central Electricity authority regulations 2013) - pre commissioning and post commissioning test

TEXT BOOK:

1. Chetan Singh Solanki: Solar Photovoltaics fundamentals, Technologies and Applications, PHI Learning Private Limited- Eastern Economy Edition.
2. H.P.Garg., Prakash J., Solar Energy: Fundamentals & Applications, Tata McGraw Hill, New Delhi, 1997
3. S P Sukhatme, Solar Energy, Tata McGraw Hill, 2008

REFERENCE BOOK:

1. Tiwari G.N., Suneja S., Solar Thermal Engineering System, Narosa Publishing House, New Delhi, 1997.
2. D Y Goswami, Frank Kreith and J F Kreider, Principles of Solar Engineering, Taylor & Francis, 1998
3. Alan L Fahrenbruch and Richard H Bube , Fundamentals of Solar Cells: PV Solar Energy Conversion, Academic Press, New York, 1983
4. Larry D Partain (ed.), Solar Cells and their Applications, John Wiley and Sons, Inc, New York, 1995
5. Richard H Bube, Photovoltaic Materials, Imperial College Press, 1998
6. H S Rauschenbach, Solar Cell Array Design Handbook, Van Nostrand Reinfold Company, New York, 1980

LEARNING OUTCOME:

Students will gain the knowledge to do site survey and installation feasibility of the solar power plants.

24REVC2106 SOLAR PHOTOVOLTAIC LABORATORY L 0 T 0 P 4

OBJECTIVE:

- To carry out the performance evaluation of solar PV system

- To understand and optimize the overall solar conversion devices

1. Performance evaluation of solar photovoltaic panel
2. Performance evaluation of solar photo voltaic panel in series
3. Performance evaluation of solar photovoltaic panel in parallel
4. Performance of solar photovoltaic in various shaded region
5. Effect of tilt angle on solar photovoltaic
6. Study the performance of solar street light
7. Study on charging of battery using PV panel.

LEARNING OUTCOME:

At the end of the course learner, will able to evaluate the performance of solar PV systems

WEB DESIGNING										
Course Code	**Department**	**Semester**	**Credits**	**Hours**		**Theory**		**Practical**		**Total**
				T	**P**	**CFA**	**ESE**	**CFA**	**ESE**	

	B.Sc. Textile & Fashion Designing B.Sc. Home Science, MA (DA), MA(Sociology) , B.Voc : DPT, FP, FTQUE, OA& AD, RE Dip. in Textile Technology	III, III,IV, IV, III, IV, IV, IV, II	3	0	3	30	45	10	15	100
Cognitive Level	**K-1** Recall the basic definitions and terminologies of computer. **K-2** Summarize the knowledge in web programming **K-3** Prepare web pages related to their field using HTML									
Course Objectives	**The Course aims to** • Introduce the concepts of internet and terminologies. • Enlarge the web designing concepts • Provide an in-depth training with HTML and JavaScript									
UNIT	**CONTENT**									
I	**Introduction to Computer and HTML** • Introduction to Internet and Website, Web development tools • HTML : Introduction - Head and Body Sections • Designing Title - Designing Headings • Designing Body Section – Alignment Tags									
II	**Ordered List, Tables and Forms** • Ordered and Unordered List • Tables - Using Colors • Paragraph Tags – Hyperlink • Embedding Images and Videos • Forms and Frames: Form Elements • Buttons - Frame Layouts • Floating Frames.									
III	**Cascade Style Sheet** • Introducing Cascading style sheet • Formatting text • Formatting colors and background • More CSS Techniques									
IV	**JavaScript** • Introduction to Java Script • Anatomy of a Script • Variables, Operators and Events • Polyfills									

	• JavaScript Libraries • Database connection with JavaScript
V	**XML**
	• XML: Introduction - Syntax • XML Document Structure • Document Type Definitions • Some Simple DTD Examples.
Reference Books	Learning Web Design, Jennifer Niederst Robbins, O'Reilly Publication, 2018 JavaScript and JQuery, Jon Duckett, Wiley, 2014 Web coding Bible, Chong Lip Phang, Chong Lip Phang, 2015
Course Outcomes	**On completion of the course, students should be able to** **CO1:** Recall the fundamental concept of computer, Internet and Websites **CO2:** Be familiar with the web programming concepts **CO3:** Able to write web programs **CO4:** Understand the data manipulation using Scripting language **CO5:** Build a simple web site

24REVC2107 **L 0 T 0 P 2**

SOLAR PHOTOVOLTAIC POWER PLANT FIELD VISIT

OBJECTIVE:

To obtain the industrial exposure on site survey, feasibility analysis, installation, commissioning of solar power plants in the field visit

Student should undergo an field visit to the Solar Power Plant. Student should present a seminar about his / her learning during the visit . Evaluation is based on the report, Seminar Performance and viva voce.

MSE:

Report - 50 marks

LEARNING OUTCOME:

At the end of the course learner will be able to get Renewable Energy Industrial Exposure

24YOUV2101 Hatha Yoga Education L 0 T 0 P 1

OBJECTIVE

- To learn Yoga for keeping body and mind in good condition

UNIT -I: History of Yoga – Definition of the term Yoga – Comprehensive Nature and Scope Yoga – Aims and Objectives of Yoga – Various School of Yoga

UNIT–II : Pantanjali yoga – Astangayoga – Tantrayoga – Mantrayoga – Hathayoga – Layayoga, Rajayoga – Ganayoga – Bhaktiyoga – Karmayoga.

UNIT–III: Yoga as an ideal system of physical culture – Do's and Don'ts of specific Yogic Techniques – Difference between practice of Asanas and Physical Exercise – Modern vs. Yogic concept on diet

UNIT–IV: Preparing Oneself for Yogi practices – Different kinds of Yogic practices – Suryanamaskar – Asanas (Padmasana – Vajrasana – Gomukhasana – Sarvangasana– Halasana – Shalabhasana – Dhanurasana – Paschimottanasana – Yogamudra –Utkatasana – Savasana - Makarasana)

UNIT–V: Parnayamas (Anuloma – Viloma Pranayama, Nadisuddi) – Bandhas (Jalandharabandha – Uddiyananbandha – Mulabandha) – Suddhikriyas (Kapalabhati) – Mudras – Dhyana – Meditation – Gandhiyan way of Meditation

REFERENCES:

1. Asanas, Swami Kuvalayananda, Kaivalaydhama, Lonavla, 1993
2. Light on Yoga, B.K.S Iyengar Harpine Collins Publication, New Delhi, 2000
3. Sound Health through Yoga, K.Chandrasekaran, Prem Kalyan Publications, Sedapatti, 1999
4. Yoga for All, Maharishi Patanjali, Sahni Publications, 2003
5. Yoga for Health, Institute of Naturopathy and Yogic Sciences, Bangalore, 2003
6. Yoga for Health, K. Chandra Shekar, Khel Sahitya Kendra, Theni, 2003
7. Yoga for the Modern Man, M.P. Pandit, Sterling Publishers Private Limited, New Delhi, 1987
8. Yoga for You, Indira Devi, Jaico Publishing house, Chennai, 2002

LEARNING OUTCOME

- Students know about Yoga for keeping body and mind in good condition.

Semester- 4

24REVC2201 GRID ISSUES IN RENEWABLE ENERGY SOURCES L 3 T 0 P 0

OBJECTIVES

- To Introduce The Power Quality Problem

- To Study The Sources And Effect Of Harmonics In Power System
- To study the grid integrated issues of renewable energy systems
- To Impart Knowledge On Various Methods Of Power Quality Monitoring

UNIT I - INTRODUCTION

Introduction to renewable energy grid integration, concept of mini/micro grids, and smart grids - Terms and Definitions: Overloading – Under Voltage – Over Voltage - Concepts of Transients – Short Duration Variations Such As Interruption – Long Duration Variation Such As Sustained Interruption. Sags And Swells – Voltage Sag – Voltage Swell – Voltage Imbalance – Voltage Fluctuation – Power Frequency Variations.

UNIT II - POWER QUALITY MONITORING

Monitoring Considerations – Monitoring and Diagnostic Techniques for Various Power Quality Problems – Power Line Disturbance Analyser – Quality Measurement Equipment

UNIT III - SOLAR POWER QUALITY ISSUES

Power quality issues of Solar power integration, common attributes of grid integration, basic power conversion of solar photovoltaic system, Grid requirements of PV System for both rooftop and utility scale- Mitigations

UNIT IV - WIND POWER QUALITY ISSUES

Power quality issues of wind power integration, common attributes of grid integration of power, basic power conversion of Wind power system - Grid requirements of Wind energy conversion system for utility scale and micro wind power plants- Mitigations

UNIT V - POWER QUALITY STANDARD

International Standards of Power Quality-Computer Business Equipment Manufacturers Associations (CBEMA) Curve – various International Electro technical commission (IEC) and Institute of Electrical and Electronics Engineers (IEEE)

TEXT BOOK:

1. C.Sankaran: Power Quality, CRC Press

REFERENCES:

1. Roger C.Dugan, Mark F.McGranaghan, Surya Santoso & H.Wayne Beaty : Electrical Power systems Quality, Tata McGraw-Hill
2. Remus Teodorescu, Marco Liserre and Pedro Rodriguez: Grid Converters for Photovoltaic and Wind Power Systems, Wiley and sons Ltd

LEARNING OUTCOME:

Students will gain adequate knowledge in the grid integration and power quality issues and mitigations of various renewable energy sources.

24REVC2202 WASTE TO ENERGY CONVERSION TECHNOLOGIES L 3 T 0 P 0

Course Objectives:

- ✓ To characterize the solid / liquid waste
- ✓ Analyze the sustainable waste management in industries

Unit I

Solid Waste -Definitions: Sources, types, compositions; Properties of Solid Waste; Municipal Solid Waste: Physical, chemical and biological property; Collection, transfer stations; Waste minimization and recycling of municipal waste

Unit II

Landfill method of solid waste disposal; Landfill classification; Types, methods & siting consideration; Layout & preliminary design of landfills: Composition, characteristics, generation; Design of Sanitary Land fill - Movement and control of landfill leachate &gases; Environmental monitoring system for landfill gases.- Gas Recovery – Applications

UNIT III

Sources of water – Ground and surface water – Hydrological cycle – Importance of water quality – Sources of pollution – Different types of pollutants – wastewater characteristics Water quality – BOD, COD – DO – pH measurement – temperature, turbidity – TDS – Salinity – Redox potential-Biogas- generation- slurry output estimation- slurry management.

UNIT IV

Thermochemical Conversion -Basic aspects of biomass combustion - heat of combustion - different types of grates - Co combustion of biomass – Gasification - Fixed and Fluidized bed gasifier - Gasification technologies for the selected waste like Rice Husk, Coir pith, Bagasse, Poultry litter etc., - Pyrolysis

UNIT V

E-waste: Introduction, toxicity due to hazardous substances in e-waste and their impacts, domestic e-waste disposal, e-waste management, technologies for recovery of resource from electronic waste, guidelines for environmentally sound management of e-waste, Incineration occupational and environmental health perspectives of recycling e-waste in India.

TEXT BOOK:

1. APHA, (2002), "Standard methods for examination of water and wastewater"; 21st Edition
2. Chobanoglous G., Theisen H., Viquel S.A., "Integrated Solid Waste Management: Engineering, Principles and Management issues", Tata McGraw Hill Publishing Company Ltd., New Delhi.

REFERENCES:

1. Karia G.L., and Christian R.A., "Wastewater treatment concepts and design approach" (2001), Prentice Hall of India Pvt. Ltd., New Delhi
2. Fair, G.M., Geyer J.C and Okun, (1969) "Water and waste water engineering" Vol II, John Wiley Publications
3. Weber W.J., "Physico - chemical processes for water quality control" 1975

4. AWWA, “Water quality and treatment “MC Graw hill 1971
5. Cpheeo manual, “Water supply and treatment”, GO Publications, 1991
6. Peavy, H.S., Rowe and Tchobonoglous, G, “Environmental Engineering”, McGraw Hill 1985
7. Viessman Jr, Hammer J. M, Perez, E.M, and Chadik, P. A, “Water supply and pollution control”, PHI Learning, New Delhi, 2009
8. Bhide AD., Sundaresan BB, Solid Waste Management in Developing Countries, INSDOC, New Delhi, 1983.

LEARNING OUTCOME:

Students will gain adequate knowledge in the waste water treatment systems with advanced technologies

24REVC2203 ENERGY AUDITING AND CONSERVATION L 2 T 1 P 0

OBJECTIVES

- Describe and formulate basic –auditing terms.
- Define and analyze the auditing approaches for a selective industry.
- Evaluate the performance analysis and optimization of thermal utilities.

- Describe and categorize the global environmental concerns for effective energy conservation and compare with international standards.

UNIT I - BASICS OF ENERGY & ITS VARIOUS FORMS

Electricity basics – DC and AC currents, electricity tariff, load management and maximum demand control, power factor. Thermal basics – fuels, thermal energy content of fuels, temperature and pressure, heat capacity, sensible & latent heat, evaporation, condensation, steam, moist air, humidity and heat transfer, units and conversion. - Energy Conservation Act-2001 and its Features

UNIT II - ENERGY MANAGEMENT AND AUDIT

Definition, energy audit – need, types of energy audit, energy management (audit) approach – understanding energy costs, benchmarking, energy performance matching energy use to requirement, Maximizing system efficiencies - Electricity billing, Electrical load management and maximum demand control, Power factor improvement and its benefit, Selection and location of capacitors,

UNIT III - LIGHTING SYSTEM

Light source, Choice of lighting, Luminance requirements, and Energy conservation avenues in lightning

UNIT IV - ENERGY EFFICIENT TECHNOLOGIES IN ELECTRICAL SYSTEMS

Maximum demand controllers, Automatic power factor controllers, Energy efficient motors, Soft starters with energy saver, Variable speed drives, Energy efficient transformers, Electronic ballast, Occupancy sensors, Energy efficient lighting controls, Energy saving potential of each technology.

