AP STATE COUNCIL OF HIGHER EDUCATION
B.Sc. RENEWABLE ENERGY MANAGEMENT SYLLABUS UNDER CBCS
[For Mathematics combinations]
w.e.f. 2020-21 (Revised in May 2020)

SRI KRISHNADEVARAYA UNIVERSITY:: ANANTAPURAMU

REVISED SYLLABUS OF RENEWABLE ENERGY MANAGEMENT COURSE Under C.B.C.S. pattern (w.e.f. 2020-'21 Academic Year)

First Semester
Course I: BASICS OF ENERGY AND HEAT TRANSFER
Practical Course I (Lab-1)

Second Semester
Course II: RENEWABLE ENERGY
Practical Course II (Lab-2)

Third Semester
Course III: BIO ENERGY & WIND ENERGY
Practical Course III (Lab-3)

Fourth Semester
Course IV: OCEAN ENERGY AND THRMOELECTRIC POWER
Practical Course IV (Lab- 4)

Course V: ENERGY STORAGE DEVICES
Practical Course V (Lab-V)

Fifth Semester
Course VI: SOLAR THERMAL CONVERSION
Practical Course VI (Lab- 4)

Course VII: SOLAR PHOTOVOLTAIC CONVERSION
Practical Course VII (Lab-V)

COURSE STRUCTURE UNDER CBCS PATTERN

New Subject: RENEWABLE ENERGY SOURCES
(MATHEMATICS, PHYSICS & RENEWABLE ENERGY SOURCES)
UNDER CBCS PATTERN

SEMESTER	COURSE	SUBJECT	HRS.	CREDITS	TOTAL
SEMESTER I	I	**BASICS OF ENERGY AND HEAT TRANSFER**	4	4	100
		PRACTICAL I	2	1	50
SEMESTER II	II	**RENEWABLE ENERGY**	4	4	100
		PRACTICAL II	2	1	50
SEMESTER III	III	**BIO ENERGY & WIND ENERGY**	4	4	100
		PRACTICAL III	2	1	50
SEMESTER IV	IV	**OCEAN ENERGY AND THRMOELECTRIC POWER**	4	4	100
		PRACTICAL IV	2	1	50
	V	**ENERGY STORAGE DEVICES**	4	4	100
		PRACTICAL V	2	1	50
SEMESTER V	VI	**SOLAR THERMAL CONVERSION**	4	4	100
		PRACTICAL V	2	1	50
	VII	**SOLAR PHOTOVOLTAIC CONVERSION**	4	4	100
		PROJECT/INTERNSHIP/ PRACTICAL	2	1	50

SYLLABUS FOR I B.Sc., RENEWABLE ENERGY
COURSE-I
[BASICS OF ENERGY AND HEAT TRANSFER]
SEMESTER I

No. of Hours perweek:04Total Lectures: 60

UNIT-I (7)

WORK, POWER AND ENERGY: Work done by a constant force - Work done by a variable force - Kinetic Energy - Work - Energy Theorem - Significance of work-energy theorem - Power
- Conservative forces -Potential energy - One dimensional conservative systems - Non- conservative forces - Conservation ofenergy

UNIT-II (17)

Viscosity: Viscosity of a fluid - Coefficient of viscosity - stream line turbulent flow - Reynold's number - Poiseulle's equation for the flow of liquid through a tube - Volume of the liquid flowing out - Stoke's law and terminal velocity - Experimental determination of coefficient of viscosity by i) capillary flow method ii) falling sphere method and iii)comparison of viscosities - Ostwarld viscometer method - Meyer relation for flow of a gas through a capillary tube.

Surface Tension: Molecular forces - Surface tension - Surface energy - Angle of contact - pressure difference across a liquid surface - excess pressure inside a liquid drop - Shape of liquid surface in a capillary tube - rise of liquids in capillary tube - determination of surface tension by capillary rise method- Effect of temperature on surface tension - Examples of surface tension and capillarity.

