# St Aloysius College (Autonomous)
# Mangaluru

**Re-accredited by NAAC "A" Grade**

## Bachelor of Vocational Studies

## In

# RENEWABLE ENERGY MANAGEMENT

**CREDIT BASED SEMESTER SYSTEM**

**(2021 – 22 ONWARDS)**

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ST ALOYSIUS COLLEGE
(Autonomous)
P.B.No.720
MANGALURU- 575 003, INDIA
Phone:+91-0824 2449700,2449701
Fax: 0824-2449705
Email: principal_sac@yahoo.com
Website: www.staloysius.edu.in

**Re-accredited by NAAC with 'A' Grade - CGPA 3.62**
**Ranked 94 in College Category – 2018 Under NIRF, MHRD, Government of India**
**Recognised by UGC as "College with Potential for Excellence"**
**College with 'STAR STATUS' conferred by DBT, Government of India**

Date: 16-02-2021

**NOTIFICATION**

Sub: Syllabus of **B.Voc. in Renewable Energy Management** Course under Credit Based Semester System.

Ref: 1. Academic Council decision dated 12-12-2020
2. Office Notification dated 16-02-2021

Pursuant to the Notification cited under reference (2) above, the Syllabus of **B.Voc. in Renewable Energy Management** Course under Credit Based Semester System is hereby notified for implementation with effect from the academic year **2021-22.**

**PRINCIPAL** **REGISTRAR**

To:
1. The Chairman/Dean/HOD.
2. The Registrar
3. B.Voc. Office
4. Library

# B.Voc. Programme

# RENEWABLE ENERGY MANAGEMENT

BOS meeting held on 24 November 2020 by the department of Physics St Aloysius College Mangalore.

Following members present for the meeting :

| | |
|---|---|
| Mr Lawrence Pinto | (chairman) |
| Dr Prakash Kamath | (faculty member) |
| Dr Narayan Bhat | (faculty member) |
| Dr Ishwara Bhat | (faculty member) |
| Mr Harshith B | (faculty member) |
| Mr Shawn Ajay D'Souza | (faculty member) |
| Ms Amrutha O. | (faculty member) |
| Dr Rajesh Kumar PC | (subject expert) |
| Dr Sadananda Kumar | (subject expert) |
| Mr Clavian Larry Miranda | (distinguished alumni) |
| Ms Seema G | (industry expert) |
| Ms Supuni Ranasinghe | (student representative) |

1.

| COURSE | JOB ROLE | INTAKE |
|---|---|---|
| **B VOC IN**<br><br>**RENEWABLE ENERGY MANAGMENT** | • Renewable Energy Engineers<br>• Green Engineering Manager<br>• Renewable Energy Policy & Planning Manager<br>• Sustainable Energy Technologist<br>• Industrial Ecologist<br>• Environmental Manager<br>• Environmental Engineer<br>• Green Builder etc<br>• Energy Engineer | **30** |

## 2. Scope:

Renewable energy market and applications in the 21st century has gained considerable momentum, with high potential and very ambitious plans for adding new capacities worldwide. It has been and will continue to be impacted by major economic, environmental and technical challenges. However, the capacity building and securing qualified human resources is an important factor for accelerated deployment and success of these technologies.

This course is focused on examining state-of-the-art and emerging renewable energy technologies and trends that are anticipated over the next few decades. The delegates will receive a throughout grounding of existing technologies, novel developments and options, opportunities, risks and likely achievements over this period. Practical applications and cases are frequently used along with participant exercises.

## 3. Objectives of the Course:

To create several self-employment opportunities in renewable energy and energy efficienc sectors

Become an expert in theoretical as well as practical aspects of renewable energy technologies, energy conservation, and management

Develop a thorough understanding of Renewable energy resources like solar energy, wind energy, tidal energy etc.

Participate in training programs like Hands on Training (HOT), On the Job Training (OJT) in Renewable energy Industries that enhances their ability to work

4. **The course acquires relevance in the light of factors such as:**
   - India's fast-increasing demand for energy.
   - Constant need and pressure to reduce emissions from fossil fuels.
   - Need to rely more on cleaner technologies and renewable sources of energy.

5. **The course offers to eligible candidates:**

   - Vocational training in the areas of renewable, clean energy, and energy management.
   - Advanced understanding of the effect of human activities on the environment.
   - Lessons in the socio-economic and business issues influencing delivery of the technology.

6. **Major concepts covered in the course's syllabus include:**

   - Energy conservation and energy management.
   - Manufacturing and promotion of renewable energy.
   - Energy conservation systems.
   - Research training in development of technologically and economically viable renewable energy systems.

7. **Career Prospects**

**The Ministry of New and Renewable Energy has set up 4 specialized centers:**

1. SOLAR ENERGY 2. WIND ENERGY 3. BIO-ENERGY 4. HYDRO-ENERGY

**Graduates can find lucrative employment opportunities in areas concerned with:**

1 PHOTO VOLTAIC (PV) CELLS. 2. SOLAR PANELSOWER DISTRIBUTION

3. PV CELL MANUFACTURING 4. WIND TURBINE

5. MATERIAL MANAGEMENT AND PROCUREMENT. 6. ENERGY RESEARCH WINGS.

**Structure of syllabus RENEWABLE ENERGY MANAGEMENT**
**B.Vocational (Diploma)- 1 Year**

| Semester-I | Category/ Mode | Subject Code | Subject | Theory Hours/ Week | Duration of | Marks & Credits | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | IA | Exam | Total | Credi |

| | | | | | Exams (Hrs) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| General Education / General Component | Language -1: | BV 171.1 | Communication Skill-1 | 2 | 3 | 20 | 80 | 100 | 2 |
| | Language - 2: | BV 172.1 | Kannada/Hindi | 2 | 3 | 20 | 80 | 100 | 2 |
| | Core paper- 1 Theory | BV 173.1 | Fundamentals of Physics | 3 | 3 | 20 | 80 | 100 | 3 |
| | Core paper- 2 Theory | BV 174.1 | Basic Electronics | 3 | 3 | 20 | 80 | 100 | 3 |
| | Elective Foundation | BV 175.1 | Environmental Science & Value Education | 2 | 2 | 10 | 40 | 50 | 2 |
| Skill Component | Practical-1 | BV 176.1P | Fundamentals of Physics- Lab | 6 | 3 | 30 | 120 | 150 | 6 |
| | Practical-2 | BV 177.1P | Basic Electronic slab | 6 | 3 | 30 | 120 | 150 | 6 |
| | Project/ Internship | BV 178.1P | Project-1 | 6 | | 30 Viva | 120 | 150 | 6 |
| | | | **Total** | **30** | | **180** | **720** | **900** | **30** |

| **Semester-II** | **Category/ Mode** | **Subject Code** | **Subject** | **Theory Hours/ Week** | **Duration of Exams (Hrs)** | **Marks & Credits** | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | **IA** | **Exam** | **Total** | **Credit** |
| General Education / General Component | Language - 1: | BV 171.2 | Communication Skill | 2 | 3 | 20 | 80 | 100 | 2 |
| | Language - 2: | BV 172.2 | Kannada/Hindi | 2 | 3 | 20 | 80 | 100 | 2 |
| | Core paper- 1 Theory | BV 173.2 | Photometry, Heat and Thermodynamics | 3 | 3 | 20 | 80 | 100 | 3 |
| | Core paper- 2 Theory | BV 174.2 | Fundamentals of solar Energy & Photo Voltaic Technology | 3 | 3 | 20 | 80 | 100 | 3 |
| | Elective Foundation | BV 175.2 | Fundamental of Indian Constitution | 2 | 2 | 10 | 40 | 50 | 2 |
| Skill Component | Practical-1 | BV 176.2P | Photometry, Heat and Thermodynamics - Lab | 6 | 3 | 30 | 120 | 150 | 6 |
| | Practical-2 | BV 177.2P | Fundamentals of solar Energy & Photo Voltaic Technology -Lab | 6 | 3 | 30 | 120 | 150 | 6 |
| | Project/ Internship | BV 178.2P | Project-2 | 6 | | 30 Viva | 120 | 150 | 6 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Total** | **30** | | **180** | **720** | **900** | **30** |