UNIT V - GLOBAL ENVIRONMENTAL CONCERNS:

United Nations framework convention on climate change (UNFCC), Kyoto protocol, conference of parties (COP), clean development mechanism (CDM), prototype carbon fund (PCF), sustainable development.

TEXT BOOK:

1. D Patrick and S W Fardo, Energy Management and conservation, Prentice Hall Inc., 1996

REFERENCES:

1. Bureau of energy efficiency : Study materials for energy managers and auditors examination: Paper I to IV.2006
2. Kennedy, Turner and cape hart, Guide to Energy Management , The Fairmount Press.,1996

3. CB Smith, Energy Management Principles, Pergamon press, New York, 1981
4. Wayne C Turner, Energy Management Handbook, The Fairmount Press.,2000

LEARNING OUTCOME:

Students will gain amount of knowledge in the energy basics of energy management and energy efficiency for the state of energy conservation.

24REVC2204 **L 3 T 0 P 0**

ADVANCED RENEWABLE ENERGY TECHNOLOGIES

OBJECTIVE

Describe the concepts and main characteristics of new renewable energy techniques.

UNIT I -INTRODUCTION

Energy – Renewable energy resources – Advantages – Energy plantation – Obstacles in implementation of renewable energy – Renewable energy in Indian scenario

UNIT II -THERMOCHEMICAL CONVERSION

Thermochemical conversion – Pyrolysis – Gasification – concept – Types of gasifier: fixed and fluidized bed gasifier

UNIT III -BIOMASS ENERGY

Biomass sources – Biodegradable Feed stock – organic matter and animal residues – Factors influencing biogas production – Types of bio digester

UNIT IV-OCEAN ENERGY

OTEC: open cycle and closed cycle – Tidal energy: single basin and double basin structure – MHD: open cycle and closed cycle.

UNIT V-IMPROVED ENERGY SOURCE

Thermionic – Thermoelectric – Geothermal energy conversion system – Fuel cell technologies

TEXT BOOK:

1. G.D.Rai "Non-conventional energy sources" Khanna publishers 2015

REFERENCES:

1. Parker, Colin, & Roberts, Energy from Waste - An Evaluation of Conversion Technologies, Elsevier Applied Science, London, 1985
2. G.N.Tiwari, R.K.Mishra "Advanced renewable energy resources" RSC publishing
3. Thomas B. Johansson, Henry Kelly, Amulya K.N.Reddy, Robert H. Williams "Renewable energy sources for fuels and electricity" Island press
4. Paul Breeze "Power generation technologies" Newns, Second edition

LEARNING OUTCOME:

At the end of the course, students will gain knowledge in Bio, OTEC, Tidal, Geothermal and other renewable energy sources.

24REVC2205 ELECTRICAL MAINTENANCE LABORATORY L 0 T 0 P 4

OBJECTIVE:

- To carry out the operation and maintenance of electrical distribution system with both preventive and emergency conditions

1. To study earthing of electrical installation
2. To study types of insulators
3. To study maintenance schedule for distribution transformer, testing, maintenance
4. To study maintenance schedule for underground cable
5. To study the protection of distribution transformer
6. To study of measurement of insulation resistance and capacitance
7. To study of maintenance schedule for storage battery switchgear and control equipment
8. To study fault occurring in an induction motor to troubleshoot them
9. To study types of neutral earthing and substation earthing
10. To study construction and types of earthing

LEARNING OUTCOME:

At the end of the course learner, will able to the operation and maintenance of electrical distribution system

24REVC2206 **L 2 T 0 P 1**

SITE SURVEY AND INSTALLATION OF WASTE TO ENERGY POWER PLANTS

OBJECTIVE

To understand the site survey methodology and feasibility study of Waste to Energy power plants from the point of renewable energy site surveyor

UNIT-I WASTE RESOURCE ANALYSIS

Analyse detailed site information - Collect and analyse the waste availability data. - Identify the type and quantity of waste available for incineration- Collect information about the local weather conditions such as temperature range, wind speed, humidity, rainfall and seasonal availability of the resource. - assess the ground water availability and its quality, load bearing capacities, pH levels and seismic risk and fire risk analysis

UNIT-II: WASTE QUALITY ASSESEMENT

Conduct the tests to identify the moisture content, chemical composition, presence of hazardous material, non-degradable content in waste, carbon content and calorific value of the waste available.

UNIT-III CHARECTERIZATION OF SOLID WASTE

Physical–chemical: proximate and ultimate analysis, fusion point of ash, lignocellulose composition, leaching properties, energy content: heating value

UNIT-IV METHODS OF WASTE TO ENERGY CONVERSION

Incineration – Gasification – Pyrolysis – Densification of solids – Anaerobic digestion – fermentation - transesterification

UNIT-V REPORTING AND FIELD VISIT

Identify the local support and hindrance factor and include in the special section – validate the collected data from site – Identify limitations and incentives according to relevant applicable policies, regulations and procedures.

TEXT BOOK:

1. Rai, G.D., "Non-Conventional Sources of Energy", Khanna Publishers, Delhi 1995
2. Parker., Colin, & Roberts, Energy from Waste - An Evaluation of Conversion Technologies, Elsevier Applied Science, London, 1985
3. Shah, Kanti L., Basics of Solid & Hazardous Waste Management Technology, Prentice Hall, 2000

REFERENCE BOOK:

1. Manoj Datta, Waste Disposal in Engineered Landfills, Narosa Publishing House, 1997 Rich, Gerald et.al., Hazardous Waste Management Technology, Podvan Publishers, 1987
2. Bhide AD., Sundaresan BB, Solid Waste Management in Developing Countries, INSDOC, New Delhi,1983.

LEARNING OUTCOME:

Students will gain knowledge about the waste to energy power plant site survey and installation procedures.

24REVC2207 **L 0 T 0 P 3**

WASTE TO ENERGY LABORATORY

OBJECTIVE:

- To understand the basic concepts of waste to energy conversion

1. Introduction of various waste to energy conversion methodology
2. Study on biochemical energy conversion
3. Study on thermochemical energy conversion
4. Study on working of gasifier
5. Study on COD and BOD
6. Experimental analysis of traditional cook stove
7. Experimental analysis of wooden log stove
8. Experimental analysis on wooden log stove with waste heat recovery
9. Proximate analysis of municipal solid waste - MSW
10. Proximate analysis of E-Waste

LEARNING OUTCOME:

At the end of the course, learner will able to understand the basics and experimental analysis of waste to energy conversion systems.

24REVC2208 **L 0 T 2 P 0**

SAFETY PRACTICES IN RENEWABLE ENERGY PROJECT SITE

OBJECTIVE:

- To understand and educate the students towards the industrial safety, with special focus on solar thermal and PV power plants.
- To make aware the electrical and mechanical safety in the workplace.
- To gain knowledge in the usage of personal protective equipment- PPE.

UNIT-I: INTRODUCTION TO INDUSTRIAL SAFETY

Basic Electrical safety – Mechanical safety – various Personal Protective Equipment (PPE) - Safety helmet, Safety souse, Safety belt, Ear plug, PVC hand glove, Cotton hand glove, Reflective jacket, Safety Gloves.

UNIT-II SAFETY - SOLAR PV ANS THERMAL PROJECT SITE

Identify requirements for safe work area and create a safe work environment - identify contact person when workplace safety policies are violated provide information about incident/violation. - identify the location of first aid materials and administer first aid -identify the personal protection equipment required for specific locations on-site -identify expiry dates and wear & tear issues of specified equipment -identify environmental hazards associated with the project site-identify heat and mechanical hazards. -identify personal safety hazards or work site hazards and mitigate hazards -select tools, equipment and testing devices needed to carry out the work - demonstrate safe and proper use of required tools and equipment - check access from ground to work area to ensure it is safe and in accordance with requirements

UNIT-III:SAFE WORKING PRACTICES AT WIND PROJECT SITE

Select the relevant protective clothing/equipment for specific tasks and work- state the name and location of relevant documents and people responsible for health and safety in the workplace - identify possible causes of risk at workplace and their mitigation measures -identify and follow warning signs on site -establish safe working procedures at the workplace ensure safe working practices when working at heights, confined areas and trenches. -Identify methods of accident prevention in the work environment follow safe operating procedures for lifting, carrying and transporting heavy objects& tools - inspect the work place on a regular basis for any signs of spillage.- ensure safe storage of flammable materials and machine lubricating oil -apply good housekeeping practices at all times by removal/disposal of waste products.

UNIT-IV FIRE SAFETY AND TACKLING EMERGENCY SITUATIONS

exhibit the use of various appropriate fire extinguishers on different types of fires correctly - demonstrate rescue techniques applied during fire hazard - administer appropriate first aid to victims were required e.g. in case of bleeding, burns, choking, electric shock, poisoning etc. - respond promptly and appropriately to an accident situation or medical emergency in real or simulated environments - participate in emergency procedures: raising alarm, safe/efficient, evacuation, correct means of escape, correct assembly point, roll call, correct return to work - report the accident to the relevant authority in the prescribed format - re-assess risk control measures, as required, in accordance with changed work practices and/or site conditions and undertake alterations - inspect/install fall protection and perimeter protection equipment ensuring adequacy for work and conformance to regulatory requirements - identify approved methods of moving tools and equipment to work area and minimize potential hazards associated with tools at heights - select and install appropriate signs and barricades - place tools and materials to eliminate or minimize the risk of items being knocked down - dismantle plant safely in accordance with sequence and remove from worksite to clear work area

UNIT-V: FIELD VISIT/ DEMO

Identify corporate policies required for workplace safety -Workplace safety visit for various power plants – demonstrate safe and accepted practices for personal protection (PPE)

TEXT BOOKS:

1. Kimberly Keller “Electrical safety code manual – A plan language guide to national electric code”, OSHA and NPFA 70E copyright 2010 Elsevier
2. U.S. Department of health and human service “An Introduction to safety for electrical engineers” NIOSH Instructional module

REFERENCE:

1. U.S. Department of Labor “Basic Electrical Safety” OSHA Office of Training and Education - ELECTRICAL/elbasic1/1-95

LEARNING OUTCOME:

Students will gain ample amount of knowledge in the basic electrical and mechanical safety and usage of personal protective devices (PPE) with guidelines and regulations codes

24REVC2209 INPLANT TRAINING L 0 T 0 P 6

(SOLAR / WIND / BIO ENERGY POWER PLANT O&M)

OBJECTIVE:

To sensitize students to now the operation and maintenance of Solar / Wind Power Plants

Student should undergo an inplant training in a Operation and Maintenance area of Solar / Wind Power Plant. Student should present a seminar about his / her learning during the inplant training . Evaluation is based on the report, Seminar Performance and *viva voce*.

MSE:

Report	-	60 marks

ESE:

Seminar	-	20 marks
Viva-Voce	-	20 marks

LEARNING OUTCOME:
At the end of the course learner will be able to get Renewable Energy Industrial Exposure

Semester- 5

24REVC3101 SMART GRID L 3 T 0 P 0

Objective:

- To understand the main issues of smart grid development

- To know the recent technologies that underpin for the smart grid development

Unit I

Introduction –driving the move towards Smart Grids globally and in India Smart Grid. Overview of how Indian power market is organized, operated and challenges being faced. How software can manage generation and optimize generator performance, Forecasting & basic trading, Demand response, Performance management

Unit II

Overview of power sector communications, Generic model of communication network needed for Smart-grid, Introduction to different communication technologies available in the market (Latest standards. Emphasis on importance of inoperability and standardization of communication protocols),

Unit III

Matrix of different technologies against the smart-grid communication needs in a given utility environment, AMI, AMR & MDA: How it works and how it will help to; reduce peaks manage networks more efficiently and contribute towards smarter grids,

Unit IV

Distribution Management Systems (DMS) and Meter Data Management (MDM) are improving energy efficiency and security of supply in Distribution Systems, In-home controls, Demand Side Management (DSM) Overview of Power Electronics in Electrical T&D Systems, Power Electronics in emerging Smart Grids

Unit V

Automation and Integration of Distributed Generation / Renewable Energy, Automation and Micro-grids. Challenges faced by the Transmission System Developing technology and systems that will enable smarter transmission of bulk energy (Metering, Trading mechanisms, AC – FACTS (STATCOM) DC – HVDC, Fault Current Limiters), Challenges faced by the Distribution Networks:(How to be more energy efficient, stable, reliable and environmentally friendly, Reducing losses.

Text Book

1. Join Grid wise & Smart grids groups in LinkedIn http://www.linkedin.com/
2. Sign up to Smart Grid News www.smartgridnews.com
3. US DoE Smart Grid Book http://www.oe.energy.gov/DocumentsandMedia/DOE_SG_Book_Single_Pages(1).pdf

References:

1. Technology enabling the transformation of India's power distribution http://www.infosys.com/newsroom/features/power-sector-report.pdf
2. Grid wise Alliance website http://www.gridwise.org/
3. European Union Smart Grids Technology Platform http://www.smartgrids.eu/

Learning Outcome:

- At the end of this course, students will gain knowledge about the smart grid and its various smart infrastructures.

