B.Voc. RENEWABLE ENERGY

Course Duration:

3 Years– 6 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.

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

Maximum number of Seats:50

Semester I

Course Code	Course Title	No. of Credits	L	T	P	Max. Marks		
						CFA	ESE	Total
18REEV0101	Energy Sources	2	2	0	0	20	30	50
18REEV0102	Basic Mathematics	3	3	0	0	40	60	100
18REEV0103	Fluid and Heat Transfer Physics	3	3	0	0	40	60	100
18ENGU01G1	General English I	3	3	0	0	40	60	100
18SPOU0001 / 18FATU0001	Sports & Games / Fine Arts	1	0	0	1	50	0	50
Skill Component	**Renewable Energy Site Surveyor**							
18REEV0104	Installation of Solar PV Power Plants	3	0	1	2	60	40	100
18REEV0105	Installation of Wind Power Plants	3	0	1	2	60	40	100
18REEV0106	Installation of Waste to Energy Plants	3	0	1	2	60	40	100
18REEV0107	Site Survey of Solar Power Plants	3	0	0	3	60	40	100
18REEV0108	Site Survey of Wind Power Plants	3	0	0	3	60	40	100
18REEV0109	Site Survey of Waste to Energy Plants	3	0	0	3	60	40	100
	Total	**30**						

Semester II

Course Code	Course Title	No. of Credits	L	T	P	Max. Marks		
						CFA	ESE	Total
18CSAU02A1	Computer Fundamentals and Office Automation	4	3	0	1	48	52	100
18REEV0210	Sustainable Chemistry	3	3	0	0	40	60	100
18REEV0211	Basic Electricity and Electronics	2	0	2	0	20	30	50
18ENGU02G2	General English II	3	3	0	0	40	60	100
Skill Component	**Solar Thermal Engineer**							
18REEV0212	Physics Practical	2	0	0	3	60	40	100
18REEV0213	Operation and Maintenance of Solar Thermal System	4	0	1	2	60	40	100
18REEV0214	Solar Thermal Laboratory	4	0	0	4	60	40	100
18REEV0215	Electrical and Electronics Lab	4	0	0	4	60	40	100
18REEV0216	Engineering Drawing	2	0	0	2	60	40	100
18REEV0217	Workshop Practice	2	0	0	2	60	40	100
	Total	30						

Semester III

Course Code	Course Title	No. of Credits	L	T	P	Max. Marks		
						CFA	ESE	Total
15CSKU0201	Soft Skills	2	1	1	0	50	0	0
18REEV0318	Environmental Science	4	3	1	0	40	60	100
18REEV0319	Electrical Generation and Distribution	3	3	0	0	40	60	100
18REEV0320	Instrumentation and Control System	2	2	0	0	40	60	100
18YOGV0001	Yoga	1	0	0	1	50	0	50
Skill Component	**Solar PV Engineer**							
18REEV0321	Solar Energy	3	2	1	0	40	60	100
18REEV0322	Solar Photo Voltaic Laboratory	4	0	0	4	60	40	100
18REEV0323	Wind Energy	3	2	1	0	40	60	100
18REEV0324	Wind Energy Laboratory	4	0	0	4	60	40	100
18REEV0325	Electrical Maintenance Lab	4	0	0	4	60	40	100
	Total	30						

Semester IV

Course Code	Course Title	No. of Credits	L	T	P	Max. Marks		
						CFA	ESE	Total
18REEV0426	Grid issues in Renewable Energy Sources	3	3	0	0	40	60	100
18REEV0427	Sustainable Waste Management	3	3	0	0	40	60	100
18REEV0428	Energy Auditing and Conservation	3	2	1	0	40	60	100
18REEV0429	Alternate Renewable Energy Technologies	3	3	0	0	40	60	100
Skill Component	**Wind Power Plant Planning Engineer**							
18CSAU04N2	Internet and Web Technology	3	3	0	0	40	60	100
18REEV0430	Safety Practices in Renewable Energy Project Site	3	0	2	1	60	40	100
18REEV0431	PLC & SCADA Programming	3	0	1	2	60	40	100
18REEV0432	Solar Software Simulation Lab	3	0	0	3	60	40	100
18REEV0433	In plant Training (Solar & Wind Power Plant O&M)	6	0	0	6	60	40	100
	Total	30						