UNIT- III (12)
Fluid Dynamics: Fluids - Pressure and density - The variation of pressure in a fluid at rest - Pascal's principle - Archimedes' principle - Measurement of pressure, General concepts of fluid flow - stream lines - The equation of continuity - Bernoulli's equation - Applications of Bernoulli's equation and equation of continuity - dynamic lift - Torricelli's theorem - conservation of Momentum in fluid mechanics - Fields offlow

UNIT IV(12Hrs)

Heat Transfer: Conduction Heat Transfer, Various modes of Heat Transfer – Mechanisms of Different Modes of Heat Transfer Fourier's Law of Heat Conduction, Conductivity - Electrical Analogy, Concept of Thermal Resistance – Introduction to Newton's Lawof Cooling – Unidirectional Heat Conduction , Heat Conduction with R ConvectiveEnvironment
Convection –Basic Concepts: Convective Heat Transfer Coefficients, Boundary Layer Concept, Types of Convection, Forced Convection-Laminar and Turbulent Flow, Combined Laminar and Turbulent –Nusselt Theory – Film Wise and Drop Wise Condensation.

UNIT – V(12Hrs)

Radiation Heat Transfer: Basic Concepts, Laws of Radiation-Stefan Boltzmann Law,

Kirchoff Law – Black Body Radiation Heat Exchanger & Insulation, Classification of Heat Exchangers – OverallHeatTransferCoefficient–FoulingFactor–Design&SelectionofHeatExchanger- Practical Application of Heat Exchanger – Purpose of Insulation – Classification of Insulation – Types of Insulation Material – Economic thickness of Insulation.

Reference:

1. Physics - Part I David Halliday and Robert Resnick Wiley EasternEdition
2. Physics - Marcelo Alonso and Edward J Finn - Addison Wesley Longman(AWL)
3. Unified Physics, Vol. I by S.L. Gupta and Sanjeev Gupta, 1997 Jaiprakashnath and Co., Meerut
4. Engineering Physics by R.K Gaur and S L Gupta Fifth Edition 1997 Dhanpat Rai and sons, Delhi

TEXTBOOKS:

1. Engineering Thermodynamics/ PK Nag/TMH, IIIEdition
2. Fundamentals of Thermodynamics – Sonntag, Borgnakke and vanwylen/ John Wiley & sons (ASIA)Pvt.Ltd.

REFERENCES:

1.EngineeringThermodynamics–Jones& Dugan 2.Thermodynamics–AnEngineeringApproach–YunusCengel&Boles/TMH 3.Thermodynamics–J.P.Holman/ Mc Graw Hill 4.AnintroductiontoThermodynamics/ YVCRao/ NewAge

Formoredetails, visitHttp://www.jntu.ac.in/

HEAT AND MASS TRANSFER REFERENCES:

1. Sachdeva RC,"Fundamentals of Engineering Heat and Mass Transfer" New Age International,1995
2. YadavR"HeatandMassTransfer"CentralPublishingHouse,1995.
3. HeatTransfer,S.P.Sukhatme.
4. HeatTransfer,P.K.Nag,TataMcGrawHill2002Publications.
5. HeatTransfer,RCSachdeva.
6. Thermal Insulation and Refractories-PCRA.
7. Insulation and Refractories-British Energy EfficiencyOffice.

PRACTICAL COURSE – I(I B.Sc.,) SEMESTER - I
(BASICS OF ENERGY AND HEAT TRANSFER)
LIST OF EXPERIMENTS
&
SCHEME OF PRACTICAL EXAMINATION

Practical: 2 hrs/Week

1. Bifilar Suspension - Determination of Moment ofInertia
2. Fly Wheel - Determination of Moment ofInertia
3. Determination of Surface Tension of a Liquid - Capillary tubemethod
4. Determination of viscosity of a Liquid - Searle'smethod
5. Determination of Viscosity of a Liquid - Poiseulle'smethod