24REVC3102 SMALL HYDRO POWER PLANTS L 2 T 0 P 0

Objective

To get a better knowledge about the working of small hydro power generation system and to know the basics of fluid mechanics

UNIT I FLUID PROPERTIES AND FLUID STATICS

Fluid – definition, distinction between solid and fluid - Units and dimensions - Properties of fluids -density, specific weight,specific volume, specificgravity, viscosity, compressibility, etc.,

UNIT II FLUID DYNAMICS

Fluid Kinematics – Classification and types of flow - velocity field and acceleration - continuity equation (one and three dimensional differential forms)- stream line-streak line-path line- stream function - velocity potential function - flow net. Fluid dynamics - equations of motion -Euler's equation along streamline - Bernoulli's equation – applications - venturimeter, orifice meter.

UNIT-3 SMALL HYDROPOWER SYSTEMS

Small Hydropower Systems - Overview of micro, mini and small hydro systems; Hydrology; Elements of pumps and turbine; Selection and design criteria of pumps and turbines; Site selection and civil works

UNIT-4 HYDRO TURBINES

Classification of turbines – heads and efficiencies – velocity triangles. Axial, radial and mixed flow turbines. Pelton wheel, Francis turbine and Kaplan turbines- working principles - work done by water on the runner

UNIT 5 PERFORMANCE TESTING

Speed and voltage regulation; Investment issues load management and tariff collection; Distribution and marketing issues: case studies; Potential of small hydro power in India. – SHP – Renovation and Modernization – Testing Methods

Text book

1. 'Fluid mechanics and hydraulic machines' by Dr.R.K. Bansal, Laxmi publications golden house new delhi,2007

REFERENCES

1. Systems, Chelsea Green Publishing Company; (1999)
2. Tong Jiandong(et al.) , Mini Hydropower , John Wiley, 1997
3. An Introduction to Fluid Dynamics by G.K. Batchelor

Learning Outcome:

- Students will get gain knowledge in Basics of fluid mechanics, fluid machines, small hydro power plant components

24REVC3103 PROJECT PLANNING AND COST ESTIMATION L 2 T 0 P 0

Objective

The aim is to provide a suitable framework for gaining insight in the process of preparation, appraisal, monitoring and control of a project.

Unit 1

Project preparation - Meaning and importance of Project; Types of project; Project life cycle; Project planning & implementation; Management action; Investment returns; Corporate strategy; Objectives of Project Planning, monitoring and control of investment projects.

Unit 2

Identification of investment opportunities; Pre -feasibility Studies; Project Preparation: Technical feasibility, estimation of costs, demand analysis and commercial viability, risk analysis, collaboration arrangements.

Unit 3

Planning Overview Strategy and Resource Allocation Generation and Screening of Project Ideas; financial planning; Estimation of fund requirements, sources of funds; Loan syndication for the projects. Tax considerations in project preparation and the legal aspects.

Unit 4

Project management tools, process, and plans and project planning tips; balanced scorecard, design project management; Project Management Templates, Preparation of project report – EPC – EPC Shedule preparation of Solar – Wind and Biomass Power Plants

Unit 5

Business criterion of growth, liquidity and profitability, social cost benefit analysis in public and private sectors, investment criterion and choice of techniques: Estimation of shadow prices and social discount rate. Financial evaluation: Project rating index; Time Value of Money; Investment Criteria; Project Cash Flows; Cost of Capital; Project Risk Analysis; Project Rate of Return; Special Decisions Situations

Text books

1. Chandra, P. (2009). Projects: Planning analysis, selection, financing, implementation and review (7th ed.). New Delhi: Tata McGraw Hill.
2. Clifford, F. G., & Larson, E. W. (2007). Project management the managerial process. New Delhi: McGraw-Hill.
3. Clifford, G. (2005). Project management. New Delhi: Tata-McGraw-Hill.

References

1. Bhalla, V. K. (2008). Financial management and policy. New Delhi: Anmol Publications.
2. Bhalla, V. K. (2008). Modern working capital management: Text and cases (7th ed.). New Delhi: Anmol Publications.
3. Bhavesh, M. P. (2000). Project management: Strategic financial planning, evolutions and control. India: Sangam Books.

4. Dhankar, R. S. (1995). Financial management of public sector undertakings. New Delhi: Westvill.
5. Gopalakrishnan, P. (2007). Project management. New Delhi: Tata McGraw Hill.
6. Machiraju, H. R. (2003). Introduction to project finance: An analytical perspective. New Delhi: Vikas publication.
7. Mantel, S. J., Meredith, J. R., Shafer, S. M., & Sutton, M. M. (2007). Project management (3rd ed.). India: Wiley.

Learning Outcome:

- At the end of this course, students will gain knowledge about the smart grid and its various smart infrastructures.

ENERGY ECONOMICS **L 3 T 0 P 0**

Semester : V **No. of Credits: 3**

Course Code : 24REVC3104 **No. of Hours: 48**

Objective

1. To help the students to understand the basics of energy economics and address to energy problems and issues

Specific Course Objectives of learning

1. To understand the importance of natural resources and energy economics.
2. To study relationship between energy and development.
3. To examine nexus between energy and environment.
4. To highlight energy planning and management
5. To document the energy profile in India.

Specific Course Outcomes

1. Understanding the concept of energy economics.
2. Learning the nexus between energy consumption and economic development.
3. Comparing and contrast between energy and environmental impact.
4. Understanding significance of energy conservation and management.
5. Gaining knowledge to compile the profile of various energy sources in India.

UNIT – I: INTRODUCTION TO ENERGY ECONOMICS (10 hrs)

Natural Resources – Classification – Importance – Role of Natural Resources in economic Development- Energy Resources – Classification – Properties and Forms of Energy – Energy Economics – Origin, Nature and Scope.

UNIT – II: ENERGY AND DEVELOPMENT (14 hrs)

Energy and Economic Development – Energy Indicators – Energy Intensity and Energy Elasticity – National and International Comparison – Per capita Energy and per capita Income.

UNIT – III: ENERGY AND ENVIRONMENT (12 hrs)

Energy Nexus Environment Crisis – Causes and Consequences – Remedial Measures – Impact of Energy Consumption and production on Environment.

UNIT – IV: ENERGY PLANNING AND MANAGEMENT (14 hrs)

Energy planning and energy conservation- meaning, ojectives and importance- energy management – Objectives and Importance – energy conservation- issues and challenges.

UNIT – V: INDIAN ENERGY SECTOR (14 hrs)

Indian Energy Sector – energy supply and demand in india- renewable energy programmes in india- green energy, scope and oppurtunities and barries.

Text Books:

1. Agarwal, S.K. (1985) 'Environment and Natural Resources Economics', Scott Foresman & Co., London.
2. Common, M. (1985) 'Environment and Resource Economics', London.
3. R. Perman, Y. Ma, J. Mc Gilvray, M. Common (2003) 'Natural Resource and Environmental Economics' Pearson, 3rd edition.
4. Richard Eden (1981) 'Energy Economics – Growth, Resources and Policies', Cambridge University Press, London.
5. TERI (2019) 'Teri Energy Data Directory and Year Book 2018 – 19', The Energy Research Institute, Delhi.

References:

1. Agarwal, M.C. and Monga, J.R. (1992) 'Economic and Commercial Geography', National Publishing House, Delhi
2. Anandan, M. and Ramaswamy, S., (2016) 'Oil Economics' MJP Publishers, Delhi.
3. Kneese. A.V and Sweeny, J.L, eds, (1993) 'Handbook of Natural Resource and Energy Economics', North Holland, Amsterdam, pp.61-124.
4. Munasinghe, M. and Meier, P (1993) 'Energy Policy and Modelling', Cambridge University Press, UK
5. Ramaswamy. S. and Anandan, M., (2019) 'Energy Development Issues and Policies' MJP Publishers, Delhi.

Course Outcomes:

CO1: Grasp the concept of energy economics.
CO2: Explore the relationship between energy consumption and economic development.
CO3: Analyze the interplay between energy and the environment.
CO4: Recognize the importance of energy conservation and management.
CO5: Develop skills in compiling profiles of different energy sources in India.

GANDHI'S LIFE, THOUGHT AND WORK L 2 T 0 P0

24REVC3105 **L 0 T 0 P 3**

ENTREPRENEURIAL PATHWAYS IN RENEWABLE ENERGY SECTOR

SOLAR BUSINESS DEVELOPMENT

Objective:

The aim is to provide a suitable framework for gaining business development insight for the business scope opportunities in the solar lighting solutions, Rooftop Photovoltaics systems and water pumping systems.

1. Assess the market and evaluate the market trends to decide the strategy for sale of solar solutions
2. Identify market opportunities and potential customers
3. Devise strategy to reach potential customer through business promotion techniques, media outreach plan, content for brochures and product catalogues, etc.
4. Identify the customer requirements
5. Clarify the customer queries with respect to solar lighting solutions / Rooftop Photovoltaics systems / water pumping systems
6. Assess the area of installation, power output expectation, budget, etc. during discussion with the customer
7. Create relevant solutions to meet customer requirements
8. Develop the working calculation sheet outlining the broad estimate for the solar lighting solutions / Rooftop Photovoltaics systems / water pumping systems
9. Prepare the cost benefit analysis for solar lighting solutions / Rooftop Photovoltaics systems / water pumping systems
10. Prepare a proposal for solar lighting solutions / Rooftop Photovoltaics systems / water pumping systems
11. Prepare a pitch for the customer and close the sale of solar lighting solutions / Rooftop Photovoltaics systems / water pumping systems
12. Create and manage a pipeline of potential customers of solar lighting solutions / Rooftop Photovoltaics systems / water pumping systems

Learning Outcome:

- At the end of this course, students will gain knowledge about the business development strategies on solar lighting solutions / Rooftop Photovoltaics systems / water pumping systems

WIND BUSINESS DEVELOPMENT

Objective

The aim is to provide a suitable framework for gaining business development insight in the small-scale wind power plants and its business scope opportunities

1. Assess the market and evaluate the market trends to decide the strategy for sale of small scale wind power plant
2. Identify market opportunities and potential customers
3. Identify the customer requirements
4. Clarify the customer queries with respect to small scale wind power plant
5. Assess the area of installation, power output expectation, budget, etc. during discussion with the customer
6. Create relevant solutions to meet customer requirements
7. Develop the working calculation sheet outlining the broad estimate for small scale wind power plant
8. Prepare the cost benefit analysis for small scale wind power plant
9. Prepare a proposal for small scale wind power plant
10. Prepare a pitch for the customer and close the sale
11. Create and manage a pipeline of potential customers

Learning Outcome:

- At the end of this course, students will gain knowledge about the business development methodologies on small scale wind power plant.

BIOMASS BUSINESS DEVELOPMENT

Objective

The aim is to provide a suitable framework for gaining business development insight in the field of biomass power generation and its business scope opportunities

1. Assess the market and evaluate the market trends to decide the strategy for sale of biomass power generation systems
2. Identify market opportunities and potential customers
3. Identify the customer requirements
4. Clarify the customer queries with respect to biomass power generation systems
5. Assess the area of installation, power output expectation, budget, etc. during discussion with the customer
6. Create relevant solutions to meet customer requirements
7. Develop the working calculation sheet outlining the broad estimate for biomass power generation systems
8. Prepare the cost benefit analysis for biomass power generation systems
9. Prepare a proposal for biomass power generation systems
10. Present possible raw material linkages, either available or to be developed by the client

11. Prepare a pitch for the customer and close the sale
12. Create and manage a pipeline of potential customers

Learning Outcome:

- At the end of this course, students will gain knowledge about the business development methodologies on biomass business development.

24REVC3106 FUNDAMENTALS OF GREEN HYDROGEN L 2 T 0 P 1

OBJECTIVE:

- Discuss the necessity of green hydrogen along with benefits and drawbacks of existing methods of hydrogen production.
- Discuss properties and characteristics of Hydrogen and its applications.
- Discuss key aspects related to Green Hydrogen production, transportation, storage and applications.
- Discuss the role and responsibilities of a Green Hydrogen Plant Technician and importance of doing this course.

Unit- 1 Introduction to Hydrogen

Isotopes Of Hydrogen, Properties of hydrogen, Thermodynamics properties, Hydrogen as fuel,energy content, comparison with other fuels, color coding, Hydrogen Production Methods.

Unit- 2 Hydrogen from splitting of water

Water Electrolysis, alkaline electrolysis, Polymer electrolyte membrane (PEM) electrolysis, Photo-electrolysis (photolysis), Photo-biological production (biophotolysis), Thermo-chemical water splitting, Biomass to hydrogen.

Unit- 3 Basics of Hydrogen Storage techniques

Composite tanks, Cryogenic liquid hydrogen, chemical hydrides, carbon based materials, metal hydrides.

Unit- 4 Introduction to Fuel Cells

Fuel Cells as Electrochemical Engines, Generic Fuel Cell and Stack, Classification of Fuel Cells, Potential Applications, History of Fuel Cell Development.

Unit- 5 Safety and Regulations

Safety Considerations in Hydrogen Handling and Storage, Codes and Standards for Hydrogen Storage Systems, classification of hydrogen hazards, compressed and liquid hydrogen related hazards, regulation, utilization of hydrogen in various sectors, global status and future directions.

Reference :

1. Hydrogen Fuel-Production, Transport, and Storage, edited by Ram B. Gupta, CRC Press, Taylor & Francis Group, 2009, ISBN – 978-1-4200-4575-8.
2. Fuel Cell Fundamentals by Ryan O'hayre, Suk-Won Cha, Whitney G. Colella, and Fritz B. Prinz, 2016, John Wiley & Sons, Inc. ISBN – 978-1-1191-1420-8.
3. Hydrogen Storage: State-Of-The-Art and Future Perspective by E. Tzimas, C. Filiou, S.D. Peteves and J.-B. Veyret, European Communities, 2003, ISBN – 92-894-6950-1.