**B.Vocational (Advanced Diploma)-2 Year**

| Semester-III | Category/ Mode | Subject Code | Subject | Theory Hours/ Week | Duration of Exams (Hrs) | Marks & Credits | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | IA | Exam | Total | Credit |
| General Education / General Component | Language - 1: | BV 171.3 | Business Communication | 2 | 3 | 20 | 80 | 100 | 2 |
| | Language - 2: | BV 172.3 | Kannada/Hindi (Skill Development) | 2 | 3 | 20 | 80 | 100 | 2 |
| | Core paper- 1 Theory | BV 173.3 | Basics of Computer Application | 3 | 3 | 20 | 80 | 100 | 3 |
| | Core paper- 2 Theory | BV 174.3 | Basics of Electricity | 3 | 3 | 20 | 80 | 100 | 3 |
| | Elective Foundation | BV 175.3 | Fundamental of Business Law | 2 | 2 | 10 | 40 | 50 | 2 |
| Skill Component | Practical-1 | BV 176.3P | Basic of Computer Application-Lab | 6 | 3 | 30 | 120 | 150 | 6 |
| | Practical-2 | BV 177.3P | Basics of Electricity-Lab | 6 | 3 | 30 | 120 | 150 | 6 |
| | Project/ Internship | BV 178.3P | Project-3 | 6 | | 30 Viva | 120 | 150 | 6 |
| **Total** | | | | **30** | | **180** | **720** | **900** | **30** |

**B.Vocational (Advanced Diploma)- 2 Year**

| Semester-IV | Category/ Mode | Subject Code | Subject | Theory Hours/ Week | Duration of Exams (Hrs) | Marks & Credits | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | IA | Exam | Total | Credit |
| General Education / General Component | Language -1: | BV 171.4 | English | 2 | 3 | 20 | 80 | 100 | 2 |
| | Language - 2: | BV 172.4 | Kannada/Hindi | 2 | 3 | 20 | 80 | 100 | 2 |
| | Core paper- 1 Theory | BV 173.4 | Storage Devices and Invertors | 3 | 3 | 20 | 80 | 100 | 3 |
| | Core paper- 2 Theory | BV 174.4 | Fluid Mechanics | 3 | 3 | 20 | 80 | 100 | 3 |
| | Elective Foundation | BV 175.4 | Gender Equity & Value Education | 2 | 2 | 10 | 40 | 50 | 2 |
| Skill Component | Practical-1 | BV 176.4P | Storage Devices and Invertors-Lab | 6 | 3 | 30 | 120 | 150 | 6 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Practical-2 | BV 177.4P | Fluid Mechanics-Lab | 6 | 3 | 30 | 120 | 150 | 6 |
| | Project/ Internship | BV 178.4P | Project-4 | 6 | | 30 Viva | 120 | 150 | 6 |
| **Total** | | | | **30** | | **180** | **720** | **900** | **30** |

**B. Vocational (Degree)- 3 Year**

| Semester-V | Category/ Mode | Subject Code | Subject | Theory Hours/ Week | Duration of Exams (Hrs) | Marks & Credits | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | IA | Exam | Total | Credit |
| General Education / General Component | Core paper- 1 Theory | BV 171.5 | Entrepreneurship | 3 | 3 | 20 | 80 | 100 | 3 |
| | Core paper- 2 Theory | BV 172.5 | Bio-mass Energy | 3 | 3 | 20 | 80 | 100 | 3 |
| | Core paper- 3 Theory | BV 173.5 | Geo-Thermal Energy | 3 | 3 | 20 | 80 | 100 | 3 |
| | Core paper- 4 Theory | BV 174.5 | Marketing management | 3 | 3 | 20 | 80 | 100 | 3 |
| Skill Component | Practical-1 | BV 175.5 | Bio-mass Energy-Lab | 6 | 3 | 30 | 120 | 150 | 6 |
| | Practical-2 | BV 176.5P | Geo-Thermal Energy-Lab | 6 | 3 | 30 | 120 | 150 | 6 |
| | Project/ Internship | BV 177.5P | Project-5 | 6 | | 30 Viva | 120 | 150 | 6 |
| | | **Total** | | **30** | | **180** | **720** | **900** | **30** |

**B. Vocational (Degree)- 3 Year**

| Semester-VI | Category/ Mode | Subject Code | Subject | Theory Hours/ Week | Duration of Exams (Hrs) | Marks & Credits | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | IA | Exam | Total | Credit |
| General Education / General Component | Core paper- 1 Theory | BV 171.6 | Taxation Law | 3 | 3 | 20 | 80 | 100 | 3 |
| | Core paper- 2 Theory | BV 172.6 | Legal Aspects of Business | 3 | 3 | 20 | 80 | 100 | 3 |
| | Core paper- 3 Theory | BV 173.6 | Installation & Maintenance of Renewable Energy Devices | 3 | 3 | 20 | 80 | 100 | 3 |
| | Core paper- 4 Theory | BV 174.6 | Materials & Processes in manufacturing | 3 | 3 | 20 | 80 | 100 | 3 |
| Skill Component | Practical-1 | BV 175.6 | Installation & Maintenance of Renewable Energy Devices-Lab | 6 | 3 | 30 | 120 | 150 | 6 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Practical-2 | BV 176.6P | Materials & Processes in manufacturing-Lab | 6 | 3 | 30 | 120 | 150 | 6 |
| | Project/ Internship | BV 177.6P | Project-6 | 6 | | 30 Viva | 120 | 150 | 6 |
| **Total** | | | | **30** | | **180** | **720** | **900** | **30** |

**SEMESTER – I**

**FUNDAMENTALS OF PHYSICS**

**Course Objectives:**

The objective of this paper is to learn the fundamental concepts in physics such as units and dimensions, motion, work and energy, rotation which would help in fabrication of various renewable energy devices

Course Outcomes:

- Ability to correlate different physical parameters required for the functioning of energy devices
- Understand the functioning of various renewable energy devices

**UNIT 1**

UNITS AND MEASUREMENTS

The international system of units, Measurement of length, Measurement of mass, Measurement of time, Accuracy, precision of instruments and errors in measurement, Significant figures, Dimensions of physical quantities, Dimensional formulae and dimensional equations, Dimensional analysis and its applications

MOTION IN A STRAIGHT LINE

Position, path length and displacement, Average velocity and average speed, Instantaneous velocity and speed, Acceleration, Kinematic equations for uniformly accelerated motion, Relative velocity **(12 Hrs.)**