Semester V

Course Code	Course Title	No. of Credits	L	T	P	Max. Marks		
						CFA	ESE	Total
18REEV0534	Smart Grid	3	3	0	0	40	60	100
18REEV0535	Small Hydro Power Plants	2	2	0	0	20	30	50
18REEV0536	Project Planning and Cost Estimation	3	3	0	0	40	60	100
18REEV0537	Energy Economics	3	3	0	0	40	60	100
15NSSU0001 15SHSU0001	NSS / Shanti Sena	1	1	0	0	50	-	50
Skill Component	**Renewable Energy Business Development Manager**							
18REEV0538	Solar lighting solutions business development	2	0	0	2	20	30	50
18REEV0539	Rooftop solar PV business development	2	0	0	2	20	30	50
18REEV0540	Solar water pumping systems business development	2	0	0	2	20	30	50
18REEV0541	Small scale wind power plant business development	2	0	0	2	20	30	50
18REEV0542	Biomass power generation systems business development	2	0	0	2	20	30	50
18REEV0543	Rural Smart /Micro grids business development	2	0	0	2	20	30	50
18REEV0544	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		
						CFA	ESE	Total
18REEV0645	Environmental Impact Assessment	3	3	0	0	40	60	100
18REEV0646	Green Buildings	3	3	0	0	40	60	100
18REEV0647	Energy Storage	3	3	0	0	40	60	100
18REEV0648	Professional Ethics	3	3	0	0	40	60	100
Skill Component	**Industrial training / Project work**							
18REEV0649	Renewable Energy Product Development	10	0	0	10	150	50	200
18REEV0650	Industrial Training	8	0	0	8	150	50	200
	Total	30						

SEMESTER - 1

18REEV0101 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:

1. 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

18REEV0102 BASIC MATHEMATICS L 3 T 0 P 0

OBJECTIVE: To enhance basic skills in the areas of functions, matrices, limits and vectors.

Unit I: Relations: Definition of relation – types of relations: reflexive, symmetric, transitive-equivalence relations. Functions: Definition and examples – types of functions: one to one – onto – inverse function - composition of functions

Unit II: Matrices – Basic concepts – addition and multiplication of matrices – properties – inverse of matrix – rank of a matrix.

Unit III: Limits: Constants and variables – Definition of limit of a functions – indeterminate forms – evaluation of limit of functions by factorization, rationalization – algebra of limits.

Unit IV: Differentiation of sum, productand quotient of functions. Differentiation of function as a function. Differentiation of trigonometric inverse functions. Logarithmic differentiation, Successive differentiation (excluding nth order) Applications : (a) Rate Measures (b) Errors (c) Maxima and Minima (d) Equation of tangent to a curve for explicit functions only and equation of a normal. (e) Newton's Method of solving equation using the formula f(a) /f'(a)

Unit V: Integration as inverse operation of differentiation. Simple Integration by substitution, by parts and by partial fractions (for linear factors only)Applications : (a) area bounded by a curve and axes (b) volume of solid formed by revolution of an area about axes. (Simple problems). (c) Centre of gravity (d) Moment of Inertia (e) Average value (f) Root mean square value of a function (g) gama function (reduction formula)

Text books:

1. P. R. Vittal, Business mathematics, Margham Publications, Chennai 1995.
2. P. Navanitham, Business mathematics and Statistics, 2008.
3. S. Narayanan & T.K.Manickavasagam pillai, Calculus, Vol. 1. S. Viswanathan Pvt, Ltd, Chennai 2004.
4. S. Narayanan & T.K.Manickavasagam pillai, Vector algebra and Analysis, Vol. 1. S. Viswanathan Pvt, Ltd, Chennai 1995.

LEARNING OUTCOMES:

- Students will get gain knowledge in Basics and application of Mathematics in Renewable Energy Field

18REEV0103 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 of fluids 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

18ENGU01G1 GENERAL ENGLISH – I 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.

18SPOU0001 SPORTS AND GAMES (0+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

18FATU0001 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, resthouses, 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) Encyclopedia 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

18REEV0104 INSTALLATION OF SOLAR PV POWER PLANTS L 0 T 1 P 2

OBJECTIVE:

To understand the installation of solar power plants by the underlying concepts of solar physics

UNIT-I: INTRODUCTION TO SOLAR ENERGY

Solar angles, day length, angle of incidence on tilted surface; Sun path diagrams; Effect of Shadow and determination of shadow; Extraterrestrial characteristics; Effect of earth atmosphere; Measurement & estimation on horizontal and tilted surfaces; Analysis of Indian solar radiation data and applications.