Text Books:

1. Hydrogen Generation, Storage and Utilization, Zhang, J. Z., Li, J., Li, Y., Zhao, Y., John Wiley & Sons, 2014.
2. Sustainable Hydrogen Production, Dinçer, I., Zamfirescu, C., Elsevier, 2016.
3. Advances in Hydrogen Production, Storage and Distribution, Iulianelli, A., Basile, A., Elsevier, 2014.

24REVC3107 **MINI PROJECT** **L 0 T 0 P 4**

Student should take up project related to design and development of cost effective renewable energy gadgets. Also the student can do re-engineering of any renewable energy mini products with increase in effienciey / reduction in cost.

MSE:

Seminar I (Identification of Problem)	-	10 marks
Seminar II (Report on the progress of the project)	-	10marks
Seminar III (Findings and product development)	-	10 marks
Report prepartion	-	30 marks
Total	**-**	**60 marks**

ESE:

Viva Voce	-	**40 marks**
Total	**-**	**100 marks**

LEARNING OUTCOME:

At the end of the course learner will be able to design and develop new mini renewable energy related products.

24REVC3108 SOFTWARE SIMULATION LABORATORY L 0 T 0 P 2

OBJECTIVE:

- To educate the solar designing software knowledge to the individuals to design a Solar PV plant
- Working with the PV Syst and PV Sol software
- Shadow analysis using simulation software

1. To understand the basics of Various solar simulation software
2. To study the IV characteristics of the various PV module using PV syst and PV sol
3. To study the effect of tilt angle using software simulator
4. To study the radiation of the plant location using simulation software
5. Estimation of Power output of the PV module
6. To understand the working and operation of the PV Inverter
7. Development of Linear and dynamic temperature model using PV Sol
8. Performance and Output loss calculations od PV plant
9. Economic efficiency calculation using PVsyst and PVsol
10. Design of rooftop system using PVsol software simulator
11. 2D and 3D Shadow analysis using PVsol software

LEARNING OUTCOMES:

Students will gain practical exposure towards the solar simulation software of solar Photovoltaics.

24REVC3109 **L 0 T 0 P 6**

IN PLANT TRAINING

[RENEWABLE ENERGY BUSINESS DEVELOPMENT STRATEGIES]

OBJECTIVE:
To sensitize students to now the operation and maintenance of Solar / Wind Power Plants

Student should undergo an inplant training in a business development area of Solar / Wind / Biomass Power Plant. Student should present a seminar about his / her learning during the inplant training . Evaluation is based on the report, Seminar Performance and *viva voce*.

MSE:

Report	-	60 marks

ESE:

Seminar	-	20 marks
Viva-Voce	-	20 marks

LEARNING OUTCOME:
At the end of the course learner will be able to get Renewable Energy Industrial Exposure.

Semester- 6

24REVC3201 ENVIRONMENTAL IMPACT ASSESSMENT L 3 T 0 P 0

Objective:
Critical understanding of the use, strengths, and limitations of EIA and develop working familiarity with EIA methods and analytic techniques.

Unit I
Basic concept of EIA : Initial environmental Examination, Elements of EIA, - factors affecting E-I-A Impact evaluation and analysis, preparation of Environmental Base map, Classification of environmental parameters. E I A Methodologies: introduction, Criteria for the selection of EIA Methodology, E I A methods, Ad-hoc methods, matrix methods, Network method Environmental Media Quality Index method, overlay methods, cost/benefit Analysis.

Unit II
Impact of Developmental Activities and Land use: Introduction and Methodology for the assessment of soil and ground water, Delineation of study area, Identification of actives. Procurement of relevant soil quality, Impact prediction, Assessment of Impact significance, Identification and Incorporation of mitigation measures.

Unit III
E I A in surface water, Air and Biological environment: Methodology for the assessment of Impacts on surface water environment, Air pollution sources, generalized approach for assessment of Air pollution Impact. Assessment of Impact of development Activities on Vegetation and wildlife, environmental Impact of Deforestation – Causes and effects of deforestation.

Unit IV
Environmental Audit & Environmental legislation objectives of Environmental Audit, Types of environmental Audit, Audit protocel, stages of Environmental Audit, onsite activities, evaluation of Audit data and preparation of Audit report.

Unit V
Post Audit activities, The Environmental pollution Act, The Water Act, The Air (Prevention & Control of pollution Act.), Mota Act, Wild life Act.Case studies and preparation of Environmental Impact assessment statement for various Industries.

Text Book:

1. Suresh K. Dhaneja – S.K.,Environmental Science and Engineering, Katania & Sons Publication., New Delhi.1998
2. Dr H.S. Bhatia Environmental Pollution and Control, Galgotia Publication (P) Ltd, Delhi, 1996

References:

1. Y. Anjaneyulu, Environmental Impact Assessment Methodologies, B.S. Publication, Sultan Bazar, Hyderabad. 2002
2. J. Glynn and Gary W. Hein Ke Environmental Science and Engineering, Prentice Hall Publishers 2000.

Learning Outcome:
- At the end of this course, students will gain knowledge about energy and its environmental impact analysis of various source of energy

24REVC3202 **GREEN BUILDING S** **L 3 T 0 P 0**

Objective: To assert the need, opportunities and demand of green buildings

Unit I: Introduction to architecture; Building science and its significance; Energy management concept in building - Thermal Analysis And Design For Human Comfort - Thermal comfort; Criteria and various parameters; Psychometric chart; Thermal indices, climate and comfort zones; Concept of sol-air temperature and its significance; Calculation of instantaneous heat gain through building envelope;

Unit II: Calculation of solar radiation on buildings; building orientation; Introduction to design of shading devices; Overhangs; Factors that effects energy use in buildings; Ventilation and its significance; Air-conditioning systems; Energy conservation techniques in air-conditioning systems Passive Cooling And Heating Concepts - Passive heating concepts: Direct heat gain, indirect heat gain, isolated gain and sunspaces; Passive cooling concepts: Evaporative cooling, radiative cooling; Application of wind, water and earth for cooling; Shading, paints and cavity walls for cooling; Roof radiation traps; Earth air-tunnel.

Unit III: Heat Transmission In Buildings - Surface co-efficient: air cavity, internal and external surfaces, overall thermal transmittance, wall and windows; Heat transfer due to ventilation/infiltration, internal heat transfer; solar temperature; Decrement factor; Phase lag - Design of daylighting

Unit IV: Estimation of building loads: Steady state method, network method, numerical method, correlations; Computer packages for carrying out thermal design of buildings and predicting performance. Bioclimatic Classification - Bioclimatic classification of India; Passive concepts appropriate for the various climatic zones in India; Typical design of selected buildings in various climatic zones; Thumb rules for design of buildings and building codes.

Unit V: Energy Efficient Landscape Design -Modification of microclimatic through landscape element for energy conservation; Energy conservation through site selection, planning, and design; Siting and orientation – GRIHA – Certification of Green Buildings - ECBC – DC Consumers – Standards – Labelling

References:

- M.S.Sodha, N.K. Bansal, P.K. Bansal, A. Kumar and M.A.S. Malik, Solar Passive Building, Science and Design, Pergamon Press, 1986.
- J.R. Williams, Passive Solar Heating, Ann Arbar Science, 1983
- R.W.Jones, J.D. Balcomb, C.E. Kosiewiez, G.S. Lazarus, R.D. McFarland and W.O. Wray, Passive Solar Design Handbook, Vol. 3, Report of U.S. Department of Energy (DOE/CS-0127/3), 1982.
- J Krieder and A Rabi Heating and Cooling of Buildings: Design for Efficiency, McGraw-Hill (1994) R D Brwon, T J Gillespie, Microclimatic Landscape Design, John Wiley & Sons, New York, 1990.
- D.S. Lal, Sharda Pustak Bhawan, Climatology, Allahabad, (2003).
- Majumder Milli, Energy Efficient Buildings, TERI, New Delhi 2002.
- T A Markus, E N Morris, Building, Climate and Energy, Spottwoode Ballantype Ltd. London, 1980.

Learning Outcome:

- At the end of this course, students will gain knowledge about green building in terms of design , estimation and performance.

24REVC3203 ENERGY STORAGE L 3 T 0 P 0

Objective: The aim is to provide a suitable knowledge pack for acquisition of energy storage technologies of various renewable and non-renewable energy sources.

UNIT I:

Potential energy: Pumped hydro storage; KE and Compressed gas system: Flywheel storage, compressed air energy storage; Electrical and magnetic energy storage: Capacitors, electromagnets; Chemical Energy storage: Thermo-chemical, Photochemical, bio-chemical, electro-chemical, fossil fuels and synthetic fuels. Hydrogen for energy storage- Solar Ponds for energy storage

UNIT II

Batteries: Primary, Secondary batteries; difference between primary and secondary batteries, chemistries of primary batteries such as Zinc-Carbon, Alkaline and secondary batteries such as Lead acid, Nickel Cadmium, Metal hydrides, lithium ion, lithium phosphate and high temperature batteries- sodium-Sulphur. Advantages, disadvantages, limitations and application each above mentioned batteries

UNIT III

Superconducting Magnet Energy Storage (SMES) systems; Capacitor and Batteries: Comparison and application; Super capacitor: Electrochemical Double Layer Capacitor (EDLC), principle of working, structure, performance and application, role of activated carbon and carbon Nano-tube

UNIT IV

Fuel cell definition, historical developments, working principle of fuelcell, components of fuel cell, EMF of the cell and general performancecharacteristics, Types of fuel cells, Advantages and disadvantages of fuel cells.Thermodynamic principles, fuel cell efficiency, Classification of SolidOxide fuel cells (SOFCs): Design, operating temperature and support.Components of SOFC, Cell operation and performance

UNIT V

Present status of applications, Utility use (conventional power generation, grid operation & service), Consumer use (uninterruptable power supply for large consumers), and new trends in applications, Renewable energy generation, Smart Grid, Smart Micro grid, Smart House, Electric vehicles.

Text book

1. Doughty Liaw, Narayan and Srinivasan, “Batteries for Renewable Energy Storage”, The Electrochemical Society, New Jersy,2010
2. Rai. G.D, “Non-conventional energy sources”, Khanna publishers, 2004.

References

1. Jiujun Zhang, Lei Zhang, Hansan Liu, Andy Sun, Ru-Shi Liu, “Electrochemical Technologies for Energy Storage and Conversion”, John Wiley and Sons, 2012
2. Francois Beguin and Elzbieta Frackowiak, “Super capacitors”, Wiley, 2013.

Learning Outcome:

- At the end of this course, students will gain knowledge about various energy storage technologies and methodologies of renewable and non-renewable energy sources

24REVC3204 **L 3 T 0 P 0**

UNIVERSAL HUMAN VALUES AND PROFESSIONAL ETHICS

Course Objective:

CO1 : Development of a holistic perspective based on self-exploration about themselves

(human being), family, society and nature/existence.

CO2 : Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence

CO3 : Strengthening of self-reflection.

CO4 : Development of commitment and courage to act.

Unit I

Course Introduction - Need, Basic Guidelines, Content and Process for Value Education . Purpose and motivation for the course, recapitulation from Universal Human Values. Self-Exploration– what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration Continuous Happiness and Prosperity- A look at basic Human Aspirations Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct Priority Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario Method to fulfil the above human aspirations: understanding and living in harmony at various levels. Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking

Unit II:

Understanding Harmony in the Human Being - Harmony in Myself! Understanding human being as a co-existence of the sentient 'I' and the material 'Body' Understanding the needs of Self ('I') and 'Body' - happiness and physical facility Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer) . Understanding the characteristics and activities of 'I' and harmony in 'I' . Understanding the harmony of I with the Body: Sanyam and Health; correct

appraisal of Physical needs, meaning of Prosperity in detail. Programs to ensure Sanyam and Health. Include practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease

Unit III:

Understanding Harmony in the Family and Society- Harmony in HumanHuman Relationship Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship Understanding the meaning of Trust; Difference between intention and Competence Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family. Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives

Unit IV

Understanding Harmony in the Nature and Existence - Whole existence as Coexistence 18. Understanding the harmony in the Nature Interconnectedness and mutual fulfilment among the four orders of naturerecyclability and selfregulation in nature Understanding Existence as Co-existence of mutually interacting units in allpervasive space Holistic perception of harmony at all levels of existence. Include practice sessions to discuss human being as cause of imbalance innature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

Unit V : Implications of the above Holistic Understanding of Harmony on Professional Ethics Natural acceptance of human values Definitiveness of Ethical Human Conduct. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems. Case studies of typical holistic technologies, management models and production systems Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations

Text Book:

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010

References:

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.

2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.

3. The Story of Stuff (Book).

4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi

5. Small is Beautiful - E. F Schumacher.

6. Slow is Beautiful - Cecile Andrews

7. Economy of Permanence - J C Kumarappa

8. Bharat Mein Angreji Raj - PanditSunderlal

9. Rediscovering India - by Dharampal

10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi

11. India Wins Freedom - Maulana Abdul Kalam Azad

12. Vivekananda - Romain Rolland (English)

13. Gandhi - Romain Rolland (English)

24REVC3205 RENEWABLE ENERGY PRODUCT DEVELOPMENT L 0 T 0 P 10

Student should take up project related to design and development of cost effective renewable energy gadgets. Also the student can do regineering of any renewable energy products with increase in effienciey / reduction in cost.

MSE:

Seminar I (Identification of Problem)	-	25 marks
Seminar II (Report on the progress of the project)	-	25 marks
Seminar III (Findings and product development)	-	25 marks
Report prepartion	-	50 marks
Total	**-**	**125 marks**

ESE:

Viva Voce	-	**75 marks**
Total	**-**	**200 marks**

LEARNING OUTCOME:
At the end of the course learner will be able to design and develop new gadgets on renewable energy

24REVC3206 INDUSTRIAL TRAINING L 0 T 0 P 8

OBJECTIVE:
To sensitize students to know the plant operation and performance analysis of existing renewable energy plants

Student should undergo an industrial training in any of the Renewable Energy Plant for a period of 30 calender days. Student should present a seminar about his / her learning during the training . Evaluation is based on the report, Seminar Performance and *viva voce*.