**UNIT 2**

MOTION IN A PLANE

Scalars and vectors, Multiplication of vectors by real numbers, Addition and subtraction of vectors – graphical method, Resolution of vectors, Vector addition – analytical method, Motion in a plane, Motion in a plane with constant acceleration, Relative velocity in two dimensions, Projectile motion, Uniform circular motion

LAWS OF MOTION

Aristotle's fallacy, The law of inertia, Newton's first law of motion, Newton's second law of motion, Newton's third law of motion, Conservation of momentum, Equilibrium of a particle, Common forces in mechanics, Circular motion, Solving problems in mechanics

**(12 Hrs.)**

**UNIT 3**

WORK, ENERGY AND POWER

Work, Kinetic energy, Work done by a variable force, The concept of potential energy, The conservation of mechanical energy, The potential energy of a spring, Various forms of energy : the law of conservation of energy, Power, Collisions

SYSTEM OF PARTICLES AND ROTATIONAL MOTION

Centre of mass, Motion of centre of mass, Linear momentum of a system of particles, Angular velocity and its relation with linear velocity, Torque and angular momentum, Equilibrium of a rigid body, Moment of inertia, Kinematics of rotational motion about a fixed axis, Dynamics of rotational motion about a fixed axis, Angular momentum in case of rotations about a fixed axis, Rolling motion

**(12 Hrs.)**

Reference Books


- Fundamentals of Physics by Halliday, Resnick and Walker.
- Schaum's Outlines: Beginning Physics 1 by Alvin Halpern
- Principles of Physics by V. K. Mehta and Rohit Mehta
- Physics Part 1, Textbook for class XI by NCERT


**FUNDAMENTALS OF PHYSICSPRACTICALS LAB**

1. To measure diameter of a small spherical/cylindrical body using Vernier callipers.

2. To determine the moment of inertia of a solid sphere of known mass using vernier calipers
3. To measure internal diameter and depth of a given beaker/calorimeter using Vernier callipers and hence find its volume.
4. To measure the diameter of a given wire using screw gauge.
5. To measure the thickness of a given sheet using screw gauge.
6. To measure the volume of an irregular lamina using screw gauge.
7. To determine the radius of curvature of a given spherical surface by a spherometer.
8. To determine the mass of two different objects using a beam balance.
9. To find the weight of a given body using the parallelogram law of vectors.
10. Using a simple pendulum, plot L-T and L-T2 graphs. Hence find the effective length of a second's pendulum using appropriate graph.

**I SEMESTER**

**BASIC ELECTRONICS**

**UNIT-I**

**Elements of Electronic Circuits**: Introduction to Electronics and Application areas of Electronics. Branches of Electronics, Analog and digital Electronics. Alternating and direct current. Physical parameters used in Electronics. Measuring voltage, current and resistance using multimeter.

**Electronic circuits and their realization:** Single loop circuit using voltage source and resistors, analysis using Ohms law and simple numerical problems.

**Circuit boards**: Soldering tags, bread board and PCB. Soldering technique- Soldering iron, solder-properties and types.Printed circuit boards-Procedure of preparation, testing and soldering the components. **12 hrs**

**UNIT-II**

**Electronic devices:** Linear and nonlinear, active and passive, unilateral and bilateral devices. Sources-ac and dc sources, various types of batteries-conventional and modern-Working principles and application areas. Passive devices: resistors, capacitors, inductors, fuse and switches- Explanation, I-V Characteristics, applications and symbols. Fixed resistors-types, identification- color coding and testing using multimeter. Variable resistors-types, identification-color coding and testing using millimeter.

**Transformers:** Principles of operation, types and I-V relationships. Power transformers and signal transformers-type sand applications.

**Fuses and switches**-Operating principles, Types, testing and applications.

**Active devices**: Semiconductor diodes, transistors, Field effect transistors working, I-V Characteristics, types and symbols, Biasing techniques, configurations of use and mention of Applications, Specifications and Testing. **12 hrs**

## UNIT-III

**Elements of Digital Electronics**: Digital signal, Binary numbers-Binary arithmetics, Representation of binary numbers using timing. Logic gates: Introduction, truth table, obtaining truth table of any Boolean function. AND/OR/NOT gates- truth table, symbol and Boolean equation.Universal gates, EXOR and EXNOR gates .Realization of Boolean functions using AND/OR/NOT gates.

**Combinational Logic Circuit**: Design procedure with examples –Half Adder, Full Adder, Half subtractor, Four bit parallel binary adder, Parity Bit Generator, multiplexers and demultiplexers

**Sequential circuits:** Flip Flops – RS Flip Flop – basic type (using NAND gates), pulse and Edge Triggering, clocked RS Flip Flops with timing diagram. D Flip Flop – truth table, timing diagram. JK Flip Flop – truth table, timing diagram, racing in flip-flops, Master slave JK flip flop, T Flip Flops.

**12 hrs**

**Reference Books:**


1. Basic Electronics and Linear circuits – N.N Bhargava, D.C Kulashreshtha& S.C Gupta – Tata McGraw Hill.
2. Electronics principles – A.P. Malvino, 3rd edition – TMH edition.
3. Electronic Devices and Circuits – Boylestad & Nashelesky 6th edition, Pearson education.
4. Electrical, Electronic and Computer Engineering for Scientists and Engineers – K A Krishna Murty & M R Raghuveer 2nd edition – New Age International Ltd Publishers.
5. Digital Design – Thomas L Floyd – 8th edition – Pearson Education.
6. Digital Logic and Computer design – Moris M Mano – PHI publishers
7. Digital systems, principles and applications – Ronald J Tocci, Neal S Widmer, PHI publications

## I SEMESTER PRACTICALS-1

**SUGGESTED LIST OF EXPERIMENTS:**

**PART A:**

1. Soldering practice.
2. Use of Multimeters
3. Identification of Resistors and Capacitors.
4. Verification of Ohms law,
5. Study of series and parallel combination of resistors by measurement of p.d across each resistor and combination.
6. Verification of Voltage divider rule.
7. Verification of Current divider rule.
8. Study of Transformers.
9. Investigation of L & C in an AC circuits using Vector Diagram Method

**PART B:**

1. Characteristics of Rectifier Diode
2. Characteristics of Zener Diode
3. Study of Half wave rectifier.
4. Study of Full wave rectifier
5. Characteristics of Transistor
6. AND and OR gates using diodes
7. NOT gate using Transistor

8. Realisation of AND, OR, and NOT gates using NAND gates using 7400IC
9. Verification of truth table of D Flip flop.
10. Verification of truth table of JK Flip flop

**I SEMESTER INTERNSHIP**

Students will be guided to develop a finished electronic gadget under the guidance of Faculty. The Project should be supervised by concerned Faculty member/members. Regular recording of weekly work done should be carried out. At the end of semester a project report along with completed project should be submitted by each student. Continuous assessment will be performed based on the involvement, skill and recording of observations at various stages if fabrication. In addition students are required to take up a viva-voce about the project. End semester assessment will be carried out based on the project selection, quality of project assembly, presentation and project report.

List of suggested projects:

1. PCB preparation.
2. Fabrication of Fixed RPS.
3. Fabrication of Variable RPS.
4. Fabrication of Function generator.
5. Fabrication of Audio Amplifier.
6. Fabrication of Pulse generator.
7. Fabrication of Line detecting Robot.
8. Fabrication of Water level Indicators.

**Semester II**

**PHOTOMETRY, HEAT AND THERMODYNAMICS**

**Course Objective:**

The objective of this paper is to have a good understanding of the basic concepts of photometry, Heat and Thermodynamics , in order to design and develop energy harvesting devices.

