

## Semester VI

RENEWABLE ENERGY POWER PLANTS (OPEN ELECTIVE)			
Course Code	21ME652	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3-0-0-0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
<b>Course objectives:</b> <ul style="list-style-type: none"><li>To introduce the concepts and principles of solar energy, its radiation, collection, storage and application.</li><li>To understand application aspects of Wind, Biomass, Geothermal, hydroelectric and Ocean energy.</li><li>To examine energy sources and systems, including fossil fuels and nuclear energy, and then focus on other forms of alternate energy sources.</li></ul>			
<b>Teaching-Learning Process (General Instructions)</b> <p>These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.</p> <ol style="list-style-type: none"><li>Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.</li><li>Chalk and Talk method for Problem Solving.</li><li>Adopt flipped classroom teaching method.</li><li>Adopt collaborative (Group Learning) learning in the class.</li><li>Adopt Problem Based Learning (PBL), which fosters students’ analytical skills and develops thinking skills such as evaluating, generalizing, and analyzing information.</li></ol>			
<b>Module-1</b>			
<b>Introduction:</b> Energy sources (including fossil fuels and nuclear energy), India’s production and reserves of commercial energy sources, need for nonconventional energy sources, energy alternatives, Indian and global energy scenario.			
<b>Solar Radiation &amp; Measurement:</b> Extra-Terrestrial radiation, spectral distribution of extra-terrestrial radiation, solar constant, solar radiation at the earth’s surface, beam, diffuse and global radiation, solar radiation data. Pyrometer, shading ring Pyrheliometer, sunshine recorder, schematic diagrams, and principle of working, actinometer and bolometer.			
<b>Teaching-Learning Process</b>	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving. /White board		
<b>Module-2</b>			
<b>Solar Radiation Geometry:</b> Flux on a plane surface, latitude, declination angle, surface azimuth angle, hour angle, zenith angle, solar altitude angle, expressions for the angle between the incident beam and the normal to a plane surface (No derivation) local apparent time, apparent motion of sun, day length, numerical problems.			
<b>Solar Thermal Systems:</b> Flat plate collector, Evacuated Tubular Collector, Solar air collector, Solar concentrator, Solar distillation, Solar cooker, Thermal energy storage systems, Solar Pond, Solar Chimney (Tower).			
<b>Solar Photovoltaic Systems:</b> Introduction, Solar cell Fundamentals, Characteristics and classification, Solar cell: Module, panel and array construction.			
<b>Teaching-Learning</b>	1. Power-point Presentation, 2. Video demonstration or Simulations,		

<b>Process</b>	3. Chalk and Talk are used for Problem Solving. /White board
<b>Module-3</b>	
<p><b>Wind Energy:</b> Properties of wind, availability of wind energy in India, wind velocity and power from wind; major problems associated with wind power, wind machines; Types of wind machines and their characteristics, horizontal and vertical axis windmills, elementary design principles; coefficient of performance of a windmill rotor, design aspects, numerical examples.</p> <p><b>Energy from Biomass:</b> Energy plantation, biogas production from organic wastes by anaerobic fermentation, description of bio-gas plants, transportation of biogas, problems associated with bio-gas production, application of biogas, application of biogas in engines, cogeneration plant, advantages &amp; disadvantages.</p>	
<b>Teaching-Learning Process</b>	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving. /White board
<b>Module-4</b>	
<p><b>Hydroelectric plants:</b> Advantages &amp; disadvantages of waterpower, Hydrographs and flow duration curves-numericals, Storage and pondage, General layout of hydel power plants- components such as Penstock, surge tanks, spill way and draft tube and their applications, pumped storage plants, Detailed classification of hydroelectric plants.</p> <p><b>Tidal Power:</b> Tides and waves as energy suppliers and their mechanics, fundamental characteristics of tidal power, harnessing tidal energy, limitations of tidal energy.</p> <p><b>Energy from ocean waves:</b> Wave energy conversion, Wave energy technologies, advantages, and disadvantages.</p>	
<b>Teaching-Learning Process</b>	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving. /White board
<b>Module-5</b>	
<p><b>Ocean Thermal Energy Conversion:</b> Principle of working, Rankine cycle, OTEC power stations in the world, problems associated with OTEC, case studies.</p> <p><b>Geothermal energy:</b> Introduction, Principle of working, types of geothermal stations with schematic diagram Estimates of Geothermal Power, Nature of geothermal fields, Geothermal resources, Hydrothermal, 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 energy forms, Geothermal stations in the world</p>	
<b>Teaching-Learning Process</b>	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving. /White board
<p><b>Course outcome (Course Skill Set)</b></p> <p>At the end of the course the student will be able to :</p> <ul style="list-style-type: none"> <li>• Describe the various forms of non-conventional energy resources.</li> <li>• Apply the fundamental knowledge of mechanical engineering to design various renewable energy systems</li> <li>• Analyze the implications of renewable energy forms for selecting an appropriate system for a specific application</li> <li>• Discuss on the environmental aspects and impact of non-conventional energy resources, in comparison with various conventional energy systems, their prospects and limitations.</li> </ul>	