6. Determination of viscosity of liquid - OstwaldViscometer
7. Determination of Surface tension - Stalagnometer method/Drop numbermethod
8. Vibration of Springs - Determination of Force Constant of a Spring and verification of laws of combination of springs (Series andparallel)
9. Torsion Pendulum - Determination of rigidity modulus of the material of a givenwire
10. Specific Heat of solids - Method ofmixtures
11. Coefficient of conductivity of a bad conductor - Lee'smethod
12. Verification of Boyle'slaw
13. Resistancethermometer
14. Thermocouplethermometer
15. Newton's law ofcooling
16. Determination of Stefan'sconstant
17. Efficiency of akettle

LEARNING OUTCOMES:
Working knowledge of the subject. Suggested student Activities:
Student seminars, group discussions, assignments, field trips, study project and experimentation using virtual lab

SYLLABUS FOR I B.Sc., RENEWABLE ENERGY

COURSE-II

[RENEWABLE ENERGY]

SEMESTER II

No. of Hours perweek:04 Total Lectures: 60

UNIT-I (12 hrs)

1. Introduction to Energy: Definition and units of energy, power, Forms of energy, Conservation of energy, second law of thermodynamics, Energy flow diagram to the earth. Origin and time scale of fossil fuels, Conventional energy sources, Role of energy in economic development and socialtransformation.

2. Global Energy Scenario: Energy consumption in various sectors, projected energy consumption for the next century, exponential increase in energy consumption, energy resources, coal, oil, natural gas, nuclear and hydroelectric power, impact of exponential rise in energy usage on globaleconomy.Energy demand and Energy trilemma index, Classification of energy resources, Conventional-Nonconventional, Renewable-Nonrenewable, Green energy, Clean energy (Definitions and examples), Green footprint, Carbon footprint, Ecological footprint concepts,

UNIT-II (12 hrs)

3. Indian Energy Scene: Energy resources available in India, urban and rural energy consumption, energy consumption pattern and its variation as a function of time, nuclear energy - promise and future, energy as a factor limiting growth, need for use of new and renewable energysources.National Green Tribunal (NGT) act, NGT activities.

4. Environmental Effects : Environmental degradation due to energy production and utilization, air and water pollution, depletion of ozone layer, global warming, biological damage due to environmental degradation. Environmental effects of thermal power station, nuclear power generation, hydroelectric power, Geothermal power, Ocean energy harvesting, Wind energy harvesting, Solar energy harvesting, Bioenergy.

UNIT-III (10 hrs)

5. Solar constant, Solar Radiation spectrum, Classification of Solar cells – First generation – Single crystalline, Poly crystalline, Second Generation – Thin film, CdS, CIGs, Third Generation – Polymer based, DSSC, Parovskites, Hybrid, Quantum Dots, Multi Junction Tandem cells. (And/Or) Organic, Inorganic and Hybrid cells. Key elements of Silicon Solar cell, PV Solar cell, Module, panel and array. Solar thermal systems types, applications of Solar PV and Solar Thermal systems.
6. Wind Energy: Introduction, Principle of wind energy conversion, Advantages and disadvantages of wind mills, Applications of windenergy.

UNIT-IV (12 hrs)

9. Geothermal energy: Introduction – Estimates of Geothermal Power – Nature of geothermal fields – Geothermal resources – Hydrothermal (convective) Resources Geo pressured resources
– Hot dry rock resources of petro-thermal systems – Magma resources-Interconnection of geothermal fossil systems – Advantages and disadvantages of geothermal energy over other energyforms

UNIT – V (14 hrs)

7. Ocean Energy: Introduction, Principle of ocean thermal energy conversion (OTEC), Tidal power generation, Tidal energy technologies, Energy from waves, Wave energy conversion, Wave energy technologies, advantages anddisadvantages.
8. Bio-Energy

Energy from biomass – Sources of biomass – Different species –
Conversion of biomass into fuels – Energy through fermentation –
Pyrolysis, gasification and combustion Biogas plants –
Properties and characteristics of biogas.