At the end of the course, the students should be able to –

- have a clear and basic of fundamental concept of photometry in order to estimate available light energy.
- demonstrate the capability of designing and developing energy harvesting devices solar water heaters, solar cookers and heat pumps.
- design and fabricate heat harvesting devices in order to optimize the utilization of heat energy.

## Unit 1

**Photometry :**

Physical nature of light- Electromagnetic waves. Concept of frequency and wavelength, Particle nature of light. Dual nature. Reflection, Absorption and transmission of light.

Measurements in photometry - Basic principles and methods of measurement of the photometry. Measurement of the luminous flux, solid angle, luminance, the illuminance and the luminance measurement of the spatial characteristics of light. Inverse square law in photometry. Lambert's Cosine law.

Laws of the thermal radiation, luminescence. Fluorescence. Phosphorescence.

Electromagnetic Spectrum, the photometric quantities and units.

Standard photometric observer CIE, Interaction of the light with the solids and the environment, Spatial characteristics of light **(12 Hrs)**

## Unit 2

**Thermometry and Heat Transfer**

Thermometry - Principle and Types of Thermometry, Thermometers, Seebeck effect, Peltier effect, Thomson effect. Thermocouples & other temperature sensors.

Heat Transfer**-** Various modes and mechanisms of Heat Transfer.

Conduction: Laws of thermal conductivity, Electrical Analogy, Concept of Thermal Resistance. Convection: Mechanism and types. Radiation Heat Transfer: Mechanisms, Laws of Radiation, Prevost's theory of exchanges, Stefan's law, Stefan Boltzmann Law, Kirchhoff's Law, Black Body Radiation. Newton's Law of Cooling.

Heat Exchangers & Insulations – purpose, types of materials. **(12 Hrs)**

## Unit 3

**Heat and Thermodynamics**

System, Surrounding, Boundaries.

Zeroth Law of Thermodynamics, Definition of Temperature. Thermodynamic Processes (isothermal, adiabatic, isobaric, isochoric),

Internal Energy of System. Specific heat, Thermal capacity, Water equivalent. Molar specific heat. Specific heat at constant pressure and constant volume.

The Ideal Gas Equation. Equation of state. Indicator Diagrams.

First Law of thermodynamics. Work done during Isothermal and Adiabatic changes. Reversible and Irreversible processes.

Second Law of Thermodynamics: Conversion of Heat into Work and its converse. Mechanical Equivalent of heat. Carnot's Cycle, Carnot's Heat Engine and its efficiency. Entropy. Principle of increase in entropy. Heat Engines and examples. General Principle of refrigerator & Heat Pump.

**(12 Hrs)**

**Text books/ Reference books**


1. Introduction to Radiometry and Photometry, Second Edition (Optoelectronics) – by William McCluney (Author)
2. Applied Photometry, Radiometry, and Measurements of Optical Losses

by Bukshtab, Michael |Springer Series
3. Photometrical Measurements and Manual for the General Practice of Photometry: With Especial Reference to the Photometry of ARC and Incandescent Lamps (1909) by Wilbur M Stine
4. "Heat and Thermodynamics" by M W Zemansky
5. Engineering Thermodynamics / PK Nag /TMH, III Edition
6. Fundamentals of Thermodynamics – Sonntag, Borgnakke and van wylen / John Wiley & sons (ASIA) Pvt. Ltd. "Engineering Thermodynamics" by Nag P K
7. Sachdeva R C, "Fundamentals of Engineering Heat and Mass Transfer" New Age International, 1995
8. Yadav R "Heat and Mass Transfer" Central Publishing House, 1995.
9. Heat Transfer, S.P. Sukhatme.

**PHOTOMETRY, HEAT AND THERMODYNAMICS LAB** (6 Hrs./week)

**Course Objective:**

The objective of this course is to get a clear idea of available light energy in generation of electrical energy and harvesting of heat energy.

At the end of the course, the students should be able to –

- demonstrate the capability of selecting suitable materials to store and conduct heat.
- have the basic fundamental concepts of designing energy harvesting systems.

**List of Experiments**

1. Verification of Inverse square law in photometry.
2. LDR characteristics.
3. Study of phase change of a given liquid (by plotting the cooling curve) and determination of the melting point.
4. Determination of Specific heat capacity of water by heating coil method.
5. Verification of Newton's Law of cooling of different materials and liquids.
6. Determination of Stefan – Boltzmann constant $\sigma$
7. Heat transfer by Radiation (To compare heat transfer between different material surface and the black body surface by radiation, to find the emissivity of different material surface)

8. Thermal conductivity of material by two slabs guarded hot plate method.
9. Heat transfer by natural convection (To determine the overall heat transfer coefficient at the surface of a given vertical metal cylinder)
10. Thermocouple – Seebeck effect (To verify the relation between thermo emf of a thermocouple and temperature difference between two hot junctions)

**II SEMESTER**

**Paper Title: FUNDAMENTALS OF SOLAR ENERGY AND PHOTOVOLTAIC TECHNOLOGY**

**UNIT-I**

**Basics of Solar Energy**: Theories of nature of light(Qualitative), Solar radiation - Solar Spectrum, Radiation on the Earth Surface, Global, Direct and Diffuse Solar Radiation, Solar Radiation at a Given Location, Annual Variation in Solar Radiation, Optimal Tilt for Solar Equipment, Monthly Averaged Global Radiation at Optimal Tilt. Extra-terrestrial Radiation and Cosmic rays.

**Photelctric effect** – Concept of Photoelectric effect, Experiment to study Photoelectric effect – Observation, Einstein's Photoelectric equation and explanation. Photocells, Photoemissive and Photoconductive cells – structure, action, materials and characteristics should be discussed for each type. 12 Hrs

**UNIT-II**

**Fundamentals of Solar Cells** : Characteristics of semiconductors, Differences between semiconductors, insulators and conductors Theory of p n junction, Principle of operation of p-n junction Solar Cell, I-V Characteristics Solar Cell parameters ,Voc, Isc, FF ,conversion efficiency and power output of solar cell,Status of Photovoltaic Technologies.

**Solar Cells and PV modules:** Solar cell types, Equivalent circuit diagrams of solar cells, Spectral sensitivity, Efficiency of solar cells and PV modules, Types of modules, Design options for PV modules, Module cable outlets and junction boxes, Wiring symbols, Characteristic I-V curves for modules, Irradiance dependence and temperature characteristics 12 Hrs

UNIT -III

**Solar PV Technology**: Advantages and Limitations, Brief History of the Technology, Basics of Technology, the Amount of Power Generated, the Rated Power and Actual Power from a Module, Generating More Power Using Solar PV, Protection of Solar Cells. Solar PV Systems and their applications : Solar PV Module Ratings and Cost, Battery Ratings and
Cost, Inverter Ratings and Cost, Maximum Power Point Tracking (MPPT), Solar PV Lantern, Design and Costing, Stand-alone PV System: Home Lighting and Other Usage, Solar PV System Designing , Case Study, Cost Estimation of a PV System.

