

**Department of Electrical Engineering,**

**School of Engineering,**

**University of Management and Technology**

**Course Outline**

**Course code……EE 407… Course title……Renewable Electrical Energy Resources …Semester Fall 2015**

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| Program | BSEE |
| Credit Hours | 3 |
| Duration | One semester |
| Prerequisites | Circuits and DevicesPhysics and Chemistry |
| Resource Person (s) | Jameel Ahmad, Assistant Professor |
| Class Time and Counselling (SEN-501 ) | Counselling: on office door |
| Contact | Jameel Ahmad Jameel.ahmad@umt.edu.pk (0333-558-3815) |

Chairman/Director signature………………………………….

Dean’s signature……………………………

Date………………………………………….

**Learning Objectives:**

The objectives of this course will be to introduce students to

* 1. Why is there a need of renewables worldwide and in Pakistan Scenario?
	2. Basic understanding of wind power system and some design aspects
	3. Detailed understanding of PV cells and technologies
	4. In depth analysis on PV systems and applications
	5. Costing of renewable systems

Renewable energy comes from natural resources such as sun, wind, water, biomass and earth. A conversion system is required to convert renewable energy into electrical energy. This course covers several types of renewable energy conversion systems. It is a lecture-based course with design assignments and a research oriented group project analysis. Available renewable energy estimation, system sizing, design, modeling and control of renewable energy systems will be covered in the course. The course includes the following topics: introduction to Wind Energy Conversion Systems (WECS), assessment of wind energy potential, wind turbine aerodynamics, types of WECS, wind turbines modeling and control strategies, isolated and grid connected WECS systems, hybrid energy systems, energy storage, solar energy systems, photovoltaic cells, module and array concepts, PV system engineering, stand-alone systems, grid connected systems, concentrator systems, sizing and maximum power tracking, solar water pumping, micro-hydro electromechanical system and control, introduction to tidal power, wave energy converters, ocean thermal systems, and hybrid energy system sizing using **RETSCREEN, HOMER and Hybrid2.**

**Student Learning Outcomes:**

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| The purpose of this course is to provide a survey of the most important renewable energy resources, and the technologies for harnessing these within the framework of a broad range of simple to state-of the-art advanced energy systems. After completion of the course, students will be able to:* Explain the technological basis for harnessing renewable energy sources
* Describe the main components of different renewable energy systems
* Design renewable/hybrid energy systems that meet specific energy demands, are economically feasible and have a minimal impact on the environment
* Suggest the best combination of technological solutions to minimize the emission of greenhouse gases and increase the sustainability of the energy system in specific areas/regions
* Understanding of Economics of renewable and hybrid systems.
* Discuss how to utilize local energy resources (renewable and non-renewable) to achieve the sustainable energy system
* Comprehensive understanding of fundamentals of PV cells and systems.
* Design of Wind Turbine Systems
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**Learning Methodology:**

Lecture, interactive, participative,Software tools and Analysis

**Grade Evaluation Criteria**

Following is the criteria for the distribution of marks to evaluate final grade in a semester

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| --- | --- |
| Marks Evaluation | Marks in percentage |
| Quizzes  | 15 |
| Project Assignments and Presentations  | 10 |
| Mid Term  | 25 |
| Final exam  | 50 |
| Total  | 100 |

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| Textbooks: |
| 1. Renewable and Efficient Electric Power Systems’ by Gilbert M. Masters2004 by John Wiley & Sons, Inc.
2. *Renewable Energy* Resources, 2nd Edition, John Twidell and Tony Weir, Taylor &Francis, 2006

Reference books:1. ‘Wind Energy Explained Theory, Design and Application Second Edition J. F. Manwell, J. G. McGowan and A. L. Rogers, 2009 John Wiley & Sons Ltd.,
2. Photovoltaics System Design and PracticeFeb 13, 2012by Heinrich Häberlin
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**Tentative Course Schedule**

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| **WEEK** | **Topics** | **Book chapters** |
| 1 | Lecture 1: Course introduction and overview of world energy resources and consumption trendsLecture 2: Renewable energy system types, current status and future, place of PV and Wind Power in context of Pakistan and its importance. | Chapter-6 Gilbert M Masters |
| 2 | Lecture 3: Energy in the wind, types of wind turbine and their output characteristicsLecture 4: Assessment of annual energy output of a wind turbine  | Chapter-6 Gilbert M Masters |
| 3 | Lecture 5: Wind turbine aerodynamicsLecture 6: Mathematical modeling of wind energy conversion systems | Chapter-6 Gilbert M Masters |
| 4 | Lecture 7: Control of wind energy conversion systemsLecture 8: Variable speed wind turbines and their grid interface | Chapter-6 Gilbert M Masters |
| 5 | Lecture 9: Grid interconnection standards and economics of WECSLecture 10: Wind diesel hybrid power systems  | Chapter-6 Gilbert M Masters |
| 6 | Lecture 11: The solar resourceLecture 12: Photovoltaic materials and their characteristicPart-1 | Chapter-7-8 Gilbert M Masters |
| 7 | Lecture 13: Photovoltaic materials and their characteristicPart-2Lecture 14: Photovoltaic materials and their characteristicPart-3 | Chapter-8-9 Gilbert M Masters |
| 8 | **MIDTERM** |  |
| 9 | Lecture 15: PV systemsPower electronics and control of PV systemsLecture 16: Grid connected and standalone PV Systems | Chapter-7-9 Gilbert M Masters |
| 10 | Lecture 17: Introduction to solar water pumping and heating systemsLecture 18: Energy storage technologies ,Costing: payback period, life cycle cost, case study etc. | Chapter-7-9 Gilbert M Masters |
| 11 | Lecture 19: Micro-hydro power sizing and electromechanical system Lecture 20: Micro-hydro power electrical system and control | Chapter-8 John Twiddle |
| 12 | Lecture 21: Ocean/Tidal energy systemsLecture 22: Wave energy systems | Chapter-12-13 John Twiddle |
| 13 | Lecture 23: Ocean thermal energy conversion (OTEC)Lecture 24: Biomass and biofuels | Chapter-11 and 14 John Twiddle |
| 14 | Lecture 25: Geothermal Energy SystemsLecture 26: Institutional and economic factors | Chapter-15 and 17 John Twiddle |
| 15 | Lecture 27: Energy systems, storage and transmissionLecture 28: Buildings and other solar thermal applications | Chapter-16 and 6 John Twiddle |
| 16 | **FINAL** |  |