References:

1. Solar Energy Principles, Thermal Collection &Storage, S.P.Sukhatme: Tata McGraw Hill Pub., NewDelhi.
2. Non-Conventional Energy Sources, G.D.Rai, NewDelhi.
3. Renewable Energy, power for a sustainable future, Godfrey Boyle,2004,
4. The Generation of electricity by wind, E.W.Golding.
7. Non-Conventional Energy Resources by B.H. Khan, Tata McGraw Hill Pub.,2009.
8. Fundamentals of Renewable Energy Resources by G.N.Tiwari, M.K.Ghosal, Narosa Pub., 2007.
9. Non-Conventional Energy Resources by B.H. Khan, Tata McGraw Hill Pub., 2009. (Ch:6)
10. Non-Conventional Energy Resources by Shobh Nath Singh, Pearson India., 2016. (Ch:2, 4)
11. Solar Cells: From Materials to Device Technology edited by S. K. Sharma, Khuram Ali, Springer (2020)
12. Rational Design of Solar Cells for Efficient Solar Energy Conversion edited by AlagarsamyPandikumar, Ramasamy Ramaraj, Wiley (2018).

13. Energy fables, Edited by edited by Jenny Rinkinen, Elizabeth Shove, Jacopo Torriti, Routledge a T&F group, (2019).
14. Environmental Justice in India: The National Green Tribunal, By Gitanjali Nain Gill, Routledge (2016).
15. Ref: The Oxford Handbook of Comparative Environmental Law, edited by Emma Lees, Jorge E. Viñuales, Oxford University Press (2019).
16. Environmental Impacts Of Renewable Energy by Frank R. Spellman, CRC Press (2015)

PRACTICAL COURSE – II (I B.Sc.,) SEMESTER - II
(RENEWABLE ENERGY)
LIST OF EXPERIMENTS
&
SCHEME OF PRACTICAL EXAMINATION

Practicals 2Hrs/Week

1. Preparation of copper oxide selective surface by chemical conversionmethod.
2. Performance testing of solarcooker.
3. Determination of solar constant usingpyroheliometer.
4. Measurement of I-V characteristics of solarcell.
5. Study the effect of input light intensity on the performance of solarcell.
6. Study the characteristics ofwind.
7. *Solarmapping*

Topics in italics are suggested by representatives of industry
LEARNING OUTCOMES: Working knowledge of the subject

SYLLABUS FOR II B.Sc., RENEWABLE ENERGY
COURSE-III
[BIO ENERGY & WIND ENERGY]
SEMESTER III

No. of Hours perweek:04 Total Lectures:60

UNIT - I (12hrs)

Basics in Biomass Study: Biomass-types and its advantages and drawbacks – Indian scenario – Characteristics –Conversion Mechanisms – Fuel Assessment Studies, Selection of site for biogasplant.

Biomethanation: Microbial systems, Phases in Biogas Production – Parameters Affecting Gas Production-Biogas Plants: Types, Design, Constructional Details and Comparison – Factors affecting thedesign.

UNIT – II (18hrs)

Methods for Maintaining Biogas Production: Insulating the Gas Plant – Composting – Hot Water circulation – Use of Chemicals –Solar energy systems, problems related to biogasplants

Commissioning and Management of Bio Gas Plant: Commissioning and Management of Biogas plant, Community Plant-Biogas Appliances –Effect of Biogas on Engine Performance - Socio-Economic Aspects of Biogas – Cost – Benefit Analysis of Biogas Plant

Biofuel: Ethanol and Methanol production fromCellulose and wood – Biomass –
Biodiesel Production from Non-Edible Oil Seeds

Students are advised to visit and submit a detailed on the following

1. Production of bio gas with microbialsystem
2. Production of Biodiesel
3. TextBooks1.DavidBoyles,BioEnergyTechnologyThermodynamicsandcosts,Ellis Hoknood, Chichester,1984.
4. Non-ConventionalEnergySources,G.D.Rai,KhannaPublications.
5. Non-Conventional Energy Resources, B.H. Khan, Tata Mc Graw HillPublications.