**PV Systems:** Direct Coupled PV System, Stand-Alone Applications, Grid-Connected Systems, Hybrid-Connected Systems, Types of Applications, Design of PV Systems, Electrical Loads, Absorbed Solar Radiation, Cell Temperature, Sizing of PV Systems, Hybrid PV/T systems

12 Hrs

**REFERENCES**


1. Renewable Energy Technologies: A Practical Guide for Beginners, Chetan Singh Solanki, PHI|School Books (2008)
2. Solar Photovoltaics: Fundamentals, Technologies and Applications, Chetan Singh Solanki PHI; 3 edition 2015
3. Renewable Energy Sources and Emerging Technologies, Kothari D.P. and Singal K. C, New Arrivals - PHI; 2 edition (2011)
4. Planning and installing photovoltaic systems-A guide for installers, architects and engineers; The German Energy Society; 2008; Second Edition; Earthscan, UK.
5. Solar energy Engineering Processes and systems; Academic Press 2009.
6. Fundamentals of Renewable Energy Systems Paperback – D. Mukherjee, New Age International Publisher; First edition (2011)


## II SEMESTER PRACTICALS-3

**SUGGESTED LIST OF EXPERIMENTS:**

**PART A:**

10. LED Characteristics
11. Phototransistor characteristics
12. LDR characteristics
13. Characteristics of LED Lasers
14. Characteristics of Photodiodes
15. Determination of focal length of a lens

16. Study of solar spectrum (Fraunhofer lines)
17. Study of absorption spectrum – sodium source
18. Study of emission spectrum – mercury source

**PART B:**

11. Characteristics of solar cell-TYPE1
12. Characteristics of solar cell-TYPE2
13. Characteristics of solar cell-TYPE3
14. Characteristics of solar panel
15. Study of solar lighting using solar panel
16. Study of solar pump using solar panel
17. Study solar cooker
18. Study of voltage versus distance curve of a solar cell
19. Study of effect of filters on the voltage of a solar cell

**II SEMESTER INTERNSHIP**

Students will be guided to develop a finished electronic gadget under the guidance of Faculty. The Project should be supervised by concerned Faculty member/members. Regular recording of weekly work done should be carried out. At the end of semester a project report along with completed project should be submitted by each student. Continuous assessment will be performed based on the involvement, skill and recording of observations at various stages if fabrication. In addition students are required to take up a viva-voce about the project. End semester assessment will be carried out based on the project selection, quality of project assembly, presentation and project report.

List of suggested projects:

1. Construct and study a solar Pond
2. Construct and study a solar distillation unit
3. Construct and study a solar cooker unit
4. Construct and study a solar drying system
5. Construct and study a solar fencing
6. Fabrication of a solar cell
7. Fabrication of a charging system
8. Design of solar street light

**III Semester**

## BASICS OF ELECTRICITY

**Course Objective:**

- To enable the students to design and troubleshoot electrical circuits, networks and appliances through hands-on mode.
- To develop the basic understanding of household electrical networking and its function.

### Unit 1

**Basic Electricity Principles:**

Voltage, Current, Resistance and Power. Ohm's law, Series, parallel, and series-parallel combinations. AC Electricity and DC Electricity. Familiarization with multimeter, voltmeter and ammeter.

**Understanding Electrical Circuits:**

Main electric circuit elements and their combination. Rules to analyze DC sourced electrical circuits. Current and voltage drop across the DC circuit elements. Single-phase and three-phase alternating current sources. Rules to analyze AC sourced electrical circuits. Real, imaginary and complex power components of AC source. Power factor. Saving energy and money.

**(12 Hrs.)**

### Unit 2

**Electrical Drawing and Symbols:**

Drawing symbols. Blueprints. Reading Schematics. Ladder diagrams. Electrical Schematics. Power circuits. Control circuits. Reading of circuit schematics. Tracking the connections of elements and identify current flow and voltage drop.

**Generators and Transformers:**

DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers. Electric Motors: Single-phase, three-phase & DC motors. Basic design. Interfacing DC or AC sources to control heaters & motors. Speed & power of ac motor.

**Solid-State Devices:**

Resistors, inductors and capacitors. Diode and rectifiers. Components in Series or in shunt. Response of inductors and capacitors with DC or AC Sources. **(12 Hrs.)**

## Unit 3

**Electrical Protection:**

Relays. Fuses and disconnect switches, Main Switch, switch gear. Change over switch. Circuit breakers. Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. Interfacing DC or AC sources to control elements (relay protection device)

**Electrical Wiring:**

Different types of conductors and cables. Basics of wiring-Star and delta connection. Voltage drop and losses across cables and conductors. Instruments to measure current, voltage, power in DC and AC circuits. Insulation. Solid and stranded cable. Conduit. Cable trays. Electrical Panel. Splices: wire nuts, crimps, terminal blocks, split bolts, and solder. Preparation of extension board.

**(12 Hrs.)**

**Basics of Electricity Lab:**

The objective of this course is to get a clear idea of basic electrical devices and their characteristics and applications.

At the end of the course, the students should be able to –

- demonstrate the capability of selecting suitable components to do electrical networking
- have the basic fundamental concepts of designing energy supply systems.

**List of Practical's:**

1) Construction and characterization of Bridge Rectifier
2) Understanding of Working of dynamo and induction motor
3) Construction and study of Battery charging circuits
4) Verification of p-n Diode, Zener diode Characteristics
5) Verification of Kirchhoff's voltage and current law
6) Load and Line regulation using SMPS Supply
7) Designing Change-over switches
8) verification of AND, OR gate operations
9) Designing 2-way switches to drive a load
10) Verification of voltage regulated power supplies

**Reference Books:**


• A text book in Electrical Technology - B L Theraja - S Chand & Co.
• A text book of Electrical Technology - A K Theraja
• Performance and design of AC machines - M G Say ELBS Edn.


**III SEMESTER Paper Title: Basics of Computer Applications**

**UNIT-I**

**Computer Hardware:** Computer system as information processing system; Types of computer system, hardware options - CPU, input devices, output devices, storage devices, communication devices, configuration of hardware devices and their applications.

**Personal Computer:** PC and its main components, hardware configuration, CPU and clock speed, RAM and secondary storage devices, other peripherals used with PC; Factors influencing PC performance; PC as a virtual office.

**Operating system MS Window** -Definition & functions, Basic components of windows, types of icons, taskbar, using desktop, title bar, running applications, exploring computer, managing files and folders, copying and moving files and folders. Control panel -adding and removing software and hardware, setting date and time, screen saver and appearance.

**(12 Hours)**

**UNIT-II**

**MS-Word** –Documentation, Introduction to Office Automation, Creating & Editing Document, Formatting Document, Auto-text, Autocorrect, Spelling and Grammar Tool, Document Dictionary, Page Formatting, Bookmark, Advanced features of MS-Word-Mail Merge, Macros, Tables, File Management, Printing, Styles, linking and embedding object, Template.

**(12 Hours)**

**UNIT-III**

**INTERNET:** Introduction to concept of Internet, Terms used in connection with internet, Internet Architecture, MODEMs, domains Internet services-email, www, search engine, news, FTP, internet telephony, internet protocols and internet banking.: Internet applications, web browsers (Internet Explorer, Google Chrome, Mozilla), Elements of Web design and Applications.