UNIT-II: 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-III: 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-IV: 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

UNIT-V: FIELD VISIT / DEMO AND REPORTING

Identify local support and hindrance factors and include in the report as a special section for any site-specific restrictions-Identify limitations and incentives according to relevant applicable policies, regulations and procedures

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. Larry D Partain (ed.), Solar Cells and their Applications, John Wiley and Sons, Inc, New York, 1995
6. Richard H Bube, Photovoltaic Materials, Imperial College Press, 1998
7. H S Rauschenbach, Solar Cell Array Design Handbook, Van Nostrand Reinfold Company, New York, 1980.

LEARNING OUTCOME:

Students will gain knowledge about the installation of solar PV power plant

18REEV0105 INSTALLATION OF WIND POWER PLANTS L 0 T 1 P 2

OBJECTIVE:

To understand the installation of wind power plants by 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 DESIGN OF WIND TURBINE

Wind turbine design considerations; Methodology; Theoretical simulation of wind turbine characteristics; Test methods. Wind Energy Application – Wind pumps -Performance analysis, design concept and testing; Principle of WEG; Stand alone, grid connected and hybrid applications of WECS

UNIT- III PRILIMINARY ANALYSIS

Identify project objective and constraints – Study the prefeasibility and feasibility study and identify physical viability of project execution – Analyse the project DRP and assist in preparing the work plan – Analyse the wind farm layout and identify the necessary permits and clearance to be taken – Identify the possible risks and assist in preparing mitigation procedures -

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. 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)

REFERENCE BOOK:

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

LEARNING OUTCOME:

Students will gain knowledge about the installation of wind power plant

18REEV0106 **L 0 T 1 P 2**

INSTALLATION OF WASTE TO ENERGY POWER PLANTS

OBJECTIVE

To understand the installation of Waste to Energy power plants by the underlying concepts of waste and their physical and chemical compositions

UNIT-I INTRODUCTION

Waste – Properties of waste – Types of waste – pre production process of different types of wastes – Identify location for power curve test.

UNIT-II CHARECTERIZATION OF SOLID WASTE

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

UNIT-III METHODS OF WASTE TO ENERGY CONVERSION

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

UNIT-IV 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.

UNIT-V DEVELOPMENT OF WASTE POWER GENERATION SYSTEM BUSINESS

Identify market trend and potential customer – Identify the customer requirements - Clarify customer queries – assess area of installation – Prepare cost benefit analysis – Prepare a proposal for biomass power generation systems – Present possible raw material linkages – prepare a pitch for the customer and close the sale – create and manage a pipeline of potential customer.

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 installation and feasibility analysis of the same

18REEV0107 SITE SURVEY OF SOLAR POWER PLANT L 0 T 0 P 3

OBJECTIVE:

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

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: SOIL ANALYSIS

Perform the soil analysis while ensure conducting of soil testing like soil resistivity, dust percentage, soil strength, etc. as per requirement

UNIT-III: 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-IV: PV PLANTS AND ITS ENVIRONMENTAL IMPACT

Analyse environmental and social impact of the plant and the risks involved at the site like insect infestation or wild animals – Environment pollution act- wild life act – Preparation of Environment impact assessment.

UNIT-V: FIELD VISIT / DEMO AND REPORTING

Ensure identification of accessibility of the site i.e. its connectivity to various transport mechanisms including rail, road, connecting roads, etc.-assess grid availability for power evacuation including nearest substation and transmission line capacity as well as distance from project site-ensure compilation of all the data arrived from the analysis done and present to the concerned senior authority

TEXT BOOK:

1. Chetan Singh Solanki: Solar Photovoltaics fundamentals, Technologies and Applications, PHI Learning Private Limited- Eastern Economy Edition

REFERENCE BOOK:

1. Tiwari G.N., Suneja S., Solar Thermal Engineering System, Narosa Publishing House,
2. Alan L Fahrenbruch and Richard H Bube , Fundamentals of Solar Cells: PV Solar Energy Conversion, Academic Press, New York, 1983
3. Larry D Partain (ed.), Solar Cells and their Applications, John Wiley and Sons, Inc, New York, 1995
4. Richard H Bube, Photovoltaic Materials, Imperial College Press, 1998
5. 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 feasibility study of the power plants.