MSE:

Report & Attendance	-	**125 marks**

ESE:

Viva-Voce	-	**75 marks**
Total	-	**200 marks**

LEARNING OUTCOME:
At the end of the course learner will be able to get Renewable Energy Industrial Exposure

Semester - 7

24REVC4101 THERMAL ENGINEERING L 3 T 0 P 0

COURSE OBJECTIVES:

1. To learn the concepts and laws of thermodynamics to predict the operation of thermodynamic cycles and performance of Internal Combustion(IC) engines and Gas Turbines.

2. To analyzing the performance of steam nozzle, calculate critical pressure ratio

3. To Evaluating the performance of steam turbines through velocity triangles, understand the need for governing and compounding of turbines

4. To analyzing the working of IC engines and various auxiliary systems present in IC engines

5. To evaluating the various performance parameters of IC engines

UNIT I THERMODYNAMIC CYCLES

Air Standard Cycles – Carnot, Otto, Diesel, Dual, Brayton – Cycle Analysis, Performance and Comparison, Basic Rankine Cycle, modified, reheat and regenerative cycles.

UNIT II INTERNAL COMBUSTION ENGINES

Internal combustion engines - classification, components and functions - Fuel supply systems - Ignition Systems - Lubrication system and cooling system - Performance calculation - Heat balance sheet.

UNIT III GAS TURBINES

Gas turbine cycle analysis – open and closed cycle. Performance and its improvement - Regenerative, Intercooled, Reheated cycles and their combinations. Materials for Turbines.

UNIT IV AIR COMPRESSORS

Classification and working principle - work of compression with and without clearance, volumetric efficiency, isothermal efficiency and isentropic efficiency of reciprocating air compressors. Multistage air compressor, Work of compression. Rotary compressors - Centrifugal, vane and roots blower, screw compressors.

UNIT V REFRIGERATION AND AIR-CONDITIONING

Vapour compression refrigeration cycle - Effect of operating conditions on COP, performance calculations. Working principle of vapour absorption system- Ammonia-water, Lithium bromidewater systems (Elementary treatment only), comparison between vapour compression and absorption systems. Cooling load calculations, Concept of RSHF, GSHF, ESHF, Air conditioning systems.

OUTCOMES:

At the end of the course the students would be able to

1. Apply thermodynamic concepts to different air standard cycles and solve problems.

2. To solve problems in steam nozzle and calculate critical pressure ratio.

3. Explain the flow in steam turbines, draw velocity diagrams, flow in Gas turbines and solve problems. 4. Explain the functioning and features of IC engine, components and auxiliaries.

5. Calculate the various performance parameters of IC engines

TEXT BOOKS:

1. Mahesh. M. Rathore, “Thermal Engineering”, 1st Edition, Tata McGraw Hill, 2010.

2. Ganesan.V, " Internal Combustion Engines" 4th Edition, Tata McGraw Hill, 2012.

REFERENCES:

1. Ballaney. P, “Thermal Engineering”, 25th Edition, Khanna Publishers, 2017.

2. Domkundwar, Kothandaraman, &Domkundwar, “A Course in Thermal Engineering”, 6th Edition, DhanpatRai& Sons, 2011.

3. Gupta H.N, “Fundamentals of Internal Combustion Engines”, 2nd Edition Prentice Hall of India, 2013.

4. Mathur M.L and Mehta F.S., “Thermal Science and Engineering”, 3rd Edition, Jain Brothers Pvt. Ltd, 2017. 5. Soman. K, “Thermal Engineering”, 2nd Edition, Prentice Hall of India, 2011.

24REVC4102 POWER ELECTRONICS L3 T0 P0

Objective:

➢The main objective of power electronics is to devise efficient, compact, and economical techniques for transforming and regulating electrical energy between different forms.

➢To know the recent electronics used in renewable energy

Unit I – Introduction

What is Power Electronics?- Power Electronics Applications-Power Semiconductor Devices and Their Classifications-Power Semiconductor Devices: Characteristics and Ratings
Ideal and Real Switches: Comparison of Characteristics-Power Electronic Systems
Types of Power Electronic Circuits/Converters-Merits and Demerits of Power Electronic Converters

Unit II- Power Switching Devices and their Characteristics

Power diodes-Diode V-I Characteristics,Diode Reverse Recovery Characteristics,Types and Ratings of Power Diodes- Series and Parallel Operation of Diodes-Thyristor Structure symbol and V-I Characteristics-snubber circuits- Other Thyristor devices-TRIAC,DIAC-Power transistors – BJT,MOSFET,IGBT.

Unit III –AC to DC converters

Preliminary phase control- The principle of phase control-converter clssification-single phase fullwave thyristor converters-single phase full wave bridge converters-Three phase thyristor converter circuit- AC to AC Converters, DC to DC Converters

Unit IV – Inverters

Inverters-classification (Prallel inverters,series inverters)- single phase bridge voltage source inverters-force commutated thyristor inverter-Three phase bridge inverter-voltage control in single phase inverter-current source inverter

Unit V – Power controllers and their applications

DC motor speed control-Phase controlled converterschopper controlled DC drives-AC drives - Synchronous motor control – Static circuit breaker-HVDC transmission- Uninterrupted Power supply(UPS)

Text Book

- V.Jagannathan “Power Electronics Devices and Circuits”-Second Edition.
- “Power Electronics :Devices Circuits and applications” By Muhammad H.Rasshid,1988

References:

- **https://zealpolytechnic.com/wp-content/uploads/2023/04/Power-Electronics-by-Ps-bimbhra.pdf**
- **https://mrcet.com/downloads/digital_notes/EEE/31082020/Power%20Electronics.pdf**
- **https://powerunit-ju.com/wp-content/uploads/2016/11/Book-Power_Electronics_Handbook_3rd_Edition_M_Rashid.pdf**

Learning Outcome:

At the end of this course, students will gain knowledge about the power electronics used in renewable energy.

24REVC4103 ENGINEERING MATHEMATICS L 3 T 0 P 0

Course Objective:

This course aims to equip students with a solid foundation in advanced calculus concepts, preparing them for practical applications in engineering, physics, and other related fields.

UNIT- I Differential Calculus

Standard Formulae (Except Hyperbolic Function) - Derivative of Sum, difference - Multiplication and Division of two Functions - Differentiation of Function of a Function - Logarithmic Differentiation - Differentiation of Implicit Functions - Differentiation of Parametric Functions - Differentiation by Trigonometric Transformations Differentiation of a Function w.r.t another Function - Second Order Derivative - Maxima and Minima of Function with one Variable.

UNIT- II Tracing of curves

Tracing of curves: Tracing of curves – Folium of Descarte's – cycloid, cardioid and Lemniscate of Bernoulli.

UNIT-III Integral Calculus

Integral Calculus: Properties of definite integral – Bernoulli's formula & reduction formulae – double and triple integrals – changing the order of integration – Jacobians and change of variables.

UNIT-IV Beta and Gamma functions

Beta and Gamma functions: Beta and Gamma functions – applications of Beta and Gamma functions in evaluation of double and triple integrals, improper integrals.

UNIT- V Laplace Transform

Laplace Transform: Definition – Conditions for existence - Transform of elementary functions – Properties of Laplace transform – Inverse Laplace transform – Applications to differential equations.

OUTCOMES:

On successful completion of the course, the students will be able to

CO1: define function, limit and continuity and solve problems in differential Calculus.

CO2: perform cartesian and parametric form.

CO3: evaluate the integrals.

CO4: deal with beta and gamma functions.

CO5: apply Laplace and Inverse Laplace transforms to solve ODE.

Text Books:

1. Manickavasagam Pillai T.K., T. Natarajan, Calculus, Vol. I S. Viswanathan Printers, 2014. Unit

4: Chapter II, V (Max-Mini problems)

2. Paulraj Joseph & G. Mahadevan, A text book of Calculus, Anuradha Publications, 2016. Unit II: Chapter 4, Sec 4.1 – 4.4 Unit III: Chapter 5, Sec 5.1 – 5.4 Chapter 6, Sec 6.1 – 6.9 Unit IV: Chapter 7, Sec 7.1 – 7.3

3. T.K. Manicavachogom Pillay, T. Natarajan & K.S. Ganapathy, Calculus Vol. III, S.ViswanathanPvt. Ltd., Chennai, 2010. Unit V: Chapter V, Sec. 1 – 7

REFERENCES:

1. S. Narayanan & T.K. Manicavachogom Pillay, Ancillary Mathematics, S. Viswanathan Pvt. Ltd., Chennai, 2002.

2. Arumugam S. and A. Thangapandi Isaac. Calculus, New Gamma Publishing House, 2012.

24REVC4104 ELECTRICAL MACHINES L 3 T 0 P 0

Objective:

- To understand the basic working principle, constructional details, operational features & characteristics and testing of different types of electrical machines which are widely used in industry

- To expose the students to the concepts of various types of electrical machines and their applications.

Unit I - Introduction to Electrical Machines

Introduction-Principle of Energy Conversion-Faraday's Law of Electromagnetic Induction-Singly and Multiply-Excited Magnetic Field Systems-Torque Production in Rotating Machines-General Analysis of Electromechanical System-Types of machines.

Unit II - DC Generator (DC Machines)

Principle of a generator- Types of d.c generators & load characteristics: construction of DC generator-Methods Of Excitation - Separately Excitecd Generators and self Excited Generators - Load Characteristics Of Shunt, Series And Compound Generators –Parallel Operation Of D.C Generators.

UNIT III – DC Motors (DC Machines)

D.C Motors- principle's operation Types of DC motors, characteristics and application of separately excited,shunt,series and compound motors-Armature reaction and commutation-speed control of dc motor-.Lossess ,efficiency and testing of DC machines esting of D.C. Machines: Losses - Constant & Variable losses- calculation of efficiency – conditions for maximum efficieny-Methods of Testing - direct, indirect and regenerative testing - brake test – Swinburne's test-Hopkinson's test - Field's test - Retardation test - separation of stray losses in a DC motor test.

UNIT IV- AC Generator (AC Machine)

Poly phase circuits -inter connection of three phases-Unbalanced star and delta connection-Transformers-constructions working principle and testing of transformers-Windings,terminals,Tappings,Brushes - Single phase transformer and three phase transformer-CT and PT(Instrument transformer)- Synchronous generators or alternators

UNIT V - AC Motor(AC machines)

Poly phase Induction motors – classification of AC motor and its constructional details - Slip,Frequency,Rotor EMF,Torque -single phase motors-types of single phase motor-synchronous motor and its constructional details.

TEXT BOOKS:

1. Electrical Machines, P.S. Bimbra, Khanna Publishers.
2. Principles of Electrical Machines, V. K. Mehta, Rohit Mehta, S. Chand Publishing.
3. Electric Machines by I.J. Nagrath & D.P. Kothari, Tata Mc Graw-HillPublishers.

REFERENCE BOOKS:

1. Electric Machines, Mulukutla S. Sarma, Mukesh K. Pathak, Cengage Learning.
2. Fundamentals of Electric Machines, B. R. Gupta, Vandana Singhal, New Age

International Publishers.
3. Electrical Machines, M. V. Deshpande, PHI Learning Private Limited.
4. Electrical Machines, R. K. Srivastava, Cengage Learning.

24REVC4105 ELECTRICAL VEHICLE OPERATION AND MAINTENANCE L 2 T 0 P 2

Course Objectives:

CO1 : Describe the fundamentals of Electric Vehicles
CO2 : Design and Analysis of the Electric Vehicles
CO3 : Repair and maintenance of the Electric Vehicles
CO4 : Understand the concepts of regular maintenance routine and troubleshooting
CO5 : Study on various recent EV Technologies

Unit-1 Introduction

Introduction to Electric Vehicles- Automotive Industry-Current Market Scenario of EVs in India-Classification of EV- Plugin hybrid vehicle, BEV, SPEV- Government Initiatives to Promote EV-Sustainable development goals-climate change- Organisational Skills Hazard Identification and Prevention Energy Conservation Practices 5S for Lean Management Health and Safety Standards.

Unit-2 Plan for Proper Operation and Maintenance of EV

Identify the EV, its manufacturer's specifications, and functioning from the user manual and vehicle drawings - interpret the maintenance checklist and coordinate with the superior to confirm the maintenance tasks - read the maintenance schedule of EV and plan the time and schedule for conducting the maintenance - identify and arrange the tools, consumables and spare parts required during the task.

Unit-3: Troubleshooting of Mechanical Components

Introduction to components of EV-working principle-classifications-Inspection of Faults in the Mechanical Systems in EV-Overview of Components in EV Handling High Voltage (HV) Safely and Servicing -Major component location

Unit-4: Troubleshooting of Electrical and Electronics Components

Overview of Electronic Wiring Diagrams and Symbols Basic Electrical Principles, EV-Electrical System Components Overview-Servicing and Maintaining Electronic Aggregates-Troubleshooting - Systems Function- Battery maintenance- Electric motor maintenance and repair- Troubleshooting techniques of throttle, wiring harness, controller, response from the various other components- understanding of warning lights and fault ride through.

Unit-5 Preventive Maintenance and Documentation

Preventive maintenance and servicing- regular routine checklist-weekly-monthly- Perform basic health check-up of vehicle for defined performance parameters such as battery status, sensor calibration, actuators status, other electronic circuitry response, etc. as specified in the maintenance checklist-Advanced diagnostics and repair- battery health monitoring- thermal management-preventive maintenance instruments and tools – Documentation of the service and service record

all repairs carried out, time taken, and unplanned tasks encountered during the maintenance activities.