**(12 Hours)**

**References:**


1. Microsoft Office – Dienes,Sheila S. – BPB Publication Delhi
2. MS Office : Sanjay Saxsena
3. Management Information System – O'Braian – Tata McGraw Hill New Delhi
4. Information Technology International: Dennis P. Curtin, MC Graw Hill
5. Fundamentals of Computers : P.Mohan, Himalaya publications
6. Fundamentals of Computers : AtulKahate, Tata McGraw Hill
7. Fundamentals of Computers : V.Srinivas, Kalyani Publications


## III SEMESTER PRACTICALS-3

**SUGGESTED LIST OF EXPERIMENTS:**

**PART A: Experiments in MS-WORD**

1. Typing and formatting an essay
2. Preparation of a time table
3. Preparation of a Mark sheet
4. Build a resume
5. Study of mail merging
6. Study of paragraph options.
7. Exercise1:Creating specified document
8. Exercise2:Creating specified document
9. Exercise3:Creating specified document

**PART B: Experiments Using INTERNET:**

**Any eight experiments must be conducted about using Internet for searching of down loading of documents, images, audio video, Sending emails, creating signature, Study of tools in Google and Microsoft.**

## III SEMESTER INTERNSHIP

Students will be guided to develop a finished electronic gadget under the guidance of Faculty. The Project should be supervised by concerned Faculty member/members. Regular recording of weekly work done should be carried out. At the end of semester a project report along with completed project should be submitted by each student. Continuous assessment will be performed based on the involvement, skill and recording of observations at various stages if fabrication. In addition students are required to take up a viva-voce about the project. End semester assessment will be carried out based on the project selection, quality of project assembly, presentation and project report.

List of suggested projects:

1. Preparation of a document in MS word.
2. Preparation of Invitation, Cover page, Banners etc.
3. Preparation of news bulletin.
4. Preparation of Magazine.
5. Design a website.
6. Prepare E-content and upload to social media

## Semester IV
## FLUID MECHANICS

**Course Objective**:

The objective of this paper is to enable the student to have a good grounding in the basic concepts of Fluid Mechanics and its application in the field of energy capture, conversion and utilization with remarkable efficiency.

At the end of the course, the students should be able to –

- Develop an ability in basic fundamental concepts of hydrostatics and hydrodynamics.
- Calculate and estimate the amount of available energy for the end utilization for maximum efficiency
- Select and suggest suitable energy storing mechanisms depending on the available resources in the environment and also go for higher studies in the relevant field.

### Unit 1

**Fluids :**

Gases, Liquids and Density, Relative density, Fluid thrust on a plane surface, Pressure in a fluid, Pascal's Law, Atmospheric pressure, Absolute pressure and gauge pressure, Pressure gauges, Concept of pressure head, Fluid upthrust, Buoyancy, Archimedes principle, Principle of floatation. **(12 Hrs.)**

### Unit 2

**Surface tension**

Definition and units, Molecular explanation of surface tension and surface energy. Adhesion and Cohesion. Capillarity- explanation for capillarity, capillary rise. Formation of meniscus, Applications of capillarity.

Interfacial tension. Variation of surface tension, Force between two plates separated by a thin liquid film. **(12 Hrs.)**

**Unit 3**

**Friction and Fluid Flow:**

Friction : Basic concepts of friction.

Fluid Flow :Fluid friction, Viscosity and viscous drag. Turbulence. Velocity gradient. Coefficient of viscosity. Poiseuille's formula for liquids and gases. Stokes Law, Terminal velocity.

Streamline flow and turbulent flow, Reynold's number. Equation of continuity, Kinds of energy of a fluid in motion, Total energy. Bernoulli's theorem, Speed of efflux. **(12 Hrs.)**

**Text books/ Reference books**


1. University Physics with Modern Physics | 14th Edition | By Pearson | Hugh D. Young (Author), Freedman Roger A. (Author)
2. Elements of Properties of Matter by D S Mathur, S Chand Publication
3. Properties of Matter by Brij Lal, Subrahmanyam (Author) | S Chand & Company Pvt Ltd (Publisher)
4. Physics for Today and Tomorrow, by Tom Duncan, 2nd Edition.
5. Feynman lectures.


**FLUID MECHANICS LAB**

**Course Objective**:

The objective of this course is to inculcate practical knowledge to students regarding basic properties of fluids.

At the end of the course, the students should be able to –

- demonstrate the capability of selecting suitable materials for renewable energy systems.
- have a clear basic fundamental knowledge of materials and processes required for fabrication of energy generating and storage devices.

**LIST OF PRACTICALS** **(**6 Hrs. per week**)**

1. Surface tension of liquid by drop weight method.
2. Interfacial tension between two liquids by drop weight method and using Hare's apparatus.
3. Kinetic energy and velocity of a fluid using pressure head.

4. Coefficient of viscosity of a liquid using Stokes law.
5. Coefficient of viscosity of a liquid using Poiseuille's method.
6. Determination of Reynold's number.
7. Verification of Pascal's law.
8. Mass of a falling body using Stokes law.
9. Verification of Bernoulli's principle using venturi meter.
10. Determination of density of liquids using Archimedes' principle.
11. Determination of surface tension of a liquid by capillary rise method.

## Storage Devices & Inverters

**Course objectives:**

The objective of this paper is to enable the student to have a good grounding in the basic concepts of Electrical Energy Storage devices, DC to AC converters and its application in the field of energy capture, conversion and utilization with remarkable efficiency.

At the end of the course, the students should be able to

- List types of batteries and their operating principles.
- Demonstrate battery maintenance and testing techniques.
- Utilize correctly the various types of test equipment and hand tools.

### Unit 1

**Battery :**

Purpose, Full charge, Appearance of normal cells, Chemical changes, Internal self-discharge and effect of impurities on floating voltage, Temperature characteristics, Proper amount of charge, High-rate overcharging

Low-rate overcharging, Undercharging, over discharge, Sedimentation, Replacement water, Water replacement rate for lead-antimony cells, Water replacement rate for lead-calcium cells, Water replacement for lead-selenium cells, Adjusting specific gravity, Hydrometer readings, Constant voltage charging

Battery life for different types and services, Cleanliness, Internal shorts, Normal sulfate and over sulfation, Elimination of over sulfation, Water treatment for over sulfation

Normal sulfate and over sulfation, Elimination of over sulfation, Water treatment for over sulfation, Acceptance testing, Capacity tests to determine replacement, Flooded, wet cell. Lead-acid battery maintenance schedule. **(12 Hrs.)**

## Unit 2

**Battery Maintenance:**

Adjusting specific gravity, Hydrometer readings, Constant voltage charging, Battery life and different types and services

Cell replacement, Visual readings, Connection resistance, Vented nickel cadmium battery maintenance schedule, Vented nickel cadmium battery condensed instructions, Electrolyte, Electrolyte level, General care, Battery records, Batteries for microwave and VHF radio equipment, Battery safety, Explosive hazard, Safety Hazard, Ventilation, Battery room design, Safety meetings. Battery charging equipment, Static rectifier chargers, Replacement storage battery sizing. **(12 Hrs.)**

## Unit 3

**Inverters:**

Planning & Design: Planning Procedure, System capacity and Energy Demand, Site selection, System concept, Module selection and PV Generator, Selection and sizing of cables, Standalone System; Battery sizing, Charge Controller and Inverter, Grid Connected Systems; Selection and inverter sizing, Generator Junction Box and DC Main Switch, Safety Measures, Grid Interface, Mounting System, tender specification, Standards and certification. **(12 Hrs.)**

## Storage Devices & Inverters Lab

**Course Objective**:

The objective of this course is to inculcate practical knowledge to students regarding basic properties of batteries, their types and maintenance.

At the end of the course, the students should be able to –

- demonstrate the capability of selecting suitable batteries for renewable energy systems.

