**BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI – HYDERABAD CAMPUS**

**SECOND SEMESTER 2018-2019**

**COURSE HANDOUT (Part II)**

**07/01/2019**

In addition to part I (general handout for all courses appended to the timetable) this portion gives further specific details regarding the course.

Course no : **ME F433**

Course title : **Solar Thermal Process Engineering**

Instructor in charge : MORAPAKALA SRINIVAS

1. **Course Description**

Fundamentals of solar energy, earth-sun angles, solar spectrum, solar radiation, measurement and estimation of solar energy on horizontal and tilted surface, conversion routes and technologies, Standards and Performance Testing, thermal utilization of solar energy, modes of heat transfer and equations for performance calculations of systems- conduction, convection and radiation of heat, Flat plate collectors, solar concentrator systems, geometric optics, tracking methods, thermal analysis, energy storage, materials and properties, solar process loads and system calculations for time dependent loads, Life cycle cost analysis and economic analysis for various applications of solar thermal processes, solar water heating, space heating and cooling in Buildings, Industrial process heating, solar air-conditioning and refrigeration, Use of Simulation tools for performance simulation and Project Assignments, solar thermal power generation, Role of Govt., policies and plans.

1. **Scope and objective**

The main objective the course is to give the student a comprehensive knowledge on design, analysis of solar thermal technologies used for various low temperature as well as high temperature applications. Hands on experience on designing and analysis of these systems would be imparted with the associated software and laboratory based exercises.

1. **Text books**
2. **John Twidell, Anthony D. Weir, "Renewable energy resources", Second Edition, Taylor & Francis, NY, 2006(TB1) John Twidell, Anthony D. Weir, "Renewable energy resources", Second Edition, Taylor & Francis, NY, 2006.  
   (TB2) Aldo V. Da Rosa, "Fundamentals of Renewable Energy Processes", 2nd Edition, Academic Press (an Imprint of Elsevier), MA, USA, 2009.**Soteris Kalogirou, “Solar Energy Engineering : Processes and Systems”, First edition, Academic Press (an Imprint of Elsevier), USA, 2009
3. Garg .H.P., Prakash. J, “Solar Energy fundamentals and Applications” Twelfth reprint, Tata McGrawhill, New Delhi, 2010.
4. **Reference books**
5. John Twidell, Anthony D. Weir, Renewable Energy Resources, 2nd Ed, Taylor & Francis, NY,2006
6. Aldo V. Da Rosa, “Fundamentals of Renewable Energy Processes”, Second Edition, Academic Press (an Imprint of Elsevier), MA, USA, 2009.
7. **Course plan**

| **Lecture** | **Learning objective** | **Topics to be covered** | **Chapter in the Text Book** |
| --- | --- | --- | --- |
| 1-2 | General introduction to renewable  energy technologies | Overview of various renewable energy technologies, importance and historical development of Solar energy applications | 1 of TB1 |
| 3-5 | To understand the environmental characteristics associated with solar energy utilization | Sun- earth relationships, Solar angles, calculations of solar energy available at a particular location, on a particular surface, | 2 of TB1, 1 of TB2 |
| 6-8 | Solar radiation and its measurement | Thermal radiation and associated calculations, solar energy measuring techniques | 2 of TB1, 1 of TB2 |
| 9-11 | Comprehensive understanding on Solar energy collectors | Engineering and technological considerations of flat plate collectors, dish collectors, trough collectors, etc. and associate thermal analyses | 3 of TB1, 2&3 of TB2 |
| 12-14 | Comprehensive understanding on Solar energy collectors | Engineering and technological considerations of dish collectors, trough collectors, etc. and associate thermal analyses | 3 of TB1, 2&3 of TB2 |
| 15-17 | Performance of collectors | Characteristics of various collectors, Critical factors affecting the performance of various collectors, Different kinds of tests to assess the performance of collector | 4 of TB1, 2 &3 of TB2 |
| 18-20 | Solar water heating systems | Engineering and technological considerations of Analysis and design of different kinds of SHWS; Storage systems used for SHWS applications | 5 of TB1, 4 of TB2 |
| 21-23 | Solar water heating systems | Engineering and technological considerations of Storage systems used for SHWS applications | 5 of TB1, 4 of TB2 |
| 24-25 | Solar space heating and cooling systems | Thermal load estimations, passive space heating design | 6 of TB1, 10 of TB2 |
| 26-28 | Solar space heating and cooling systems | Engineering and technological considerations of Analysis and design various Solar space heating and cooling systems, heat pumping systems | 6 of TB1, 10 of TB2 |
| 29-30 | Desalination systems | Importance and relationship between water and energy, Desalination of water. | 8 of TB1, 6 of TB2 |
| 31-33 | Solar desalination systems | Desalination processes, thermal analyses, performance of solar stills | 8 of TB1, 6 of TB2 |
| 34-38 | Designing and Modeling  Solar Energy Systems | f-chart method and Designing of systems using f-chart method and program | 11 of TB1 |
| 39-42 | Solar Economic Analysis | Life cycle analysis, Time value of money, Description of the life cycle  analysis method, etc. | 12 of TB1, 18 of TB2 |

1. **Evaluation scheme**

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| --- | --- | --- | --- | --- |
| **Evaluation component** | **Duration** | **Weightage** | **Date/Time/Venue** | **Evaluation type** |
| Mid semester test | 90 min | 25% | 15/3  3.30 - 5.00 PM | Closed book |
| Surprise tests# | 10 min each | 15% | Surprise | Open book |
| Lab/simulations based projects@ | Take home | 10% | Will be informed | Open book |
| Seminar/Presentations on projects@ | To be informed | 10% | Will be informed | Open book |
| Comprehensive Examination | 3 hours | 40% | 11/05 AN | Closed book |

# On the whole there would be 4 surprise tests of which 3 best would be considered for 15% weightage. These surprise tests would be conducted during regular class work sessions.

@ On the whole there would be two projects, the topics of which would be given to the students. The projects are based on laboratory investigations and/or simulations using TRNSYS/other solar energy/energy software. For each of the projects, a report is to be submitted. The seminars /presentations shall be on projects. All other details would be communicated separately.

1. **Chamber consultation hours** To be announced in class.
2. **Course notices** To be displayed on ME notice board only.
3. **Academic Honesty and Integrity Policy**: Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

**Instructor-in-charge, ME F433**