Course Outcome :

- A basic level of repair and maintenance knowledge skillset
- Understanding of common running repairs and troubleshooting
- Identification of common faults and ride-through to address the issue
- Recognition of preventive maintenance and regular checklist for the better healthy operation of EV

TEXT BOOKS:

- Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
- Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.

REFERENCES:

1. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
2. Automotive Skills Development Council and National Skill Development Corporation , "Electric Vehicle Maintenance Technician" – Electrical QP Code: ASC/Q6809, NSQF Level:4.
3. Norman G. Meade, The Electric Vehicle, Its Construction, Operation and Maintenance, Legare Street Press, 2023 ISBN:9781019410332.

24REVC4106 TRANSMISSION AND DISTRIBUTION FOR ELECTRICAL NETWORKS L 2 T 0 P 2

Objective:

- To enable the students to understand the economic aspects of power generation, analyse the performance of transmission lines, distribution systems, insulators and cables.

Unit I - Electrical and mechanical design of overhead lines

Constants of Transmission lines-Skin Effect-Flux Linkages- Inductance of Single phase and Three phase Overhead Lines-Main components of Overhead Lines-Conductor materials – Insulators and its types- Corona –Factors affecting Corona.

Unit II – Performance of transmission lines

Classification of overhead Transmission Lines-Important Terms-Performance of Single Phase ShortTransmission Lines-Three-Phase ShortTransmission Lines- Medium Transmission Lines-End Condenser Method-Nominal T Method Nominal Method- Long Transmission Lines.

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UNIT III – Underground cables

Underground Cables- Economical Construction of Cables-Insulating Materials for Cables-Classification of Cables-Cables for 3-Phase Service-Laying of Underground Cables-Insulation Core Cable- Dielectric Stress in a Single Core Cable- Thermal resistance of dielectric of single-Types of cable faults-Murray loop test-Varley loop test.

UNIT IV- Distribution Systems

Distribution System-Classification of Distribution Systems-A.C. Distribu-tion-D.C. Distribution-Methods of obtaining 3-wire D.C. System Over- head versus Underground System- Connection Schemes of Distribution System-Requirements of a Distribution System-Design Considerations in Distribution System.

UNIT V – Protecctive Devices

Introduction to Switchgear – Symmetrical Fault –Unsymmetrical Fault-Circuit Breakers-Arc phenomena- Classification of Circuit Breaker- MCB,MCCB,ELCB,RCCB-Fuses- Desirable Characteristics – Types of Fuse -Protective Relays.

TEXT BOOKS:

1. Principles of Power systems, V. K. Mehta, Rohit Mehta, S. Chand Publishing.
2. Power system Engineering, A.Chakrabarti,M.L.Soni, P.V.Gupta,U.S.Bhatnagar.

REFERENCE BOOKS:

1. http://www.iqytechnicalcollege.com/BAE%20670-Power%20System%20Engineering.pdf
2. https://g.co/kgs/6CAMVBY
3. https://gcebargur.ac.in/sites/gcebargur.ac.in/files/lectures_desk/MPSA-Sol.pdf

24REVC4107 PLC AND PROGRAMMING L 0 T 2 P 2

UNIT-1: INTRODUCTION TO PLC

Introduction to Programmable Logic Controller - Development of PLC - Components of PLC - Key concepts to understand PLC computing- Real Time Computing- Importance of Time Based Control - Time-Based Control - Event-Triggered Control - Scan-Based Control

UNIT-2: LADDER LOGIC PROGRAMMING

Basics of Ladder Logic - Basic Symbols and Notations - Normally Open Contact - Normally Open Coil - Normally Closed Contact Normally Closed Coil - Basic AND & OR Gates - Basic Timers & Counters - Ladder Logic Programming

UNIT-3 INPUT AND OUTPUT COMPONENTS

Human Machine Interface – scan process – data flow in PLC –Scan patterns – Horizontal and vertical scan –Programming language – parallel branch input instructions- modes of operation – Program – run – test –Remote mode

UNIT-4 SCADA SYSTEMS

SCADA SYSTEMS Introduction, definition and history of Supervisory Control and Data Acquisition, typical SCADA System Architecture, Communication Requirements, Desirable properties of SCADA system, Features, advantages, disadvantages and applications of SCADA.

UNIT-5 SCADA ARCHITECTURE

First generation-Monolithic, Second Generation-Distributed, Third generation Networked Architecture, SCADA.

TEXT BOOKS:

1. Allen-Bradley “Micro Logix_ 1000 Programmable Controllers” (Bulletin 1761 Controllers)-User manual
2. Ronald L Krutz, “Securing SCADA System”, Wiley Publication
3. “PLC and Industrial application”, Madhuchhandan Gupts and Samarjit Sen Gupta, pernram international pub (Indian) Pvt. Ltd., 2011.

REFERENCE:

- 1. Gary Dunning, “Introduction to Programmable Logic Controllers”, Thomson, 2nd Edition.
- 2. Stuart A Boyer, “SCADA Supervisory Control and Data Acquisition”, ISA, 4th Revised edition
- 3. John W Webb, Ronald A Reis, “Programmable Logic Controllers: Principles and Application”, PHI Learning, New Delhi, 5th Edition

LEARNING OUTCOME:

At the end of the course students will gain ample amount of knowledge in the basic of PLC and SCADA systems.

A systems in operation and control of interconnected power system, Power System Automation, Petroleum Refining Process, Water Purification System, Chemical Plan

24REVC4108 COMPUTER AIDED DESIGNING L 2 T 0 P 1

OBJECTIVES:

- To provide an overview of how computers are being used in mechanical component design
- To understand the application of computers in various aspects of Manufacturing viz.,

Design, Proper planning, Manufacturing cost, Layout & Material Handling system.

UNIT I FUNDAMENTALS OF COMPUTER GRAPHICS

Product cycle- Design process- sequential and concurrent engineering- Computer aided design – CAD system architecture- Computer graphics – co-ordinate systems- 2D and 3D transformations- homogeneous coordinates - Line drawing -Clipping- viewing transformation.

UNIT-II GEOMETRIC MODELING

Representation of curves- Hermite curve- Bezier curve- B-spline curves-rational curves- Techniques for surface modeling – surface patch- Coons and bicubic patches- Bezier and B-spline surfaces. Solid modeling techniques- CSG andB-rep.

UNIT-III VISUAL REALISM

Hidden- Line-Surface- Solid Removal algorithms- shading- colouring- computer animation.

UNIT- IV ASSEMBLY OF PARTS

Assembly modelling, interferences of positions and orientation, tolerance analysis, mass property calculations, mechanism simulation and interference checking.

UNIT- V CAD STANDARDS

Standards for computer graphics- Graphical Kernel System (GKS) - standards for exchange images- Open Graphics Library (OpenGL) - Data exchange standards - IGES, STEP, CALS etc. - communication standards.

OUTCOMES:

Upon the completion of this course the students will be able to

CO1 Explain the 2D and 3D transformations, clipping algorithm, Manufacturing models and Metrics CO2 Explain the fundamentals of parametric curves, surfaces and Solids

CO3 Summarize the different types of Standard systems used in CAD

CO4 Apply NC & CNC programming concepts to develop part programme for Lathe & Milling Machines

CO5 Summarize the different types of techniques used in Cellular Manufacturing and FMS

TEXT BOOKS:

1. Ibrahim Zeid “Mastering CAD CAM” Tata McGraw-Hill PublishingCo.2007

2. Mikell.P.Groover “Automation, Production Systems and Computer Integrated Manufacturing”, Prentice Hall of India, 2008.

3. Radhakrishnan P, SubramanyanS.andRaju V., “CAD/CAM/CIM”, 2nd Edition, New Age International (P) Ltd, New Delhi,2000.

REFERENCES:

1. Chris McMahon and Jimmie Browne “CAD/CAM Principles", "Practice and Manufacturing management “ Second Edition, Pearson Education, 1999.

2. Donald Hearn and M. Pauline Baker “Computer Graphics”’. Prentice Hall, Inc,1992.

3. Foley, Wan Dam, Feiner and Hughes - "Computer graphics principles & practice" Pearson Education -2003

4. William M Neumann and Robert F.Sproul “Principles of Computer Graphics”, McGraw Hill Book Co. Singapore, 1989.

24REVC4109 ADVANCES IN PV SYSTEM DESIGN L0 T0 P3

OBJECTIVES:

To impart knowledge and skill to familiarize with design of solar PV system for electrical energy

requirements, sizing of PV modules, battery, electronics, etc and to get acquainted with solar simulation software.

UNIT-I

Selection of PV module technology - Crystalline technology - Thin film technology - Bi-facial technology - Comparison between PV module technology - Comparison between solar power plant energy

output - Identify the electrical components associated with a PV system - DC Combiner box - DC Energy meters - Array junction Boxes(AC & DC Distribution Boxes) – Battery – Inverter - AC disconnect – switch - AC combiner box - Study the colour conventions and ratings for AC and DC cables used in a PV module - Earthing connections - Surge Protection Devices(both in dc and ac sides) - Lightning arrestor - Familiarize the operation of solar inverters - Pulse Width Modulated (PWM) Controller - Maximum Power Point Tracking (MPPT) Controller.

UNIT-II

Connection of PV Module(Series and Parallel Circuit) - Series Circuits - Parallel Circuits - Combining Series & Parallel Circuits - PV module string connection - Matching The PV Array to the Voltage Specifications of An Inverter - Matching the PV Array to the Inverter's Current Rating - Matching the PV Array to the Inverter's Power Rating - Summary of Calculations for Matching Array and Inverter - Develop a circuit to plot the V-I characteristics of a single solar panel and draw the equivalent circuit of a solar cell - Measurement of V-I characteristics of a single solar panel at various levels of insolation - Identify the best operating conditions of a single solar panel by observing the following effects on cell

Current - Effect of Colour (Wavelength) - Effect of Shading - Effect of Tilt Angle - Effect of Distance.

UNIT-III

Types of Solar Power Plant - Grid Connected solar Power Plant - Grid interactive solar power plant - Net Metering Solar Power Plant- Off-Grid / Hybrid solar power plant - Schemes of solar power plant - selection of site and shadow analysis - PV module structure interrow spacing calculation - Pitch analysis - Selection of PV module tilt angle - Near shading object calculation - Site survey and plant assessment - Type of solar radiation - Irradiance assessment and comparison- Solar Radiation Data - Sun path Diagram - Defining the Position of the Sun - Solar Altitude - Geometric Effects -Tilting Solar Modules - Magnetic North & True North - Selection of PV module - Characteristics of a Solar Cell – Power Characteristics of a Solar Cell - Fill factor and Equivalent Solar cell Circuit.

UNIT IV

Selection and Sizing (Grid Connection and Off Grid) - Types of solar inverter - Selection of string /central

/ off grid inverter - Selection of power conditioning unit (PCU) - Sizing of solar inverter for roof top and grid connected projects - Selection and sizing of string inverter - Selection and sizing of central inverter - AC/DC overloading calculation and losses - Protection requirement of solar inverter Passive and active protection - Anti- islanding protection - Mounting arrangement of string inverter - Apply suitable methods to calculate the energy demand of a given electrical installation and compare it with the electricity bill - Apply suitable methods for finding the ratings of a given off grid PV system Converter and Charge Controller Sizing - Inverter Sizing - Sizing of the Batteries - Sizing of the PV Array - Sizing of the Cables.

UNIT V

Preparation of single line diagram and plant array layout - Preparation of rooftop solar power (single line diagram) SLD - Preparation of Net Metering solar power (single line diagram) SLD - Preparation utility scale solar power (Ground mounted) SLD - Rooftop solar power plant layout - Ground mounted solar power plant layout - DC SLD /AC SLD - Protection SLD - Earthing Layout/ AC /DC cabling Layout - DC Block sizing layout - Overall Array Plant Layout - Familiarize with any solar simulation software and design a solar system - PV syst – PVSOL – SOLAR PRO or similar.

COURSE OUTCOMES:

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

1. Demonstrate and produce different types of solar PV system models.
2. Gain knowledge of development with simulation software's for the analysis of solar PV systems.
3. Understand the Basics operation and installation of major components in a solar PV system.
4. Perform & identify the procedures to size an Off Grid Solar PV System for the given load and backup time.

REFERENCES

1. C. S. Solanki, Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers, Prentice Hall of India, 2013.
2. Solanki, Chetan Singh, Renewable Energy Technologies: A Practical Guide for Beginners, PHI Learning.
3. Christopher Kitcher, A Practical Guide to Renewable Energy: Power Systems and their Installation: Microgeneration systems and their Installation.
4. Michael Boxwell,Solar Electricity Handbook - 2021 Edition: A simple, practical guide to solar energy - designing and installing solar photovoltaic systems.

Semester- 8

24REVC4201 CONTROL SYSTEM ENGINEERING L3 T0 P0

Objective:

- To Be Able To Obtain A Working Mathematical Model Of A System.
- To Be Able To Do Time-DomainAnd Frequency-Domain Analyses Of The Model To Predict The System's Behavior.

- To Be Able To Design Control Systems That Meet Design Specifications

Unit I : Introduction To Control Systems

Basic Concept Of Control Systems-Basic Terminologies In Control systems-Classification – Open Loop And Closed Loop Control System-Comparision Between Open And Closed Loop Control Systems- General Characteristics-Real And Reactive Power Control-Basicp-F And Q-V Control Loops-Overview Of Power System Control(Plant Level And System Level Control) – Unit Commitment

UNIT II : Mathematical Modelling

Mathematical Modelling of Electrical Systems, Mechanical Systems, Electro-Mechanical Systems. Laplace Transforms, Transfer Functions, Electrical Analogues Of Other Dynamical Systems. State-Space Modelling Of Dynamical Systems. Block Diagrams, Block Diagram Reductions. Signal Flow Graph, Mason's Gain Formula. Linearity, Time-Invariance Versus Nonlinearity And Time-Variance. Linearization. Distributed Parameter Systems.