References

1. Khandelwal, K.C., Mahdi, S.S., Biogas Technology – A Practical Handbook, Tata Mc Graw–
Hill, 1986.
2. R. C. Maheswari, Bio Energy for Rural Energization, ConceptsPublication, 1997.

3. Tom, B. Reed, Biomass Gasification– Principles and Technology, Noyce Data Corporation, 1981

UNIT-III (10Hrs)

Introduction: Nature of the wind, Power of the Wind, Forces of the Blades, Wind generation, meteorology of wind, world distribution of wind, wind speed variation with height, wind speed statistics, Wind energy conversion principles; Generalintroduction;
Wind Measurements: Eolian features, biological indicators, rotational anemometers, other anemometers, wind measurements withballoons.

UNIT-IV (12Hrs)

Wind Energy Conversion System: Types and classification of WECS; Power, torque and speed characteristics, Aerodynamic design principles; Aerodynamic theories; Axial momentum, blade element and combine theory; Rotor characteristics; Maximum power coefficient; Prandlt's tip losscorrection.

Design of Wind Turbine: Wind turbine design considerations; Horizontal axis machines, vertical axis machines, Advantages and drawbacks, Methodology; Theoretical simulation of wind turbine characteristics; Test methods.

UNIT-V (8Hrs)

1. Wind Energy Application: Wind pumps: Performance analysis, design concept and testing; Principle of wind energy generation; Standalone, grid connected and hybrid applications of wind energy conversion systems, Economics of wind energy utilization; Wind energy in India; Environmental Impacts of Wind farms.

Reference Books:

1. Dan Charis, Mick Sagrillo, LanWoofenden, "Power from the Wind", New Society Pub.,2009.
2. Erich Hau, "Wind Turbines-Fundaments, Technologies, Applications, Economics", 2ndEdition, Springer Verlag, BerlinHeidelberg, NY, 2006.
3. Joshue Earnest, Tore Wizelius, Wind Power and Project Developmen", PHI Pub.,2011.
4. T. Burton, D. Sharpe, N. Jenkins, E. Bossanyi, Wind Energy Handbook, John Wiley Pub., 2001.
5. Paul Gipe, "Wind Energy Basics", Chelsea Green Publications,1999.
6. Khan, B.H., "Non-Conventional Energy Resources", TMH, 2nd Edition, New Delhi,2009.
7. Tiwari, G.N., and Ghosal, M.K, Renewable Energy Resources – Basic Principles and applications, Narosa PublishingHouse,2007.
8. G.D.Rai, Non-conventional Energy Sources, Khanna Publishers, New Delhi(2008)

PRACTICAL COURSE – III (II B.Sc.,) SEMESTER - III
(BIO ENERGY & WIND ENERGY)
LIST OF EXPERIMENTS
&
SCHEME OF PRACTICAL EXAMINATION

Practicals 2 Hrs/Week

1. Estimation of wind speed usinganemometer.
2. Determination of characteristics of a windgenerator
3. Study the effect of number and size of blades of a wind turbine on electric poweroutput.
4. Performance evaluation of vertical and horizontal axes wind turbinerotors.

LEARNING OUTCOMES: Working knowledge of the subject

The following Scheme may be followed instead of practicals ComprehensiveViva: 1credit

Seminar : 1 credit

OR

Project: 2credits
OR
Internship: 2credits

SYLLABUS FOR II B.Sc., RENEWABLE ENERGY

COURSE-IV

[OCEAN ENERGY AND THRMOELECTRIC POWER]

SEMESTER IV

No. of Hours perweek:04 Total Lectures:60

UNIT-I (12Hrs)
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; Speed and voltage regulation; Investment issues load management and tariff collection; potential of small hydro power in India. Wind and hydro based stand-alone hybrid powersystems.