- have a clear basic fundamental knowledge of batteries and inverters required for functioning of electrical appliances.

**List of Practical's:**

1) Practice procedure for electrical and personal safety measures
2) Use of multimeter
3) Testing of active and passive Components
4) Testing of transformers
5) Testing of semiconductor components
6) Testing of unregulated and regulated Voltages
7) Soldering and de-soldering techniques
8) Assemble and test rectifier circuits – half wave, full wave & bridge rectifier
9) Assemble a power amplifier circuit (ce,emitter follower)
10) Assemble and test an audio power amplifier (buzzer)
11) Construct a RC- oscillator and test it.
12) Find the total load and select a suitable UPS/Inverter (rating factor)
13) Installation of UPS and Inverters
14) Maintenance of battery.

**Refrence:**


1) "Power Analysis of Solar Inverter on FPGA" by Nanda Khyati and Kalia Kartik
2) "Advanced DC/AC Inverters Applications in Renewable Energy" By Fang Lin Luo, Hong Ye 2017
3) Electrical Engineer's Reference Book By D.F. Warne · 2002 by D.F. Warne, M. A. Laughton


**Semester V**

**BIOMASS ENERGY**

**Course Objective**:

The objective of this paper is to enable the student to understand the relevance of biomass as a renewable energy source.

At the end of the course, the students should be able to –

- Learn the various methods of harvesting biomass.
- Gain knowledge in converting biomass into fuel.
- Suggest various techniques of utilization of biomass.

**Unit 1**

**Overview**

Introduction, Overview of biomass as energy source; Production of biomass, Photosynthesis, efficiency of C3 & C4 plants on biomass production. Classification of biomass.

Biomass as fuel- Physicochemical characteristics of biomass as fuel, Thermal characteristics of biomass as fuel, Biomass conversion routes: biochemical, chemical and thermo-chemical.

Biochemical conversion of biomass for energy production- Anaerobic digestion, biogas production mechanism. Types of digesters, installation, operation and maintenance of biogas plant. Biogas plants manure-utilization and manure values. Biogas utilization and storage. Biogas for motive power generation etc. **(12 Hrs.)**

## Unit 2

**Biofuel**

Liquid biofuel: Biodiesel – the mechanism of transesterification, fuel characteristics of biodiesel, technical aspects of biodiesel engine utilization. Alcohol production from biomass- types of materials of alcohol production-process description, utilization.

Chemical conversion of biomass for energy production - Chemical conversion processes, Hydrolysis and hydrogenation

Synthesis biofuel - Modern biofuel synthesis, Bio- refinery **(12 Hrs.)**

## Unit 3

**Biomass conversion**

Thermochemical conversion of biomass - Combustion in excess oxygen and oxygen deficient atmosphere. Pyrolysis, Carbonization, Charcoal production. Biomass gasification--different types--power generation from gasification. Biomass based power generation

Energy plantation - Overview on energy plantation. Basis of selecting the plants for energy plantation. Waste land utilization through energy plantation **(12 Hrs.)**

**Text books /Reference books**


1. Mukunda HS. Understanding Clean Energy and fuels from biomass. Wiley-India Pvt. Ltd, 2011
2. Pandey A. Hand book of plantbased biofuel. CRC Press, Taylor & Francis, 2008
3. Mital KM. Biogas Systems, Principle and Applications. New Age International Ltd. 1996
4. Rai GD. Nonconventional energy sources. Khanna Publication, 2001
5. Ravindranath NH. Hall DO. Biomass, Energy and Environment, A developing country perspective from India. Oxford University Press, 1995


## BIOMASS ENERGY LAB

**Course Objective**:

The objective of this course is to inculcate practical knowledge to students regarding generatable energy from biomass.

At the end of the course, the students should be able to –

- Estimate the viable energy that can be generated from biomass.
- Understand and implement the various methods of generating renewable energy from biomass.

**List of Experiments** **(6 Hrs./week)**

1. Waste thermal energy harvesting from combustion gases from biomass using thermocouple.
2. Waste heat recovery and thermal energy harvesting from heat engines.
3. Estimation of energy obtained from biomass using bomb calorimeter.
4. Determination of the Gross Calorific Value of Refuse and Refuse-Derived-Fuel Using Constant Pressure Flow Calorimeter.
5. Estimation of heat energy produced per unit mass from molasses.
6. Estimation of specific heat of biodiesel.
7. Estimation of water equivalent of a given mass of biowaste.
8. Capture of heat energy from anaerobic processes.
9. Energy produced per unit mass while converting biomass into vermi-compost.
10. Specific heat of ethyl alcohol.

## Geothermal Energy

**Course Objective**:

The objective of this paper is to give the student a clear understanding about various sources of geothermal energy, the sites where it is available, advantage, disadvantage and the means to tap this energy source.

At the end of the course, the students should be able to –

- Develop an ability in basic fundamental concepts of tapping geothermal energy.
- Suggest appropriate designs for tapping geothermal energy based on locations

### Unit 1

**Introduction to Geothermal Energy:**

Overview of geothermal energy, Geological Background , Origin of geothermal energy, Terrestrial heat flow, geothermal gradient, Relationship of plate tectonics and terrestrial heat flow, Geothermal field, Geothermal reservoir .

Types of Geothermal Reservoirs: High, medium and low enthalpy reservoirs, Fractured reservoirs, Liquid dominated reservoirs, Vapor dominated reservoirs, Artificial EGS reservoirs, Porous reservoirs, Low enthalpy porous systems, Medium and high enthalpy porous systems geothermal system, Hydrothermal systems, Nature of geothermal fields-Resources, Types of wells, Hot dry rock resources-Magma resources **(12 Hrs.)**

## Unit 2

**Harnessing and applications of Geothermal Energy:**

Methods of harnessing the energy- Dry steam flash, Flash steam plants, binary cycle plants. Geothermal exploration-advantages and disadvantages of geothermal energy-applications of geothermal energy- geothermal heat pumps. **(12 Hrs.)**

## Unit 3

**Production Technologies and Environmental Impacts:**

Production Technologies:

Natural up flow due elastic expansion, Artificial lift methods, Air lifting, Submersible pumps, Line shaft pumps, The effect of production technology on the recovery factor, Production with injection

Environmental Impact:

Reservoir depletion, Greenhouse gas emission, Dissolved solids emission, Pollution of aquifers and surface waters, Noise within drilling and well testing, Catastrophic events with examples. Operational and environmental problems, Types of Geothermal power plants, geothermal power plants in India -Scope in India for this energy **(12 Hrs.)**

**Text books/ Reference books:**


1. Non-conventional energy sources: G.D Rai 201`1, 5th edition, Khanna Publishers
2. Non-conventional energy sources and utilization (Energy engineering) R.K Rajput
    i. 2012: Ist edition, S.Chand and company Ltd.
3. Geothermal Energy, an alternate resource for the 21st century- Harsha gupta and
    i. Sukanta Roy, Elsevier Sc. And technology
4. Geothermal Energy –Orr Tamra, Cherry Lake publishing
5. Energy opportunities and social responsibility. Satyesh C. Chakraborty Jaico publications


**Geothermal Energy Lab**

**Course Objective**:

The objective of this course is to inculcate practical knowledge to students regarding thermal energy.

At the end of the course, the students should be able to –

- Design systems to tap geothermal energy
- Suggest appropriate systems for distribution and utilization of geothermal energy.