UNIT III : Time Response Of Dynamical Systems

Obtaining Solutions From Mathematical Models. Poles And Zeros And Their Effects On Solutions. Step Response Of Standard Second Order Systems, Time-Domain Specifications And Their Formulae. Stability: Definition Of Stability. Routh-Hurwitz Test. Lyapunov Theory

UNIT IV : Properties Of Feedback

Basic Idea Of Feedback Control Systems. Error Analysis. P, PI, PD, PID Controllers. Design Of Controllers: The Root-Locus Technique, Steps In Obtaining A Root-Locus. Design Of Controllers Using Root-Locus. Pole Placement With State Feedback, Controllability. Pole Placement With Output Feedback, Observability, Luenberger Observer. LQR Control. Design Of Controllers: The Root-Locus Technique, Steps In Obtaining A Root-Locus. Design Of Controllers Using Root-Locus.

UNIT V: CONTROLLERS

Basic Control Action And Response Of Control Systems - Application Of Control Theory To Non-Engineering Fields- Economic Inflation Problem- Pollution Control In Auto Engine- Control Of Blood Pressure With Anesthesia.

TEXT BOOKS:

1. Control systemEngineering, I.J.Nagrath M.Gopal 1975,New Age international publishers.
2. Power system Operation and Control,M.Jeraldin Ahila A.R.S Publications.

REFERENCE BOOKS:

1. https://www.ee.iitb.ac.in/~debasattam/EE302/syllabus.pdf

2. https://mrcet.com/downloads/digital_notes/ECE/II%20Year/CONTROL%20SYSTEMS.pdf
3. https://www.jbiet.edu.in/pdffls/EEE-Coursematerial/Control-Systems-Notes.pdf

24REVC4202 STRUCTURAL DESIGN FOR RENEWABLE ENERGY SYSTEMS L 3 T 0 P 0

OBJECTIVES:

To state the basis of the analysis of the structure in solar and wind power systems.

To know different types of cement as per their properties for different field applications, properties of Aggregates and Admixture then understand & to describe the layout of hydroelectric power plant.

UNIT-I

Introduction - Objectives of the Design of Reinforced Concrete Structures - Compressive and tensile strength test, flexural strength and their relationship, factors affecting strength of concrete - Method of Design - Limit state method - Working stress method - Analysis of Structures - Design Loads - Loads and Forces - Dead loads - Imposed loads - Wind loads - Snow loads - Earthquake forces - Shrinkage, creep and temperature effects - Combination of loads - Other forces and effects.

UNIT-II

Basics and constituents of concrete - composition of concrete - Constituent of Concrete - Cement - Chemical composition, hydration, heat of hydration, hydrated structure, various types of cement, grades of cement, testing of cement as per Indian standard - Aggregates - Utility in concrete, classification, effect of geometry & texture, strength, mechanical properties, moisture content, water absorption, bulking of sand, deleterious substances, sieve analysis, various grading and grading requirements - Water - General Requirements & limiting values of impurities - Additives and admixtures - Additives and admixtures - Methods of batching and mixing. Workability -factors affecting workability, measurement tests on workability - characteristics of high strength concrete, high performance concrete, self-compacting Concrete, fiber reinforced concrete, light weight and heavy weight concrete - Distress in structure - Cracks in concrete.

UNIT-III

Civil foundation works and cross girders supporting the solar PV module - module mounting structure - cable tray and cable trench - detailed contour survey & soil investigation of the site - topographical survey - soil test - soil investigations – foundations - switch yard civil works - buildings - RCC works - brick works - roads within solar power plant - peripheral boundary wall and fencing – drainage.

UNIT IV

Irrigation structures - classification of head works - storage and diversion head works - their suitability under different conditions. Storage Headworks: Dams and its classification: Earthen dams and Gravity dams (masonry and concrete). Earthen Dams and spillway - Components with function, typical cross section. Gravity Dams - typical cross section, drainage gallery. Spillways-Definition, function, location, Energy dissipaters. Diversion head works - Layout, components and their function. Weirs - components, parts, types Barrages - components and their functions. Difference between weir and Barrage. Canal regulators - Head regulator, Cross regulator, Escape, Falls and Outlets (Brief description only) Cross Drainage works - Aqueduct, siphon aqueduct, super passage, level crossing (Brief description only)

UNIT V

Different types of foundations for wind turbines - spread foundation - Gravity foundation - soil stabilization - piled foundation - Piling to bedrock - Piled-raft foundation - structural design - Concrete cover - Internal forces - Design for bending moment - Design for shear - Design for fatigue loading - Control of crack width - Building Integrated/Mounted Wind Turbines (BUWTS), Building Augmented Wind Turbines (BAWTs).

COURSE OUTCOMES:

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

• Define the characteristic load,

• Understand the different loads, forces and effects to be considered in the design, name the three methods of design of concrete structure and identify the best

method of design,

• Express the design loads in terms of characteristic loads in limit state and

working stress methods,

• State the basis of determining the combination of different loads acting on the

Structure & Gain an experience in the implementation of Concrete Materials on Engineering concepts which are applied on Construction Fields

•Understand the process of mix design of concrete.

•Differentiate special concrete from conventional concrete & Analyze causes of deterioration of concrete components

REFERENCES:

- Dr. R.K.Bansal : Fluid Mechanics & Hydraulic Machine ; Laxmi Publishers
- B.C. Punmia : Irrigation Engineering ; Laxmi Publishing Co:
- S.K.Garg : Irrigation Engineering ; Khanna Publishers

- Design of foundations for wind turbines, master's dissertation by henrik svensson, department of construction sciences, structural mechanics, isrn lutvdg/tvsm--10/5173--se (1-158) issn 0281-6679.
- "Wind Effects on Structures" by Emil Simiu and Robert H. Scanlan
- "Wind Engineering: A Handbook for Structural Engineers"
- Dynamic Response of Structures to Wind and Earthquake Loads"
- Wind loading: A practical Guide to BS 6399-2.
- "Solar PV Engineering and Installation: Preparation for the NABCEP PV Installation Professional Certification" by Sean White.
- "Solar Power in Building Design: The Engineer's Complete Project Resource" by Peter Gevorkian
- Solar Electricity Handbook: A Simple, Practical Guide to Solar Energy - Designing and Installing Photovoltaic Solar Electric Systems" by Michael Boxwell.

TEXT BOOKS:

1. Dr. R.K.Bansal : Fluid Mechanics & Hydraulic Machine ; Laxmi Publishers
2. B.C. Punmia : Irrigation Engineering ; Laxmi Publishing Co:
3. S.K.Garg : Irrigation Engineering ; Khanna Publishers

24REVC4203 HIGH VOLTAGE ENGINEERING L3 T0 P0

Objective:

- To get a fair knowledge about the generation of high voltages and currents.
- Understand the generation and measurement of high voltages and currents
- Understand the concept of solid, liquid and gaseous dielectrics.

- Gain knowledge in testing of high voltage equipments

Unit I – Introduction

Electric field stress-Gas /Vacuum as insulator-Liquid Dielectrics-Solids and composites-Estimation and control of of electric stress-charge simulation method-boundary element method-gases and insulating materials- Breakdown in non uniformfields and corona discharge- Liquid insulators- breakdown in solid dielectrics.

UNIT II – Applications of Insulating materials

Application in power transformer - Application in rotating machines - Application in Circuit breaker - Application in cables - Application in power capacitor- Application inHigh Voltage Bushings- Application in Fractional Horse power Motor.

UNIT III- Generation and measurements of High voltages and currents

Generation of High Direct Current voltages - Generation of High AC and impulse Voltages-generation of impulse voltage –measurement of high direct current voltages- measurement of High AC and impulse Voltages CRO for impulse voltage.

UNIT IV – Overvoltage phenomenon and insulation- overvoltage

Natural Causes for Overvoltages-Lightning - Overvoltage due to Switching Surges, System Faults and other Abnormal Conditions- Principles of Insulation Coordination on High-Voltage and Extra High-Voltage Power Systems.

UNIT V –Testing ,Designing And Planning of High Voltage in laboratories

Testing Of Isolators And Circuit Breakers,Cables,Transformers,Surge Arresters,testing of HVDC Valves and Equipment-Test facilities provided in High voltage Laboratories-activities and studies in High Voltage and UHV Laboratories-Classifications of high voltage laboratories- Sizing and ratings of Large Size High voltage laboratories.

TEXT BOOKS:

1. Control system Engineering, I.J.Nagrath M.Gopal 1975, New Age international publishers.
2. Power system Operation and Control,M.Jeraldin Ahila A.R.S Publications.

REFERENCE BOOKS:

1. https://www.ee.iitb.ac.in/~debasattam/EE302/syllabus.pdf
2. https://mrcet.com/downloads/digital_notes/ECE/II%20Year/CONTROL%20SYSTEMS.pdf
3. https://www.jbiet.edu.in/pdffls/EEE-Coursematerial/Control-Systems-Notes.pdf

24REVC4204 STRENGTH OF MATERIALS L3 T0 P0

OBJECTIVES:

- To understand the concepts of stress, strain, principal stresses and principal planes.
- To study the concept of shearing force and bending moment due to external loads in

determinate beams and their effect on stresses.

- To determine stresses and deformation in circular shafts and helical spring due to torsion.
- To compute slopes and deflections in determinate beams by various methods.
- To study the stresses and deformations induced in thin and thick shells.

UNIT I STRESS, STRAIN AND DEFORMATION OF SOLIDS

Rigid bodies and deformable solids – Tension, Compression and Shear Stresses – Deformation of simple and compound bars – Thermal stresses – Elastic constants – Volumetric strains –Stresses on inclined planes – principal stresses and principal planes – Mohr's circle of stress.

UNIT II TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM

Beams – types transverse loading on beams – Shear force and bending moment in beams – Cantilevers – Simply supported beams and over – hanging beams. Theory of simple bending– bending stress distribution – Load carrying capacity – Proportioning of sections – Flitched beams – Shear stress distribution.

UNIT III TORSION

Torsion formulation stresses and deformation in circular and hollows shafts – Stepped shafts– Deflection in shafts fixed at the both ends – Stresses in helical springs – Deflection of helical springs, carriage springs.

UNIT IV DEFLECTION OF BEAMS

Double Integration method – Macaulay's method – Area moment method for computation of slopes and deflections in beams - Conjugate beam and strain energy – Maxwell's reciprocal theorems.

UNIT V THIN CYLINDERS, SPHERES AND THICK CYLINDERS

Stresses in thin cylindrical shell due to internal pressure circumferential and longitudinal stresses and deformation in thin and thick cylinders – spherical shells subjected to internal pressure – Deformation in spherical shells – Lame's theorem.

OUTCOMES:

Students will be able to

- Understand the concepts of stress and strain in simple and compound bars, the importance of principal stresses and principal planes.

- Understand the load transferring mechanism in beams and stress distribution due to shearing force and bending moment.
- Apply basic equation of simple torsion in designing of shafts and helical spring
- Calculate the slope and deflection in beams using different methods.
- Analyze and design thin and thick shells for the applied internal and external pressures.

TEXT BOOKS:

1. Bansal, R.K., "Strength of Materials", Laxmi Publications (P) Ltd., 2016

2. Jindal U.C., "Strength of Materials", Asian Books Pvt. Ltd., New Delhi, 2009

REFERENCES:

1. Egor. P.Popov "Engineering Mechanics of Solids" Prentice Hall of India, New Delhi, 2002

2. Ferdinand P. Been, Russell Johnson, J.r. and John J. Dewole "Mechanics of Materials", Tata McGraw Hill Publishing 'co. Ltd., New Delhi, 2005.

3. Hibbeler, R.C., "Mechanics of Materials", Pearson Education, Low Price Edition, 2013

4. Subramanian R., "Strength of Materials", Oxford University Press, Oxford Higher Education Series, 2010.

24REVC4205 ADVANCES IN WIND ENERGY CONVERSION SYSTEM L 0 T 0 P 2

OBJECTIVES:

To impart knowledge and skill on capacity building in the field of wind energy for research and industry with the experience of wind power and to know the fundamentals and main characteristics of wind energy technologies

UNIT-I

Historical developments of Wind Energy - Wind Energy Basics: Status, Advantages and disadvantages of wind energy systems, Advantages and disadvantages - wind energy dynamics - power extracted - axial thrust on turbines – torque - maximum power and Betz coefficient - wind turbine operational characteristic - site selection - Wind energy conversion system - basic integration issues related to wind power - status of Wind power in India - Types of wind energy converters - local Effects on wind - site selection: roughness length - wind shear - Wind Speed Variability - Obstacles to wind flow - Indian scenario -turbine rating - wind power plant economics, installation and operation costs – decommissioning - Nature of atmospheric winds - wind resource characteristics and assessment; anemometry; wind statistics; speed frequency distribution - effect of height - wind rose - Weibull distribution - atmospheric turbulence - gust wind speed - effect of topography.

UNIT-II

Vertical and horizontal axis turbines - design characteristics - multiple stream tube theory - vortex wake structure - tip losses - rotational sampling -wind turbine design programs - tower shadow - wind shear - blade coning – gyroscopic - transient and extreme loads - Aerodynamic damping and stability - teetering motion - stiff and soft towers - Power train dynamics - Design of Wind Turbine - Wind turbine design considerations – Methodology and Theoretical simulation of wind turbine characteristics - Fixed speed and variable speed systems - Electrical machines for wind energy systems - synchronous and asynchronous generators and power electronics - Integration of wind energy systems to electrical networks – converters – inverters - directly connected - wind energy storage solutions.