18REEV0108 SITE SURVEY OF WIND POWER PLANT L 0 T 0 P 3

OBJECTIVE

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

UNIT-I: 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-II: CONTOUR MAPPING

Prepare a detailed survey plan of the land proposed for installation of wind power plant with elevations and topography - calculate the exact land area of the proposed site where installation is to be commenced -prepare contour map of proposed wind plant site -conduct field surveys and give site ranking -identify position of WTG, substation, transmission line, transformers, etc.

UNIT-III: PHYSICAL SITE ACCESSIBILITY

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: ENVIRONMENTAL IMPACT ASSESMENT:

Analyse environmental and social impact of the plant and site risk analysis -Identify local support and hindrance factors and include in the report as a special section -Identify limitations and incentives according to relevant applicable policies, regulations and procedures

UNIT-V: REPORT PREPARATION

Validate collected wind data from site -verify the wind potential with other resources such as NREL/ATLAS -prepare detailed site survey report using GPS/DGPS and wind data analysis software.

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)

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)

LEARNING OUTCOME:

Students will gain knowledge about the wind power plant site survey and feasibility analysis of the same

18REEV0109 **L 0 T 0 P 3**

SITE SURVEY 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 INTRODUCTION TO WASTE TO ENERGY

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 - Thermal – Thermochemical conversion techniques.

UNIT-II 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-III: 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-IV: ENVIRONMENTAL IMPACT ASSESMENT:

Identify bi-products and waste from the plant and their disposal arrangements - Environment impact for storage and disposal of waste -Analyse environmental and social impact of the plant and site risk analysis -Identify local support and hindrance factors and include in the report as a special section -Identify limitations and incentives according to relevant applicable policies, regulations and procedures

UNIT-V: FIELD VISIT / DEMO AND REPORTING

Prepare the report - Analyse and present comparison of different types of technologies for waste-to-energy conversion - identify the load - Analyse the pre-site selection baseline data for project execution suitability

TEXT BOOK:

1. Parker., Colin, & Roberts, Energy from Waste - An Evaluation of Conversion Technologies, Elsevier Applied Science, London, 1985
2. 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 feasibility analysis of the same

SEMESTER – 2

18CSAU02A1	**COMPUTER FUNDAMENTALS AND OFFICE AUTOMATION**
Credits : 3+1	**Lecture hours/week : 3** **CFA (T+P) : 24+24**
Lab hours/week : 2	**ESE (T+P) : 36+16**

Objective(s):

- To understand the basic concepts of computers
- To develop applications using MS Word, MS Excel and MS PowerPoint

Learning Outcomes

Students should be able to

- Know the basic computer concepts.
- Understand the basic hardware devices.
- Create document in MS Word.
- Draw chart using MS Excel.
- Design presentation using MS PowerPoint

UNIT	CONTENTS	Lecture Schedule
I	**Computer concepts**	**11**
	• Definition of a computer –Origin of Computer- Characteristics	1
	• Computer terminologies	2
	• Anatomy of a computer - generations of computers	1
	• Types of computers- types of operating system	2
	• Types of programming languages	2
	• Assembler - translator	1
	• Compiler – cross compiler	1
	• Discussion on recent trends and technology	1
II	**Hardware devices**	**8**
	• Input devices –Keyboard-mouse-pointing devices	2
	• Output devices - printers- plotters- monitors	2
	• Storage devices - Floppy – Compact disk – external Hard disk – Pen drives – Flash Drive	2
	• Source data entry devices – Digital camera – Scanners – Voice Recognition System – fax machine - microphone	1
	• Surprise test/ slip test	1
III	**MS-Word**	**8**
	• MS-Word: Introduction - features	1
	• Document creation - Document editing: cursor movements	1
	• Selecting text - copying text - moving text	1
	• Finding and replacing text - Spelling and Grammar	1
	• Page setup - Table creation.	1
	• Mail Merge	2
	• Test on MS word shortcut keys	1
IV	**MS-Excel**	**7**
	• MS-Excel : Introduction - Advantages & applications -	1
	• Organization of workbook - Editing a worksheet -	1
	• Range - Formatting worksheet -	1
	• Chart: creation - changing type - Print options	1

	• Built-in functions.	2
	• Test on Excel Functions	1
V	**MS-Power Point**	**8**
	• MS-Power Point: Introduction - features –	2
	• Creating presentation - viewing - saving and close presentation	1
	• Changing Layout - Changing Designs - Slide transition	1
	• Adding animation effects	2
	• Inserting table, charts, pictures, clipart in presentation	1
	• Checking the creativity of Students	1
	Total Contact Hours	**42**

References:

1. Fundamentals of Information Technology, S.K.Bansal, and A.P.H. Publishing company, New Delhi, 2002.
2. 2007 Microsoft Office System systematic, Joyce Cox, Joan Preppernau, Steve Lambert and Curtis Frye, 2007.

