**PSN COLLEGE OF ENGINEERING AND TECHNOLOGY**
**Melathediyoor, Tirunelveli 627152**
(An Autonomous Institution affiliated to Anna University, Chennai)
Approved by AICTE, Recognized by UGC under Section 2(f)
An ISO 9001:2015 Certified Institution
Accredited by NAAC with A+ Grade in 3rd Cycle

**DEPARTMENT OF MECHANICAL ENGINEERING**

# COURSE PLAN

**(Regulation 2018)**

**Version: 1** **Date: 30/May/2024(ODD SEM)** **Academic year: 2024-2025**

| | |
|---|---|
| **Subject Name & Code** | **Renewable Source of Energy & 510020** |
| **Course Type** | Core |
| **Program** | B.E. Mechanical Engineering (UG) |
| **Year/Semester/Section** | IV / VII |
| **Nature of Course/Credit** | Theory / 3 |
| **Course Coordinator** | Mr.P.Mathan, AP/Mech |

Institute Vision & Mission

| | | |
|---|---|---|
| **Institution Vision** | To provide an academic environment to learn, work and do research enabling the students to face challenges in life with strong ethical values. | |
| **Institution Mission** | **IM-1** | To achieve greater heights of excellence in technical knowledge and skill development through innovative teaching and learning practices. |
| | **IM-2** | To develop the infrastructure to meet the demands of technological revolution. |
| | **IM-3** | To improve and foster research in all dimensions for betterment of society. |
| | **IM-4** | To develop individual competencies to enhance employability and entrepreneurship in students. |
| | **IM-5** | To instill higher standards of discipline among students, inculcating ethical and moral values for societal harmony and peace. |

Department Vision & Mission

| | | |
|---|---|---|
| **Department Vision** | To provide Mechanical Engineering education to meet global standards through enhanced core activities, skill development and research. | |
| **Department Mission** | **DM-1** | To educate students to be creative, inquisitive and innovative to become entrepreneurs. |
| | **DM-2** | To instill advanced knowledge with research capabilities for global employment. |
| | **DM-3** | To uphold moral and ethical standards in life and career |

1. Pre-requisite (if any):
    - Sources of energy
    - Function of generator

2. Course Description: (not exceeding 100 words)

    - To learn the different types of renewable sources of energy.
    - Applications of renewable energies in the available fields

3. Career Opportunities: (one or two)
    - Solar energy system fabrication
    - Renewable energy system designer
4. Syllabus

| 510020 | RENEWABLE SOURCE OF ENERGY | L T P C |
|---|---|---|
| | | 3 0 0 3 |

**AIM:** Expose the students to understand the basic concepts of renewable sources of energy and the available sources.

**OBJECTIVES:**
The students are expected to identify the new methodologies / technologies for effective utilization of renewable energy sources.

**OUTCOMES:**
On successful completion on this course the student will be able to

| S.No. | COs | Blooms level |
|---|---|---|
| 1 | Assess the working and applications of solar energy systems | K1 |
| 2 | Understand wind Energy Conversion Systems and its applications | K2 |
| 3 | Demonstrate an understanding of bio-energy production and its economics | K3 |
| 4 | Develop an understanding of OTEC, tidal and geothermal energy systems | K5 |
| 5 | Identify the working and applications of new energy systems | K5 |

| | |
|---|---|
| **MODULE 1: SOLAR ENERGY**<br>Solar Radiation – Measurements of solar radiation and sunshine – Solar Thermal Collectors – Flat Plate and Concentrating Collectors – Solar Applications – fundamentals of photo voltaic Conversion – solar Cells – PV Systems– PV Applications | **9** |

| | |
|---|---|
| **MODULE 2: WIND ENERGY**<br>Wind Data and Energy Estimation – wind energy conversion Systems – Wind energy generators and its performance – Wind Energy Storage –Type of wind turbines– Applications –Hybrid systems | **9** |
| **MODULE 3: BIO – ENERGY**<br>Biomass – Biogas – Sources – Composition - Technology for utilization – Biomass direct combustion – Biomass gasifier – Biogas plant – Digesters – Ethanol production – Bio diesel production and economics | **9** |
| **MODULE 4: OTEC, TIDAL, GEOTHERMAL AND HYDEL ENERGY**<br>Tidal energy – Wave energy – Data - Technology options – Open and closed OTEC Cycles – Small hydro turbines – Geothermal energy sources. | **9** |
| **MODULE 5: DIRECT ENERGY CONVERSION SYSTEMS, NEW ENERGY SOURCES**<br>MHD generators – Thermoelectric power generation. Hydrogen – generation – storage - transport and utilization – Applications - power generation - transport – Fuel cells – technologies, Types –economics and the power generation. | **9** |
| | **Total: 45 Periods** |
| **TEXT BOOKS:**<br>1. Rai G.D., ― Non-Conventional Energy Sources‖, 4th Edition, Khanna Publishers, New Delhi, 2011.<br>2. Kothari D.P., ―Renewable Energy Sources and Emerging Technologies‖, 2nd Edition, Prentice Hall of India Pvt. Ltd., 2008. | |
| **REFERENCE BOOKS:**<br>1. Godfrey Boyle, ―Renewable Energy, Power for a Sustainable Future‖, 3rd Edition, Oxford University Press, U.K., 1996.<br>2. Tiwari G.N., ―Solar Energy -FundamentalsDesign, Modeling and Applications‖, 1st Edition, Narosa Publishing House, New Delhi, 2014.<br>3. Sukhatme S.P., ―Solar Energy‖, 3rd Edition, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2008. | |