UNIT-III

Control systems requirements, components and strategies - Small wind turbines special considerations and designs & testing - noise issues - Off-shore turbines - Wind Turbine Components - Wind Turbine -Gear Box - Wind Electric Generators & Types - Wind Turbine Rotor Aerodynamics - Aerodynamics of aero foil – lift & drag – stall - effect of Reynold's number - actuator disc - momentum theory design of wind turbine blade; effect of stall and blade pitch on coefficient of power vs tip speed ratio and cut-out wind speeds, blade materials - Wind turbine design considerations - Analysis of wind turbine characteristics - Introduction to reliability engineering, failure analysis of WECS.

UNIT IV

Test methods - Wind Energy Application - Wind pumps and its Performance analysis, design concept and testing - Principle of WEG - Stand alone, grid connected and hybrid applications of WECS - type of generators used D.C., induction and synchronous machines - grid, standalone, and hybrid schemes - Power electronics based controllers used with WECS - power quality - impact of constant and variable speed wind

turbines on transient stability of power system - wind system economic components - economic analysis methods - cost of on-shore and off-shore wind turbines - Wind pumps: Performance analysis, design concept and testing - Principle of WEG; Stand alone, grid connected and hybrid applications of WECS - Economics of wind energy - Utilization of Wind Energy - Pitch control, yaw control, Electrical and Mechanical aerodynamic braking, teeter mechanism.

UNIT V

O & M Aspects of Wind Farms - SCADA & Condition Monitoring of Wind Turbine - simulation oriented case studies - Site selection and turbine spacing, rotor selection, Annual Energy Output (AEO), optimal placement of wind turbine in a wind park, ICT based monitoring and control of wind farms - Control and Operational Management for Wind Turbines and Wind Farms - Wind farm electrical design, Planning of wind farms, special application for developing countries, maintenance and operation, wind farm management, site selection - Environmental assessment - noise, visual impact etc. Instrumentation, data loggers, remote monitoring and control - Design of Mechanical and Electrical Components - Solid Mechanics - Fluid Mechanics - Application of Computational Fluid Dynamic Software Tools.

COURSE OUTCOMES:

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

1. Develop basic knowledge about Wind energy conversion Technology and its terminologies.

2. Design and assess the small wind turbine and its performance.

3. selection and design of wind energy systems.

REFERENCES

1.G L Johnson, Wind Energy Systems, Prentice Hall Inc, New Jersey, 1985.

2. David A. Spera, (Editor) Wind Turbine Technology: Fundamental Concepts of Wind Turbine Engineering, American Society of Mechanical Engineers; (1994)

3. Erich Hau,Wind Turbines: Fundamentals, Technologies, Application and Economics, Springer Verlag; (2000)

4. Paul Gipe , Karen Perez, Wind Energy Basics: A Guide to Small and Micro Wind Systems, Chelsea Green Publishing Company; (1999)

5. J. F. Manwell, J. G. McGowan, A. L. Rogers, Wind Energy Explained , John Wiley & Sons; 1st edition (2002) 6. Tony Burton, David Sharpe, Nick Jenkin

6. John F. Walker and Nicholas Jenkins, Wind Energy Technology, John Wiley, 1997

24REVC4206 ADVANCES IN BIOMASS ENERGY CONVERSION SYSTEM L 0 T 0 P 2

OBJECTIVES:

The aim is to provide a suitable framework for gaining and Create networking opportunities that can be beneficial in future biomass power generation and Understand the production technologies required for herbaceous and woody energy crops as well as agricultural and forest by-products.

UNIT-I

Bioenergy concepts – Introduction Systems thinking Biopower, bioheat Biofuels, advanced liquid fuels, drop-in fuels Bio based products - Feedstocks for first generation biofuels Feedstocks for second generation biofuels Feedstocks for third generation feedstocks - Agricultural waste - Forestry waste- Farm waste Organic components of residential, commercial, institutional, and industrial wastes.

UNIT-II

Biomass conversion technologies – Biochemical conversion - Understanding the biorefinery concept Biorefineries and end products - Hydrolysis, enzyme, and acid hydrolysis - Fermentation - Anaerobic digestion - Trans-esterification.

UNIT-III

Thermochemical conversion - Combustion – Gasification – Pyrolysis - Other thermochemical conversion technologies - Scaling up emerging technologies

UNIT IV

Biofuels - Drop-in liquid hydrocarbons - Low-blend in gasoline - Low-blend in diesel - Compressed - bio-methane - Liquefied bio-methane - Niche fuels – Additives - Pyrolysis oils - Straight vegetable oils - Intermediate bioenergy carriers and residues - Densified biomass (pellets, briquettes) - Black and torrefied pellets - Lignin powders, etc - Upgraded biogas for grid injection - Biogas (used as fuel) - Gasification product gases - Low, medium and high calorific value (CV) gas - Agricultural and agroindustry residues - Forestry and forest industry residues - Waste-derived fuels with a high biogenic fraction - Refuse derived fuel (RDF) - Solid recovered fuel (SRF)

UNIT V

Advanced biofuels - Hydrotreated Vegetable Oils (HVO) / Hydro processed Esters and Fatty Acids (HEFA) - Cellulosic ethanol - Biosynthetic Natural Gas (BioSNG) - Methanol – BioDME - Biobutanol - Synthetic paraffinic fuel / Hydrocarbons via chemical catalysis of plant sugars - Biohydrogen - Algal biofuels – Benefits of advanced bio energy

COURSE OUTCOMES:

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

1. Understand the production technologies required for herbaceous and woody energy crops as well as agricultural and forest by-products.

2. Develop a fundamental understanding of the biology, chemistry, and thermodynamic basis of biomass energy systems.

3.Develop detailed knowledge of the technologies, benefits, and trade-offs of various thermochemical and biological energy conversion strategies.

4.Assess the environmental impacts, Locate and utilize appropriate theory and information for design and analysis of biomass energy systems.

REFERENCES

1. Biofuels and Bioenergy Author(s): John Love, John A. Bryant First published:27 February 2017

Print ISBN:9781118350560 |Online ISBN:9781118350553 |DOI:10.1002/9781118350553

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2. Advances in biofuels and bio energy, Edited by Madhugiri Nageswaran – Rao and jaya Soneji published 04 July 2018, DOI10.5772/intechopen.70022, ISBN978-1-78923-287-5.

3.Biofuel and Bioenergy Technology, edited by Wei-Hsin Chen, Keat Teong Lee and Hwai Chyuan Ong, Printed Edition of the Special Issue Published in Energies, ISBN 978-3-03897-596-0 (Pbk).

24REVC4207 ADVANCES IN GREEN HYDROGEN L 0 T 0 P 2

Course Objectives:

CO1 : Fundamentals of green hydrogen mix in the energy sector

CO2 : Understand the Schemes and Policies of Govt. of India towards green hydrogen

CO3 : Know the different advanced technologies in the green hydrogen domain

CO4 : Analyze the financial viability and cost-benefit analysis

CO5 : Able to prepare the techno-commercial report on Rural Electrification

Unit I: Introduction to Hydrogen Energy

Properties of hydrogen as fuel, Physical and chemical properties of hydrogen gas; overview of hydrogen energy utilization; Hydrogen sensing- methods of hydrogen using thermal conductivity measurements.

Unit II: Hydrogen Production

Thermal-steam reformation, gasification, pyrolysis, thermo-chemical water splitting, nuclear thermal catalytic and partial oxidation methods; Cost-economics of hydrogen production.

Unit III: Hydrogen Storage

Hydrogen separation and purification-pressure swing adsorption, solvent-based adsorption, membrane separation, cryogenic separation; Specification of the hydrogen tank, Calculate the capacity of the hydrogen tank, Selection of storage hydrogen tank, Key parameters of hydrogen tank selection: max pressure withstand, temperature, storage capacity, type of material, Design Temperature.

Unit IV: Fuel Cells

History, principle, working of fuel cells, thermodynamics of fuel cell process; concept of electrochemical potential, performance and evaluation of fuel cell; Comparison of battery and fuel cells; Types of fuel cell-PEMFC and SOFC- Selection of SOFC and PEM cells.

Unit V: Green Hydrogen: Applications, Govt. Schemes and Policies

The Use of Hydrogen in Industries-Hydrogen Safety-Oil Refineries-Petrochemicals-Chemicals Industry-Mobility- National Green Hydrogen Mission- objectives- Status and target and research and development – challenges and opportunities of green hydrogen technologies.

Textbooks/Suggested Readings:

1. Sorenson B, Hydrogen and Fuel cells, Elsevier, Academic Press, USA

2. Yurum Yuda, Hydrogen Energy Systems, NATO ASI Series, London

3. Baker BS, Hydrogen Fuel cell Technology, Academic Press, New York

4. O'Hayre R, Cha S, Colella W., Prinz F.B, Fuel Cell Fundamentals, John Willey and Sons, New York

5. Hydrogen and Fuel Cells: A Comprehensive Guide Rebecca L. Busby, PennWell Books

Reference Books:

1. T. Gonen: Electric Power Distribution System Engineering, McGraw-Hill 1986.
2. M Mohan: Rural electrification for development: policy analysis and applications. Boulder : Westview Press, 1987
3. G. Saunier: Rural electrification guidebook for Asia and the Pacific, Asian Institute of Technology, 1992.
4. H. Lee Willis and W.G. Scott: Distributed Power Generation: Planning and Evaluation, Marcel Dekker, 2000.

Course Outcome :

- Application of renewable energy technologies for rural electrification.
- Evaluate the performance of fuel cells under different operating conditions.
- Select appropriate fuel cell technology for a given application.
- Design and develop suitable hydrogen systems to be used along with the fuel cell system for sustainable rural electrification.

24REVC4208 ADVANCES IN ELECTRICAL VEHICLES L 0 T 0 P 2

Course Objectives:

CO1 : Describe the fundamentals of EV and Vehicle to Grid (V2G) Technologies
CO2 : Site Selection and Technical Design of the V2G Integrated Smart Grids.
CO3 : Operation and maintenance of the V2G Integrated smart grids.
CO4 : Socio-technical implications of the Vehicle to Grid Technology

Unit-1 Introduction

Introduction to Electric Vehicles- History and benefits of electric vehicles; fundamentals of EVs – Introduction to the Smart Grid using electrical vehicles-Introduction to vehicle to grid technologies- Smart infrastructures- AMR, AMI, Smart Meters-Energy storage technologies.

Unit-2 : Vehicle to Grid Technology

History, Definition, and Status of V2G-Defining V2G-Incorporating V2G to the EV- Aggregation-Auditing and Metering-V2G in Practice- V2G, Power Markets and Applications -Electricity Markets and V2G Suitability- grid ancillary services and Grid Applications -Beyond the Grid: Other Concepts Related to V2G- Challenges.

Unit-3 Energy Storage Batteries for EVs

Performance criterion for EV batteries-Energy density, Amp hour density, Energy efficiency, Cost, Operating temperature, number of life cycles, recharge and self-discharge rates and commercial availability, some reference batteries and extension to nonautomotive sectors.

Unit-4 On-board Chargers

Review of semiconductor devices; turn-on and turn-off characteristics; loss computation in semiconductor devices; basics of non-isolated/ isolated DC-DC and grid connected converters; classification of EV chargers; modelling and control of bi-directional DC-DC converters; discussions on V2X applications

Unit-5: Social and Environmental Dimensions of EVs in the Smart Grid

Introduction-3E System-Economic-Energy- Environmental dimension- social implications- EV charging economics – Impact of EV and V2G on Environment – LCA analysis- Effect of Renewable energy on EV and V2G Technologies- Distributed Energy Resources and management

Course Outcome :

- A basic level of repair and maintenance knowledge skillset
- Understanding of common running repairs and troubleshooting
- Identification of common faults and ride-through to address the issue
- Recognition of preventive maintenance and regular checklist for the better healthy operation of EV

TEXT BOOKS:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.

2. Lance Noel, Gerardo Zarazua De Rubens,Johannes Kester,And Benjamin K. Sovacool "Vehicle-to-Grid: A Sociotechnical Transition Beyond Electric Mobility" by Energy, Climate and the Environment , ISBN 978-3-030-04864-8.

3. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.

REFERENCES:

1. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

2. Automotive Skills Development Council and National Skill Development Corporation , "Electric Vehicle Maintenance Technician" – Electrical QP Code: ASC/Q6809, NSQF Level:4

3. Kempton W, Letendre SE. Electric vehicles as a new power source for electric utilities. Transp Res Part Transp Environ. 1997;2(3):157–75.

4. Tomić J, Kempton W. "Using fleets of electric-drive vehicles for grid support" Journal of Power Sources. 2007;168(2):459–68.

5. Norman G. Meade, The Electric Vehicle, Its Construction, Operation and Maintenance, Legare Street Press, 2023 ISBN:9781019410332

24REVC4209 **DISSERTATION** **L 0 T 0 P 10**

Student should take up project related to design and development of cost effective renewable energy gadgets / industrial projects. Also the student can do re-engineering of any renewable energy products with increase in effienciey / reduction in cost.

MSE:

Seminar I (Identification of Problem)	-	25 marks
Seminar II (Report on the progress of the project)	-	25 marks

Seminar III (Findings and product development)		-	25 marks
Report prepartion		-	50 marks
	Total	-	**125 marks**

ESE:

Viva Voce		-	**75 marks**
	Total	-	**200 marks**

LEARNING OUTCOME:

At the end of the course learner will be able to design and develop new gadgets on renewable energy.