18REEV0210 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, to give an overview of water purification, various types of non-renewable energy sources including energy storage, to comprehend the importance of corrosion of metals, 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 industrial applications
- Categorize various types and sources of non-conventional energy sources
- Demonstrate the corrosion and protection of metallic materials
- Describe the basic concepts of polymers and aware 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

18REEV0211 BASIC ELECTRICITY 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

18ENGU02G2 GENERAL ENGLISH – II 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.

18REEV0212 **L 0 T 0 P 3**

PHYSICS PRACTICAL

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 Kirchoff'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 liquidsBarton'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

18REEV0213 **L 0 T 1 P 2**

OPERATION AND MAINTENANCE OF SOLAR THERMAL SYSTEM

OBJECTIVE

To understand the operation and maintenance of solar concentrating collector underlying concepts of thermodynamics and solar physics

UNIT-I FLAT PLATE COLLECTOR

Various components of flat plate collector – Typical liquid collector – Heat transport system – Solar air heater – Collector with porous absorber – Collector with non-porous absorber – Types of solar water heating system

UNIT-II SOLAR CONCENTRATING COLLECTORS

Introduction to solar concentrating collectors – characterization of the solar collectors – classifications- mountings of the solar collectors – Advantages and thermodynamic limitations

Concentrating parabolic collector (CPC) – Performance analysis – Point focusing solar collector – performance analysis – tracking requirements –advantages and limitations of collectors

UNIT-III THERMAL ELECTRIC POWER GENERATION SYSTEM

Medium temperature system using concentrated collector – High temperature using concentrated system – parabolic concentrator – parabolic trough concentrators – Concentrators with point focus; Heliostats

UNIT-IV INSTALATION

Analyse the design and drawin0g of the solar water heating system to be installed – arrange the consumables required for civil/mechanical installations – install mounting posts, and other structural requirements – Install collector-mounting structure and apply corrosion protection paint

UNIT-V OPERATION AND MAINTRENECE

Ensure water filled in the collector is as per standard operating procedure – Insulate hot water tank as per the design and pre-insulate tank – Test system leakage by pressurizing the water designed pressure and plug any leakages – Maintenance of tracking system: check the sensors, tighten the connecting wires and replace the sensors, incase are found non-functional, lubricate all moving parts of the tracking drive system periodically, check the electrical connection of drive motor.

TEXT BOOKS:

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

REFERENCES:

1. P.K.Nag, "Engineering Thermodynamics", Tata McGraw-Hill Publishing Co., Ltd., 1994
2. Alan L Fahrenbruch and Richard H Bube , Fundamentals of Solar Cells: PV Solar
3. Energy Conversion, Academic Press, New York , 1983
4. Moran, Shapiro, Munson and Dewitt, “Introduction to Thermal Systems Engineering: D Y Goswami, Frank Kreith and J F Kreider, Principles of Solar Engineering, Taylor & Francis, 1998
5. Tiwari G.N., Suneja S., Solar Thermal Engineering System, Narosa Publishing House, New Delhi, 1997.
6. Larry D Partain (ed.), Solar Cells and their Applications, John Wiley and Sons, Inc, New York, 1995
7. Richard H Bube, Photovoltaic Materials, Imperial College Press, 1998
8. H S Rauschenbach, Solar Cell Array Design Handbook, Van Nostrand Reinfold Company, New York, 1980

LEARNING OUTCOME

Students will gain knowledge about the operation and maintenance of solar flat plate collector systems

18REEV0214 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

18REEV0215 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

18REEV0216 ENGINEERING DRAWING L 0 T 0 P 2

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

18REEV0217 WORKSHOP PRACTICE L 0 T 0 P 2

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:

1. Demonstrate and produce different types of fitting models.
2. Gain knowledge of development of sheet metal models with an understanding of their applications.
3. Perform soldering and welding of different sheet metal & welded joints.
4. 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,

SEMESTER 3

15CSKU0201: 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.

18REEV0318 ENVIRONMENTAL SCIENCE L 3 T 1 P 0

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 overexploitation 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

18REEV0319 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

18REEV0320 INSTRUMENTATION AND CONTROL SYSTEM L 2 T 0 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

18YOGV0001 YOGA 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.