5. Course Outcome (COs): CO1…..CO5 (should follow Bloom's taxonomy)
   After successful completion of the course, the students should be able to

| CO's | CO - STATEMENTS | Blooms level | PO's | PSO's |
|---|---|---|---|---|
| CO 1 | Assess the working and applications of solar energy systems | K1 | 1,3,11,12 | 1,2 |
| CO 2 | Understand wind Energy Conversion Systems and its applications | K2 | 1,2,3,11,12 | 1,2 |
| CO 3 | Demonstrate an understanding of bio-energy production and its economics | K3 | 1,3,11,12 | 1,2 |
| CO 4 | Develop an understanding of OTEC, tidal and geothermal energy systems | K5 | 1,3,11,12 | 1,2 |
| CO 5 | Identify the working and applications of new energy systems | K5 | 1,3,11,12 | 1,2 |

6. Instructional Learning outcomes (unitwise/assignments/tutorials)

| Unit | Assessment Procedure |
|---|---|
| I | The outcome will be assessed through Attendance, Assignment-1, Class test -1, MCQ Test-1, Continuous Assessment Test - I |
| II | The outcome will be assessed through Attendance, Assignment-2, Class test -2, MCQ Test-2, Continuous Assessment Test – I & II |
| III | The outcome will be assessed through Attendance, Assignment-3, Class test -3, MCQ Test-3, Continuous Assessment Test - II |
| IV | The outcome will be assessed through Attendance, Assignment-4, Class test -4, MCQ Test-4, Continuous Assessment Test - III |
| V | The outcome will be assessed through Attendance, Assignment-5, Class test -5, MCQ Test-5, Continuous Assessment Test - III |

7. Program Educational Objectives (PEOs)

| S.No | Topic | PEOs |
|---|---|---|
| **PEO1** | **Fundamental Knowledge** | To impart fundamental knowledge in mathematics, basic sciences and Mechanical Engineering to identify and solve design problems in industry using modern tools |
| **PEO2** | **Technical Knowledge** | To train the graduates to manufacture engineering components through proper production methodologies, and industrial automation processes considering safety aspects |
| **PEO3** | **Skill Development &Ethics** | To develop healthy interpersonal skills, entrepreneurship skills, communication skills, team work, adhering to professional, ethical practices and lifelong learning |

8. Program Outcomes (POs)

| PO's No | KNOWLEDGE | STATEMENTS |
|---|---|---|
| 1 | Engineering Knowledge | Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems. |
| 2 | Problem Analysis | Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences. |
| 3 | Design / Development of Solutions | Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public |

| | | |
|---|---|---|
| | | health and safety, and the cultural, societal, and environmental considerations. |
| 4 | Conduct Investigations of Complex Problems | Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions. |
| 5 | Modern Tool usage | Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations. |
| 6 | The Engineer and Society | Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice. |
| 7 | Environment and Sustainability | Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development. |
| 8 | Ethics | Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice. |
| 9 | Individual and Team Work | Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. |
| 10 | Communication | Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions. |
| 11 | Project Management and Finance | Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments. |
| 12 | Life-long Learning: | Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. |

9. Program Specific Outcomes (PSOs)

| | |
|---|---|
| **PSO1** | Ability to apply the knowledge of applied mathematics and advanced software tools for design specification, development of products, analysis of the physical systems, components and processes involved in mechanical engineering |
| **PSO2** | Development of skill and attitude to analyze the cause and effects on machine elements, processes and systems |

10. CO, PO and PSO mapping

| COs/POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | - | 2 | - | - | - | - | - | - | - | 1 | 2 | 2 | 2 |
| **CO2** | 3 | 2 | 2 | - | - | - | - | - | - | - | 1 | 2 | 2 | 2 |
| **CO3** | 3 | - | 2 | - | - | - | - | - | - | - | 1 | 2 | 2 | 2 |
| **CO4** | 3 | - | 2 | - | - | - | - | - | - | - | 1 | 2 | 2 | 2 |
| **CO5** | 3 | - | 2 | - | - | - | - | - | - | - | 1 | 2 | 2 | 2 |