UNIT-II (12Hrs)
Ocean Thermal Energy Conversion: Introduction, Working principle, Resource and site requirements, Location of OTEC system, Electricity generation methods from OTEC, open cycle and closed cycle OTEC systems, Advantages and disadvantages, Applications of OTEC,

UNIT-III (12Hrs)
Tidal Energy - Introduction, Origin and nature of tidal energy, Basic principle of tidal power generation, Components of tidal power plants, Tidal energy technology, Tidal range power, Basic modes of operation of tidal systems. Advantages and limitations

UNIT-IV (12Hrs)
Wave Energy – Introduction, Basics of wave motion, Power in waves, Wave energy conversion devices, Advantages and disadvantages, Applications of wave energy, Prospects of wave energy in India.

UNIT– V (12hrs)
Thermoelectric power: Basic principles of thermoelectric power generation – Thermoelectric power generator – performance analysis of thermo electric power generator – thermoelectric materials – selection of materials, Thermionic generation- Thermionic work function – Basic thermionic generator –analysis of thermionic generator

REFERENCEBOOKS:

1. Non-ConventionalEnergySources.G.D.Ray,KhannaPublications.
2. Non-Conventional EnergyResources, B. H. Khan, TheMcGraw Hill Publication
3. Khan, B.H., “Non-Conventional Energy Resources”, TMH, 2nd Edition, New Delhi,2009.
4. Tiwari, G.N., and Ghosal, M.K, Renewable Energy Resources – Basic Principles and applications, Narosa PublishingHouse,2007.

PRACTICAL COURSE – IV (II B.Sc.,) SEMESTER - IV
(OCEAN ENERGY AND THRMOELECTRIC POWER)
LIST OF EXPERIMENTS
&
SCHEME OF PRACTICAL EXAMINATION

Practicals 2Hrs/Week

1. Estimation of wind speed usinganemometer.
2. Determination of characteristics of a wind generator
3. Study the effect of number and size of blades of a wind turbine on electric power output.
4. Performance evaluation of vertical and horizontal axes wind turbine rotors.
5. Study the effect of wave amplitude and frequency on the wave energy generated.
6. Study the effect of density of water on the output power of hydroelectric generator.

LEARNING OUTCOMES:
Working knowledge of the subject Students are advised to visit and submit a detailed report on
1. Hydrogen storage unit
2. Thermal power stations.

Project: 2 credits
OR
Internship: 2 credits

SYLLABUS FOR II B.Sc., RENEWABLE ENERGY
COURSE-V
[ENERGY STORAGE DEVICES]
SEMESTER IV

No. of Hours perweek:04 Total Lectures:60

UNIT-I (12hr)
1. Energy Storage: Need of energy storage; Different modes of energy storage, Flywheel storage, Electrical and magnetic energy storage: Capacitors, electromagnets; Chemical Energy storage: Thermo-chemical, photo-chemical, bio-chemical, electro-chemical, fossil fuels and synthetic fuels. Hydrogen for energystorage.

UNIT-II (12hrs)
2. Electrochemical Energy Storage Systems: Batteries: Primary, Secondary, Lithium, Solid-state and molten solvent batteries; Lead acid batteries; Nickel Cadmium Batteries; Advanced Batteries. Role of carbon nano-tubes inelectrodes.

UNIT-III (12hrs)

3. Magnetic and Electric Energy Storage Systems: Superconducting Magnet Energy Storage (SMES) systems; Capacitor and battery: Comparison and application; Super capacitor: Electrochemical Double Layer Capacitor (EDLC), principle of working, structure, performance andapplication.

UNIT-IV (12hrs)

4. Fuel Cell: Fuel cell definition, difference between batteries and fuel cells, fuel cell components, principle and working of fuel cell, performance characteristics, efficiency, fuel cell stack, fuel cell power plant: fuel processor, fuel cell power section, power conditioner, Advantages anddisadvantages.

UNIT-V (12hrs)

5. Types of Fuel Cells: Alkaline fuel cell, polymer electrolyte fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell; solid oxide fuel cell, proton exchange membrane fuel cell, problems with fuel cells, applications of fuelcells.