18REEV0321 SOLAR ENERGY L 2 T 1 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
6. H S Rauschenbach, Solar Cell Array Design Handbook, Van Nostrand Reinfold Company, New York, 1980.

LEARNING OUTCOME:

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

18REEV0322 SOLAR PHOTO VOLTAIC 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

18REEV0323 WIND ENERGY L 2 T 1 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. 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)

REFERENCES:

1. Paul Gipe , Karen Perez, Wind Energy Basics: A Guide to Small and Micro Wind Systems, Chelsea Green Publishing Company; (1999)
2. J. F. Manwell, J. G. McGowan, A. L. Rogers, Wind Energy Explained, John Wiley & Sons; 1st edition (2002)
3. Tony Burton, David Sharpe, Nick Jenkins, Ervin Bossanyi, Wind Energy Handbook , John Wiley & Sons; 1st edition (2001)

LEARNING OUTCOME:

Students will gain knowledge about the solar energy utilization PV systems

18REEV0324 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

18REEV0325 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

SEMESTER- 4

18REEV0426 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 knowlede in the grid integration and power qulaity issues and mitigations of various renewable energy sources.

18REEV0427 SUSTAINABLE WASTE MANAGEMENT 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

UNIT IV

Primary waste water treatment: screening, grit removal, sedimentation – Secondary treatment process: activated sludge, trickling filters, rotating biological contactors, stabilization ponds, lagoons, aeration, filtration, chlorination-de chlorination
Conventional water treatment processes - aeration, sedimentation, rapid mixing, flocculation, coagulation, filtration, disinfection, fluoridation, water softening, turbidity removal, taste and odour control

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

LEARNING OUTCOME:

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

18REEV0428 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.

18REEV0429 ALTERNATE RENEWABLE ENERGY TECHNOLOGIES L 3 T 0 P 0

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

18CSAU04N2/ 18CSAU05N2	INTERNET AND WEB TECHNOLOGY

Credits : 3 **Lecture hours/week : 3** **CFA (T) : 40**
Course(s) : All UG Programmes **Lab hours/week : 0** **ESE (T) : 60**

Objective(s):

- To enable the students with the knowledge of Network, Internet and Its Applications
- To make the students to be familiar with multimedia tools.

LEARNING OUTCOMES

Students should be able to

- Understand the Fundamentals Of Information Technology, Information Systems and Its Applications
- Use various networks topologies and its applications
- Familiarize with internet technologies
- Have a clear idea about multimedia tools.
- Know the ethical and social problems in information technology

UNIT	CONTENTS	Lecture Schedule
I	**Information Technology**	**9**
	• Information Technology Introduction	1
	• Information systems and its components	1
	• Types of information systems	2
	• IT in business and industries	2
	• Application areas of IT – Education, Training, CAD&CAM	1
	• Application areas of IT- Entertainment, arts and science	1
	• GPS (Global positioning System)- Working method and its applications	1
II	**Internet and Communication Technology**	**10**
	• Internet basics and Internet terminologies	1
	• Network basics and its terminologies introduction	1
	• Advantages of networks	1
	• Types of networks – WAN structure and its working principle	2
	• Network topologies – Bus, Star, Ring, Tree and Mesh	2
	• Communication channels - twisted pair, co-axial and fiber optics	2
	• Internetworking devices - bridges, routers and gateways.	1
III	**Introduction to HTML**	**10**
	• History of HTML- Generations- Anchor Tag	1
	• Hyper Links	1
	• Head and body Sections: Header Section-Title-Prologue	1
	• Designing the Body Section: Aligning, Horizontal Rule, Paragraph, Tab Setting and Images and Pictures	2
	• Ordered List, Unordered List and Nested Lists	2
	• Table creation in HTML	2
	• Example Programs	1
	Multimedia	**9**

IV	• Multimedia basics	1
	• Paint and draw applications of multimedia basics and its applications	2
	• Various graphics effects and techniques and its variations	2
	• Sound and music and video tool of multimedia, various compression techniques	2
	• Multimedia authoring tools types	1
	• Various devices used in delivering multimedia • Role of multimedia in web designing	1
V	**Personal, social and ethical issues**	**5**
	• Personal, social and ethical issues- computers and operator health	2
	• Viruses – worms – malware-anti-virus	1
	• computer crime basics, types of crimes, security techniques	1
	• Cryptography – importance, techniques	1
	Total Contact Hours	**43**

References:

1. Introduction to Information Technology, ITL education solution limited, Pearson Education India, New Delhi, July 2011.
2. World Wide Web design with HTML, 13/e, C Xavier, Tata McGraw-Hill Publishing, New Delhi, 2006.
3. Fundamentals of Information Technology, 2/e, Alexis leon and Mathew leon, Vikas publication, New Delhi, 2009.
4. Internet for everyone, 2/e, Alexis leon and Mathew leon, Vikas publication, New Delhi, 2011.