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

**Continuous Internal Evaluation (CIE):**

At the beginning of the semester, the instructor/faculty teaching the course must announce the methods of CIE for the course.

Three Unit Tests each of **20 Marks (duration 01 hour)**

1. First test at the end of 5<sup>th</sup> week of the semester
2. Second test at the end of the 10<sup>th</sup> week of the semester
3. Third test at the end of the 15<sup>th</sup> week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4<sup>th</sup> week of the semester
5. Second assignment at the end of 9<sup>th</sup> week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks (duration 01 hours)**

6. At the end of the 13<sup>th</sup> week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

**CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

**Semester End Examination:**

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours**)

1. The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be reduced proportionally to 50 marks
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students must answer 5 full questions, selecting one full question from each module.

**Suggested Learning Resources:****Books**

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.
5. Non-Conventional Energy Resources by B.H. Khan, Tata McGraw Hill Pub.,2009.

**Reference Books**

1. Fundamentals of Renewable Energy Resources by G.N.Tiwari, M.K.Ghosal, Narosa Pub., 2007.
- 2.Non-Conventional Energy Resources by B.H. Khan, Tata McGraw Hill Pub., 2009.
3. Non-Conventional Energy Resources by Shobh Nath Singh, Pearson India., 2016
4. Environmental Justice in India: The National Green Tribunal, By Gitanjali Nain Gill, Routledge (2016).
5. Ref: The Oxford Handbook of Comparative Environmental Law, edited by Emma Lees, Jorge E. ViÑuales, Oxford University Press (2019).

**Web links and Video Lectures (e-Resources):**

- [https://www.youtube.com/watch?v=iZyzvDj6Y3c&list=PLwdnzlV3ogoXUifhvYB65lJCZ74o\\_fAk&index=2](https://www.youtube.com/watch?v=iZyzvDj6Y3c&list=PLwdnzlV3ogoXUifhvYB65lJCZ74o_fAk&index=2)
- [https://www.youtube.com/watch?v=Og4LEc7SpdQ&list=PLwdnzlV3ogoXUifhvYB65lJCZ74o\\_fAk&index=3](https://www.youtube.com/watch?v=Og4LEc7SpdQ&list=PLwdnzlV3ogoXUifhvYB65lJCZ74o_fAk&index=3)
- [https://www.youtube.com/watch?v=L3AEXdvtlkk&list=PLwdnzlV3ogoXUifhvYB65lJCZ74o\\_fAk&index=19](https://www.youtube.com/watch?v=L3AEXdvtlkk&list=PLwdnzlV3ogoXUifhvYB65lJCZ74o_fAk&index=19)
- [https://www.youtube.com/watch?v=TUu40kDqcEc&list=PLwdnzlV3ogoXUifhvYB65lJCZ74o\\_fAk&index=24](https://www.youtube.com/watch?v=TUu40kDqcEc&list=PLwdnzlV3ogoXUifhvYB65lJCZ74o_fAk&index=24)
- [https://www.youtube.com/watch?v=k7LX0a67V8A&list=PLwdnzlV3ogoXUifhvYB65lJCZ74o\\_fAk&index=37](https://www.youtube.com/watch?v=k7LX0a67V8A&list=PLwdnzlV3ogoXUifhvYB65lJCZ74o_fAk&index=37)

**Activity Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Case studies
- Quiz
- Topic Seminar presentation
- Assignments