**List of Experiments: (**6 Hrs. per week)

1. Determination of Thermal conductivity of a metal rod using Forbe's method.
2. Thermal conductivity of a bad conductor by Lee's disc method.
3. Measurement of surface emissivity.
4. Determination of mechanical equivalent of heat with the help of Joule's calorimeter.
5. Determination of heating efficiency of an electrical kettle with varying voltages.
6. Specific heat of solid by method of mixture and radiation correction.
7. Thermal conductivity of glass in the form of a tube.
8. Thermal conductivity of rubber in the form of a tube.
9. Specific heat of a liquid by method of cooling.
10. Determination of J by Searle's friction cone apparatus.

**Semester VI**

**INSTALLATION AND MAINTENANCE OF RENEWABLE ENERGY DEVICES**

**Course objective:**

- Course focus is on solar power projects development and quality management.
- The participants will gain knowledge and will have the opportunity to understand renewable energy project management, site assessment and planning, feasibility study and detailed project report preparation.

- Design and installation best practices, PV system performance modelling and energy yield assessment, Hands on training on consideration of various factors, inspection procedure and quality assurance.

## SYLLABUS

**Designing:**

Overview of off-grid and on-grid PV Systems, Rooftop and ground Mounted PV project site assessments & planning, Solar water pumping systems, PV Mounting Systems & Foundations, Ground mounted PV project site assessments & planning. Energy generation, consumption, load estimation, Drawings and diagrams for PV systems, Solar Water heater system fundamentals, Inverter and Battery Sizing Calculation, Lightning Arrester, Sun Tracking System, Transportation Techniques, Weather proof connections, Packing Techniques

**(12 Hrs)**

**Performance:**

Working Safely with PV Systems, Power Plant Safety, Energy Storage Mechanism, Battery Maintenance, Charge control System, Inverters, System Protection and Safety requirements for Power Plant, Fundamentals of AC Generator, AC and DC cables for transmission systems. Working of Bidirectional meter, Net Metering, PV Plant operation and performance monitoring, Troubleshooting and corrective maintenance.

**(12 Hrs)**

**Energy Management & Maintenance:**

Matching of PV Array and Inverter and MPPT, Pulse Width Modulated Chargers, Sizing and Specifying PV Array for Off-grid and Mini-grid PV Systems, Regular Inspection, Painting, Cleaning, Lubrication of Mechanical Parts, Corrosion Free Coating, Maintenance of off-grid and mini-grid PV systems, Operation and Maintenance Solar PV Water Pumping System, Operation and Maintenance Planning for Power Plants

**(12 Hrs)**

**Practical:**

1) Study of characteristics of Solar Charge Controllers
2) Virtual lab on Grid System
3) Experimental Techniques in Alternating current 240 volt
4) Measurement of RMS, Peak, Time Period, frequency of an A.C
5) Integrator and Differentiator

6) AC Filters
7) Controlling Relay
8) Rectifiers, SMPS,
9) Voltage regulators
10) Wave shaping circuits

**Reference Books**


- Solar Electricity Generation – How it works, Catalyst vol. 4 no 2 fall 2005, picture illustration by Aaron Thomason/SRPnet.com
- The Solar Electric House by Steven J. Strong with William G. Scheller, Sustainability Press, Still River, Massachusetts 01467-0143, 1987.
- From Space to Earth – The Story of Solar Electricity, John Perlin, aatec publications, Ann Arbor, MI 48107, 1999.
- The Sun – Our Future Energy Source, David K. McDaniels, John Wiley & Sons, New York, NY 10016, 1979
- Electronic Devices and Circuit Theory, 11th Edition-Robert L. Boylestad, Louis Nashelsky, Queensborough Community College, New York ©2013 |Pearson
- Solar Photovoltaics: Fundamentals, Technologies and Applications by Chetan Singh Solanki, Edition 3, Phi Learning Pvt. Ltd., 2015


## Materials and Processes in Manufacturing

**Course Objective:**

The objective of this paper is to have a good understanding the basic concepts of manufacturing via engineering materials, casting, machining, forming, joining, welding and assembly, enabling the students to develop a basic knowledge of the mechanics, operation and limitations of basic machining tools.

At the end of the course, the students should be able to –

- demonstrate the capability of selecting suitable manufacturing processes to manufacture the products optimally,
- ability to clear basic fundamental concepts of machining, welding, casting, forming processes
- selecting or suggesting suitable manufacturing processes to achieve the required products with the aim of avoiding material and time wastage.

## Unit 1

**Introduction:** Common engineering materials and their important mechanical and manufacturing properties. General classification of manufacturing processes, Importance of manufacturing processes, economics and selection of manufacturing processes.

**Metal Casting:** Principles of metal casting, casting terminology, Patterns, their functions, types, materials and pattern allowances, Characteristics of molding sand, Types of sand molds, Types of cores, chaplets and chills; their materials and functions. Casting Defects, their causes and remedies

**(12 Hrs)**

## Unit 2

**Machining Processes:** Principles of metal cutting, cutting tool materials and applications, types of single point cutting tools. Geometry of single point cutting tool. Cutting fluids and their functions, types of cutting fluids, selection of cutting fluids.

Introduction to shaper and planner machines, their operations. Introduction to multipoint cutting tools. Introduction to milling and milling operations, Drilling and allied operations, Sawing operations

**(12 Hrs)**

## Unit 3

**Welding & Allied Joining Processes:** Welding classification, types of welding electrodes, functions of flux and types of welding joints. Elements of Electric arc, Gas, Resistance and Thermit welding. Soldering, Brazing and Braze welding, Submerged arc welding (SAW). Applications of various welding processes. Welding defects, their causes and remedies.

**(12Hrs)**

**Text Books/ Reference Books:**


1. Degramo, Kohser and Black. Materials and Processes in Manufacturing, 8$^{th}$Edition, Prentice Hall of India, New Delhi.
2. Amstead Ostwald, and Bageman, Manufacturing Processes, John Wiley and sons, New Delhi.

3. Campbell, Principles of Manufacturing, Materials and Processes, Tata Macgraw HillCompany
4. Kalpakjian, S. and Schemid, S.R., Manufacturing Engineering & Technology,Prentice Hall, New York.
5. Groover, M.P., Fundamentals of Modern manufacturing: Materials, Processes andSystems, John Wiley and Sons Inc., New York.
6. B. S. Raghuwanshi, Workshop Technology (Part – I & II), Dhanpat Rai and Co., New Delhi.
7. Singh, Manufacturing Technology, Pearson Education Asia, New Delhi.
8. Khanna, O.P. and Lal, M., A Text Book of Production Technology, Dhanpat Rai Publication, New Delhi.

## Materials and Processes in Manufacturing Lab

**Course Objective**:

The objective of this course is to inculcate practical knowledge to students regarding basic manufacturing processes like: casting, machining, sheet metal forming, fitting, smithy, welding .

At the end of the course, the students should be able to –

- demonstrate the capability of selecting suitable manufacturing processes to manufacture the products optimally,
- ability to clear basic fundamental concepts of machining, welding, casting, smithy, sheet metal forming, fitting and carpentry processes.

**List of Experiments (6Hr/week)**

1. Sheet Metal Shop: Layout marking, cutting/shearing, bending in box shape with drilling and Riveting
2. Welding Shop: Butt Welding / Gas welding, Soldering.
3. Foundry Shop: Moulding of Flange, Moulding of Core and casting of pipe.
4. Smithy Shop: Poker, Circular Ring.

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