18REEV0430 SAFETY PRACTICES IN RENEWABLE ENERGY PROJECT SITE

L 0 T 2 P1

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

18REEV0431 PLC AND SCADA PROGRAMMING L 0 T 1 P 2

UNIT-I: 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-II: 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-III 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-IV 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-V SCADA ARCHITECTURE

First generation-Monolithic, Second Generation-Distributed, Third generation Networked Architecture, SCADA systems in operation and control of interconnected power system, Power System Automation, Petroleum Refining Process, Water Purification System, Chemical Plan

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

18REEV0432 SOLAR SOFTWARE SIMULATION LABORATORY L 0 T 0 P 3

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

18REEV0433 INPLANT TRAINING L 0 T 0 P 6

(SOLAR & WIND 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*.

CFA:

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

18REEV0534 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.

18REEV0535 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, specific gravity, 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

18REEV0536 PROJECT PLANING AND COST ESTIMATION L 3 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.

18REEVO537 ENERGY ECONOMICS L 3 T 0 P 0

Objective

- To help the students to understand the basics of energy economics so as to address to energy problems and issues. Specific Objectives of Learning
- The students would have understood the importance of energy in economic development and need for energy conservation.
- They also are able to take up research in energy economics.

UNIT I

Natural Resources – Classification – Importance – Role of Natural Resources in Economic Development – Energy Resources – Classification – Properties and Forms of Energy –Energy Economics – origin, Scope and Nature

UNIT II

Role of Energy in Economic Development – Energy Indicators - Energy Intensity and Energy Elasticity – National and International Comparison

UNIT III

Energy Environment Nexus Crisis – Causes and Consequences – Remedial Measures – Impact of Energy Consumption and Production on Environment with illustrations

UNIT IV

Energy Planning and Energy Conservation – Meaning, Objectives and Importance – Energy Management – Meaning, Objectives and Importance – Recent Developments: Energy Auditing – Energy Accounting – Energy conservation - Energy Pricing and Taxes

UNIT V

Indian Energy Sector – Organizational Structure – Energy Supply sources and trends in production – Energy Demand on sectoral consumption trend - Renewable Energy Programmes in India

Text book

1. Agarwal, S.K. (1985): Environment and Natural Resources Economics, Scott Foresman & Co., London.
2. Common, M. (1985): Environmental and Resource Economics, Longman, London.

References

1. Agarwal, M.C. and Monga, J.R. (1992): Economic and Commercial Geography, National Publishing House, New Delhi
2. David Pearct et al., (1990): Sustainable Development – Economics and Environment in the Third World, Earths Can Publications, London.
3. Karpagam, M. (1991): Environmental Economics, Sterling, New Delhi.
4. Kneese. A.V and Sweeny, J.L, 1993): Handbook of Natural Resource and Energy Economics, North Holland.
5. Munasinghe, M and Meier, P (1993): Energy Policy and Modelling, Cambridge University Press, UK
6. Richard Eden (1981): Energy Economics – Growth, Resources and Policies, Cambridge University Press, London
7. TERI (2015): Teri Energy Data Directory and Year Book 2014-15, The Energy Research Institute, New Delhi.

Learning Outcome:

- At the end of this course, students will gain knowledge about energy economics, policy frameworks, tax and environmental impact

15NSSU0001 **NSS**

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

15SHSU0001 FOUNDATION COURSE IN SHANTI SENA

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

18REEV0538 SOLAR LIGHTING SOLUTIONS L 0 T 0 P 2
BUSINESS DEVELOPMENT

Objective

The aim is to provide a suitable framework for gaining business development insight in the solar lighting solutions and its business scope opportunities

1. Assess the market and evaluate the market trends to decide the strategy for sale of solar lighting 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
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
9. Prepare the cost benefit analysis for solar lighting solutions
10. Prepare a proposal for solar lighting solutions
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 strategies on solar lighting systems

18REEV0539 ROOFTOP SOLAR PV BUSINESS DEVELOPMENT L 0 T 0 P 2

Objective

The aim is to provide a suitable framework for gaining business development insight in the solar Rooftop Photovoltaics systems and its business opportunities