1- Low 2- Medium 3- High

11. Text Book s & Reference Books

| S.No. | Name of the Book | Author/Publisher/Year/Edition | Text Book/Reference Book |
|---|---|---|---|
| 1 | Non-Conventional Energy Sources | Rai G.D./ 4th Edition, Khanna Publishers, New Delhi/ 2011 | Text Book |
| 2 | Renewable Energy Sources and Emerging Technologies | Kothari D.P./ 2nd Edition, Prentice Hall of India Pvt. Ltd./ 2008. | Text Book |
| 3 | Renewable Energy, Power for a Sustainable Future | Godfrey Boyle, / 3rd Edition, Oxford University Press, U.K./ 1996. | Reference Book |
| 4 | Solar Energy -Fundamentals Design, Modeling and Applications | Tiwari G.N./ 1st Edition, Narosa Publishing House, New Delhi/ 2014 | Reference Book |
| 5 | Solar Energy | Sukhatme S.P./ 3rd Edition, Tata McGraw Hill Publishing Company Ltd., New Delhi/ 2008. | Reference Book |

12. Web Resources:

| Sl. No | Topic | Web link |
|---|---|---|
| 1. | Renewable energy sources | https://www.nrdc.org/stories/renewable-energy-clean-facts |

**E – learning videos/NPTEL/ SWAYAM and other universities related to syllabus:**

| | |
|---|---|
| **Video** | http://nptel.ac.in/courses/108105058/ |
| **Lecture Notes** | http://nptel.ac.in/courses/Webcourse-contents/IISc-BANG/notused/Non-Conventional%20Energy%20Systems- |

13. Magazines & Journals

| | |
|---|---|
| **Magazine** | Solar industry magazine |
| **Journals** | Journal of renewable and sustainable energy<br>International journal of renewable energy research |

14. Lesson Plan & Content Delivery Methodologies

| S.No | Unit | Topic to be covered | Hours Needed | Mode of Teaching (BB/PPT/Others) | Text/ Ref. Book | Page No |
|---|---|---|---|---|---|---|
| **1.** | **I** | Solar Radiation | 1 | PPT | T2 | 36 |
| **2.** | | Measurements of solar radiation and sunshine | 1 | PPT | T2 | 49 |
| **3.** | | Solar Thermal Collectors | 1 | PPT | T2 | 55 |
| **4.** | | Flat Plate and Concentrating Collectors | 1 | PPT | T2 | 56 |
| **5.** | | Solar Applications | 1 | Video | T2 | 90 |
| **6.** | | Fundamentals of photo voltaic Conversion | 1 | BB | T2 | 117 |
| **7.** | | Solar cells | 1 | BB | T2 | 122 |
| **8.** | | PV Systems | 1 | PPT | T2 | 128 |
| **9.** | | PV Applications | 1 | Video | T2 | 129 |
| **10.** | **II** | Wind Data and Energy Estimation | 1 | PPT | T2 | 151 |
| **11.** | | wind energy conversion Systems | 2 | BB | T2 | 169 |
| **12.** | | Wind energy generators | 1 | BB | T2 | 167 |
| **13.** | | Generator - its performance | 1 | Open test book | T2 | 166 |
| **14.** | | Wind Energy Storage | 1 | BB | T2 | 171 |
| **15.** | | Type of wind turbines | 1 | BB | T2 | 138 |
| **16.** | | Applications | 1 | Video | T2 | 170 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **17.** | | Hybrid systems | 1 | BB | T2 | 189 |
| **18.** | **III** | Biomass | 1 | BB | T1 | 241 |
| **19.** | | Biogas - Sources | 1 | PPT | T1 | 251 |
| **20.** | | Composition | 1 | BB | T1 | 261 |
| **21.** | | Technology for utilization | 1 | BB | T1 | 287 |
| **22.** | | Biomass direct combustion | 1 | video | T1 | 287 |
| **23.** | | Biomass gasifier | 1 | BB | T1 | 303 |
| **24.** | | Biogas plant – Digesters | 2 | BB | T1 | 259 |
| **25.** | | Bio diesel production and economics | 1 | BB | T1 | 318 |
| **26.** | **IV** | Tidal energy | 1 | BB | T1 | 386 |
| **27.** | | Wave energy | 1 | Group Quiz | T1 | 404 |
| **28.** | | Data | 1 | BB | T1 | 386 |
| **29.** | | Technology options | 1 | BB | T1 | 394 |
| **30.** | | Open and closed OTEC Cycles | 2 | Open test book | T1 | 376 |
| **31.** | | Small hydro turbines | 1 | PPT | T1 | 411 |
| **32.** | | Geothermal energy sources | 2 | PPT | T1 | 333 |
| **33.** | **V** | MHD generators | 1 | PPT | T1 | 503 |
| **34.** | | Thermoelectric power generation | 1 | PPT | T1 | 531 |
| **35.** | | Hydrogen – generation – storage - transport and utilization | 2 | PPT | T1 | 464 |
| **36.** | | Applications | 1 | Group Quiz | T1 | 498 |
| **37.** | | power generation - transport | 1 | BB | T1 | 488 |
| **38.** | | Fuel cells – technologies | 2 | BB | T1 | 427 |
| **39.** | | Types –economics and the power generation | 1 | PPT | T1 | 462 |