REFERENCE BOOKS

1. J. Jensen and B. Squrensen, Fundamentals of Energy Storage, John Wiley, NY,1984.
2. M. Barak, Electrochemical Power Sources: Primary and Secondary Batteriesby,

P. Peregrinus,IEE,1980.

3. P.D.Dunn, Renewable Energies, Peter Peregrinus Ltd, London,1986.
4. B.Viswanathan and M. A. Scibioh, Fuel Cells-Principles and Applications, University Press, 2006.
5. Hart, A.B and G.J.Womack, Fuel Cells: Theory and Application, Prentice Hall, NewYork, 1989.
6. Hydrogen and Fuel Cells: A comprehensive guide, Rebecca Busby, Pennwell corporation (2005)
7. Hydrogen and Fuel Cells: Emerging Technologies and Applications, B.Sorensen, Academic Press (2012).

PRACTICAL COURSE – V (II B.Sc.,) SEMESTER - IV
(ENERGY STORAGE DEVICES)
LIST OF EXPERIMENTS
&
SCHEME OF PRACTICAL EXAMINATION

Practicals 2Hrs/Week

1. Study of charge and discharge characteristics of storagebattery.
2. Study of charging and discharging behavior of acapacitor.
3. Determination of efficiency of DC-AC inverter and DC-DCconverters
4. Study of charging characteristics of a Ni-Cd battery using solar photovoltaicpanel.
5. Performance estimation of a fuelcell.
6. Study of effect of temperature on the performance of fuel cell LEARNING OUTCOMES;

Working knowledge of thesubject

GOVERNMENT COLLEGE (A):: RAJAMAHENDRAVARAM

DEPARTMENT OF PHYSICS

SYLLABUS FOR III B.Sc., RENEWABLE ENERGY

COURSE-VI

[SOLAR THERMAL CONVERSION]

SEMESTER V

No. of Hours perweek:04 Total Lectures:45

UNIT-I (9hrs)

1. Basics of Solar Radiation: Structure of Sun, Spectral distribution of extra terrestrial radiation, Solar constant, Concept of Zenith angle and air mass, Definition of declination, hour angle, solar and surface azimuth angles; Direct, diffuse and total solar radiation, Solar intensitymeasurement

– Thermoelectric pyranometer andpyrheliometer.

UNIT-II (9Hrs)

2. Radiative Properties and Characteristics of Materials: Reflection, absorption and transmission of solar radiation through single and multi covers; Kirchoff's law – Relation between absorptance, emittance and reflectance; Selective Surfaces - preparation and characterization, Types and applications; Anti-reflective coating.

UNIT-III (9hrs)

3. Flat Plate Collectors (FPC) : Description of flat plate collector, Liquid heating type FPC, Energy balance equation, Efficiency, Temperature distribution in FPC, Definitions of fin efficiency and collector efficiency, Evacuated tubularcollectors.

UNIT-IV (9Hrs)

4. Concentrating Collectors: Classification, design and performance parameters; Definitions of aperture, rim-angle, concentration ratio and acceptance angle; Tracking systems; Parabolic trough concentrators; Concentrators with pointfocus.

UNIT-V (9Hrs)

Solar hot water system (SHWS), Types of SHWS, Standard method of testing the efficiency of SHWS; Passive space heating and cooling concepts, Solar desalinator and drier, Solar thermal power generation.

Reference Books:

1. Solar Energy Utilization, G. D. Rai, KhannaPublishers
2. Solar Energy- Fundamentals, design, modeling andapplications,
G.N. Tiwari, Narosa Pub., 2005.
3. Solar Energy-Principles of thermal energy collection & storage, S.P. Sukhatme, Tata Mc-Graw Hill Publishers,1999.