1. Assess the market and evaluate the market trends to decide the strategy for sale - identify market opportunities and potential customers
2. Identify the customer requirements
3. Check and adapt the applicable policies, regulations and processes for the proposed offer
4. Clarify the customer queries with respect to rooftop solar PV 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 the rooftop solar PV power plant
8. Prepare the cost benefit analysis for setting up of rooftop solar PV power plant
9. Prepare a proposal for setting up of rooftop solar PV 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 approaches on Solar Rooftop PV systems

18REEV0540 SOLAR WATER PUMPING SYSTEMS L 0 T 0 P 2
BUSINESS DEVELOPMENT

Objective

The aim is to provide a suitable framework for gaining business development insight in the solar water pumping systems and its business scope opportunities

1. Assess the market and evaluate the market trends to decide the strategy for sale of solar water pumping systems
2. Identify market opportunities and potential customers
3. Identify the customer requirements
4. Clarify the customer queries with respect to solar water pumping 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 solar water pumping systems
8. Prepare the cost benefit analysis for solar water pumping systems
9. Prepare a proposal for solar water pumping systems
10. Prepare a pitch for the customer and close the sale
11. Create and manage

Learning Outcome:

- At the end of this course, students will gain knowledge about the business development methodologies on Solar water pumping systems

18REEV0541 SMALL SCALE WIND POWER PLANT BUSINESS DEVELOPMENT L 0 T 0 P 2

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

18REEV0542 BIOMASS POWER GENERATION SYSTEMS L0T 0 P 2
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 power generation systems

18REEV0543 RURAL SMART / MICRO GRIDS BUSINESS DEVELOPMENT L 0 T 0 P 2

Objective

The aim is to provide a suitable framework for gaining business development insight in the smart and micro grid for sustainable development business opportunities

1. Assess the market and evaluate the market trends to decide the strategy for development of smart grids and micro grids
2. Identify market opportunities and potential customers
3. Identify the customer requirements
4. Clarify the customer queries with respect to smart grids and micro grids
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 smart grids and micro grids
8. Prepare the cost benefit analysis for smart grids and micro grids
9. Prepare a proposal for development of smart grids and micro grids
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 rural electrification through rural smart grid and micro grid concepts

18REEV06465 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

18REEV0646 GREEN BUILDING 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

18REEV0647 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

18REEV0648 PROFESSIONAL ETHICS L 3 T 0 P 0

Objective: The aim is to provide a right knowledge pack for acquisition of professional ethics to become a knowledge professional

UNIT I HUMAN VALUES

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

UNIT II ENGINEERING ETHICS

Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories.

UNIT III ENGINEERING AS SOCIAL EXPERIMENTATION

Engineering as Experimentation – Engineers as responsible Experimenters –Codes of Ethics – A Balanced Outlook on Law

UNIT IV SAFETY, RESPONSIBILITIES AND RIGHTS

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

UNIT V GLOBAL ISSUES

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility.

Text book

1. S.C. Sarkar, Hints on Modern Advocacy, Cross-Examination and Professional Ethics, India Law House, New Delhi
2. D.V. SubbaRao, Sarjiva Row 's The Advocates Act, 1961 , LexisNexis, Butterworths Nicolson and Webb, Professional Legal Ethics, Oxford University Press
3. Justice V.R. Krishna lyer, Law, Lawyers and Jusrice, B.R. Publishing Corp. Delhi

REFERENCES

1. Raju Ramach andran, Professional Ethics: Changing Profession and Changing Ethics,
2. LexisNexis, Butterworths
3. P.B. Mukharj i, Professional Ethics of the Advocale, University of Burdwan
4. Stephen Gillers, Regulation of Lowyers: Problems of Law & Ethics, Little, Brown &Com Boston Toronto, London Ross Grauston (ed.), Legal Ethics & Professional Responsibility, Clarendon Press,Oxford
5. Gary Bellow & Bea Moultan, The Lowvering Process: Ethics and Professional Responsibility, The Foundation Press, Inc.

Learning Outcome:

- At the end of this course, students will gain knowledge about ethics and code of principle to be as a successful professionals

18REEV0649 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.

CFA:

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	-	75 marks
Total	**-**	**150 marks**

ESE:

Viva Voce	-	50 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

18REEV0650 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*.

CFA:

Report & Attendance - 150 marks

ESE:

Viva-Voce - 50 marks

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