**Total Hours Needed = 45 Hours**

15. Assignments

| S.No | Unit | Name of the Topic | Submission Date |
|---|---|---|---|
| 1 | I | Solar energy application | 21-6-2024 |
| 2 | II | Components of wind turbines | 12-7-2024 |

| | | | |
|---|---|---|---|
| 3 | III | Biomass gasifier | 6-8-2024 |
| 4 | IV | Open and closed ocean thermal energy conversion systems | 27-8-2024 |
| 5 | V | Magneto Hydrodynamic Generators | 10-9-2024 |

16. Assignment Rubrics:

| Quality | Marks |
|---|---|
| Submission on Date | 2 |
| Understanding | 3 |
| Solving skill/ Presentation | 3 |
| End results with correct units conversions / Conclusion | 2 |

17. Mapping of CO to Assignment:

| CO's | CO – STATEMENTS | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|
| **CO1** | The student will be able to understand the working and applications of solar energy systems | 2 | | | | |
| **CO2** | The student should be able to understand wind Energy Conversion Systems and its applications | | 2 | | | |
| **CO3** | The student will get an idea on Demonstrate and understanding of bio-energy production and its economics | | | 2 | | |
| **CO4** | Students are expected to understand about OTEC, tidal and geothermal energy systems OTEC, tidal and geothermal energy systems | | | | 2 | |
| **CO5** | The students will able to explain the working and applications of new energy systems. | | | | | 2 |

18. Assessment Methodologies:

| Assessment Tool | | | Description |
|---|---|---|---|
| **Direct Assessment (80%)** | **Internal Test** | **40%** | CAT – I, CAT – II, CAT –III average will be considered for 15 marks, MCQ 10 marks, Assignments-5 marks, Attendance 5 marks. Class test 5 marks<br>- |
| | **Assignments** | | |
| | **End semester Examination** | **60%** | 100 % for End semester Examination<br>- |

| | | |
|---|---|---|
| **Indirect Assessment (20%)** | **Course End Survey (80%)** | At the end of Course completion will be evaluated Enclosed separately |
| | **Exit Survey (20 %)** | At the end of the degree completion will be evaluated |

Distribution of portions for assessment tests

| Assessments | Portion Covering Unit | % of weight age |
|---|---|---|
| CAT - I | Unit-I & Unit-II (50%) | 12.5 |
| CAT - II | Unit-II (50%) & Unit-III | 12.5 |
| CAT - III | Unit-IV & Unit-V | 12.5 |
| Assignments | Unit-I to Unit-V | 12.5 |
| Class Test | Unit-I to Unit-V | 12.5 |
| MCQ | Unit-I to Unit-V | 25.0 |
| Attendance | | 12.5 |
| End Semester | Unit-I to Unit-V | 100 |

19. Mark Allotment for CO Assessment:

| COs | CAT - I | CAT - II | CAT - III | Assignment | MCQ | Attendance | Class Test | End Semester |
|---|---|---|---|---|---|---|---|---|
| **CO1** | 30 | | | 5 | 10 | 5 | 5 | 20 |
| **CO2** | 20 | 20 | | 5 | 10 | 5 | 5 | 20 |
| **CO3** | | 30 | | 5 | 10 | 5 | 5 | 20 |
| **CO4** | | | 30 | 5 | 10 | 5 | 5 | 20 |
| **CO5** | | | 20 | 5 | 10 | 5 | 5 | 20 |
| **AVERAGE** | 5 | 5 | 5 | 5 | 10 | 5 | 5 | 100 |

20. Content beyond syllabus

| UNIT | TOPICS TO BE COVERED | Hrs Taken |
|---|---|---|
| I | Conventional sources of energy | 1 |
| V | Application of renewable sources of energy in industry | 1 |

**Course Instructor** **HOD/Mech** **Dean Academics** **Principal**