PRACTICAL COURSE – VI (III B.Sc.,) SEMESTER - V
(SOLAR THERMAL CONVERSION)
LIST OF EXPERIMENTS
&
SCHEME OF PRACTICAL EXAMINATION

Practicals 2Hrs/Week

1. Measurement of direct solar radiation usingpyrheliometer.
2. Measurement of global and diffuse solar radiation usingpyranometer.
3. Measurement of emissivity, reflectivity andtransitivity.
4. Measurement of efficiency of solar flat platecollector.
5. Performance testing of solar air dryerunit.
6. Performance testing of solar cookerunit

SYLLABUS FOR III B.Sc., RENEWABLE ENERGY

COURSE-VII

[SOLAR PHOTOVOLTAIC CONVERSION]

SEMESTER V

No. of Hours perweek:04 Total Lectures:45

Unit-I (9Hrs)

1. Fundamentals on Junctions: p-n junction, Type of junctions, homo, hetero and schottky junctions, depletion layer, junction in equilibrium, application of bias, energy band diagram, abrupt and graded junctions, electric field and potential distribution at the interface, calculation of built-in voltage, Expression depletion layercapacitance.

UNIT-II (9Hrs)

2. Sun – Earth geometric relationship, Layers of the sun, Earth-Sun angles and their relationships, Solar energy reaching the earth's surface, Solar cell, Module, Panel and array construction, Theory of solar cell – Energy band diagrams, Junction current, Solar cell equivalent circuit, IV Characteristics, Efficiency of Solar cell, Maximizing the solar PV output and load matching, Maximum power point tracker.

UNIT-III (9Hrs)

3. Planning – Calculating daily load demand, Amp-hour Vs. Watt-hour calculations, Choosing modules, batteries, control systems, inverter, Site surveying and Shadow analysis – Shadow types, shading analysis, Shading and PV array configuration, Mounting system and building integration – Roof basics, Slopping roofs, Flat roofs, Façade basics, Photovoltaic Facades, Glass roofs, Solar protection devices, Mounting systems for free standing installations.

UNIT-IV (9Hrs)

4. Batteries, Rated storage capacity, Charging-discharging cycles, Choosing the best battery, Charge controllers and inverters – Why use charge controllers?, Low voltage disconnect, Over charge protection, Charge controllers and system connections, Charge controller system connections, choosing charge controllers, Inverters, Choosing inverters, Voltage converters, Wiring cables, Switches, sockets and fuses, Wire size and voltage drop calculations, Earthing and lightning protection.

UNIT-V (9Hrs)

5. PV array combiner/junction boxes, string diodes and fuses, Grid connected inverters, Cabling, wiring and connection system, DC Main switch, AC switch disconnector, Inverter and PV array configurations, Inverter installation site, Sizing the inverter, Selecting and Sizing cables, Monitoring operating data and presentation.

Reference Books:

1. Non-Conventional Energy Resources by B.H. Khan, Tata McGraw Hill Pub., 2009. (Ch:6)
2. Non-Conventional Energy Resources by Shobh Nath Singh, Pearson India., 2016. (Ch:2, 4)
3. Stand-Alone Solar Electric Systems by Frank Jackson, Mark hankins, Earthscan Publishing (2010)
4. Grid-connected Solar Electric Systems, Geoff Stapleton and Susan Neill, Mark hankins, Earthscan Publishing (2010)
5. Planning and Installing Photovoltaic Systems - A guide for installers, architects and engineers Second Edition, Earthscan publishing (2008)

PRACTICAL COURSE – VII (III B.Sc.,) SEMESTER - V
(SOLAR PHOTOVOLTAIC CONVERSION)
LIST OF EXPERIMENTS
&
SCHEME OF PRACTICAL EXAMINATION

Practicals 2Hrs/Week

Practical: Solar Thermal and Photovoltaic Aspects

1. Effect of tilt angle on the efficiency of solar photovoltaicpanel.
2. Study on solar photovoltaic panel in series combination.
3. Study on solar photovoltaic panel in parallelcombination.
4. Performance of solar module under various conditions (dusting)
5. Estimation of power requirements of a house/institute.

LEARNING OUTCOMES:

Working knowledge of the Subject.