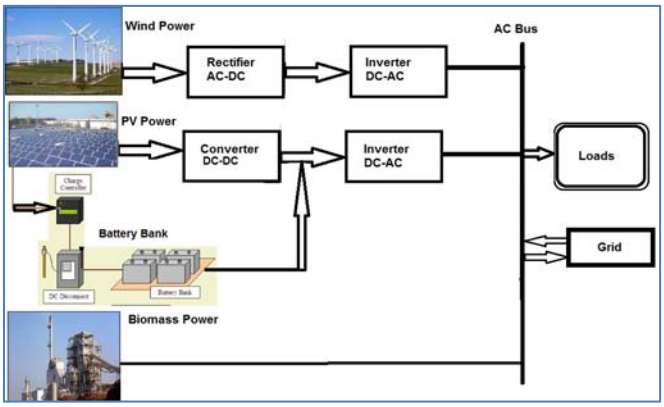
Department of Electrical Engineering,
School of Engineering,
University of Management and Technology

Course Outline

Course code……EE 407… Course title…… Renewable Electrical Energy Resources …Semester Fall 2016

Program	BSEE
Credit Hours	3
Duration	One semester
Prerequisites	Fundamentals of power systems and power electronics
Resource Person (s)	Jameel Ahmad, Assistant Professor Dr Irfanullah, Assistant Professor
Class Time and Counselling SEN 501/503	Class :Tuesday, Thursday, Friday and Saturday Counselling hours: Meet the instructor
Contact	Jameel Ahmad Jameel.ahmad@umt.edu.pk Dr Irfanullah irfanullah@umt.edu.pk

Chairman/Director signature…….
Dean's signature……
Date…….



Learning Objectives:

The objectives of this course is to introduce students with the following:-

1. Why is there a need of renewables worldwide and in Pakistan?
2. Wind power system and some design aspects
3. PV cells and technologies
4. Concentrated photovoltaic (CPV) systems and applications, concentrating solar power (CSP)
5. System aspects of micro-hydro, Biomass, Ocean and Geothermal Energy, Hydrogen energy and Fuel cells
6. Concept of microgrid and distributed generation

Renewable energy comes from natural resources such as sun, wind, water, biomass, ocean and earth. A conversion system is required to convert renewable energy into electrical energy. This is a lecture-based course with few assignments and a research group project on analysis and simulation of a hybrid power system. Reference websites for renewable energy such as www.aedb.org , http://www.nrel.gov/csp/, and http://www.nrel.gov/ , www.homerenergy.com will be exposed to students for resource assessment using HOMER-pro software from NREL.

Software: **HOMER Pro**

Student Learning Outcomes:

The purpose of this course is to provide a survey of the most important renewable energy resources and technologies. After completion of the course, students will be able to:

- Describe the main components of different renewable energy systems
- Design renewable/hybrid energy systems that meet specific energy demands, economically feasible and have a minimal impact on the environment
- Suggest the best combination of technological solutions to minimize the emission of greenhouse gases (GHG) and increase the sustainability of the energy system in specific areas/regions
- 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 and Concentrated PV (CPV) and CSP systems and application.
- Nonimaging Optics: The term non-imaging optics is concerned with applications where imaging formation is not important but where effective and efficient collection , concentration, transport and distribution of light energy is - i.e. solar energy conversion, signal detection, illumination optics, measurement and testing.
- Design of Wind Turbine Energy Systems and Optimal Wind Farm Layout

Learning Methodology:

Lectures, interactive, participative, Software tools and Analysis, videos

Grade Evaluation Criteria

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

Marks Evaluation	Marks in percentage
Quizzes based on Assignments	15
Analysis and Simulation Project related to Hybrid Solar, wind and biomass using HOMER Pro software (from homerenergy.com)	10
Mid Term	25
Final exam	50
Total	100

Textbooks:

[1] **Main Textbook: Renewable and Efficient Electric Power Systems** by Gilbert M. Masters 2004 by John Wiley & Sons.

Reference books and Research Papers:

[2] **Nonimaging Optics** by R. Winston, J.C. Mi˜nano, P. Benítez, N. Shatz, J.C. Bortz,, Elsevier Academic Press, USA, 2005.

[3] **Energy Resources and Systems: Volume 2 Renewable Energy** by Tushar K. Ghosh & Mark A. Prelas, Springer 2011

[4] Solar Engineering of Thermal Processes, 4th edition, John A. Duffie, William A. Beckman, John Wiley & Sons, Inc. 2013

[5] Selected research papers from IEEE /Elsevier as reference reading material.(3-5 papers)

Tentative Course Schedule

WEEK	Topics	Book chap/Refer
1	Lecture 1: Introduction to Renewable energy systems and resources, current status of Solar, biomass and Wind Power systems in Pakistan and future (http://www.aedb.org/). Lecture 2: Single and three phase power and power factor correction	Chap-2/3 [1]
2	Lecture 3: Power Quality Issues such as Harmonics Lecture-4 :Types of wind turbines and their characteristics	Chap- 3 [1] Chap- 3 [1]
3	Lecture-5: Power in the wind, Lecture-6: Impact of Tower Height	Chap-6 [1]
4	Lecture-7: Wind Turbine Generators and their types (PMSG,SCIG,DFIG,WRIG) Lecture 8: Average power in the wind and Estimates of Wind Energy	Chap-6 [1]
5	Lecture 9: Power Electronics in Wind Energy Systems Lecture 10: Wind energy conversion systems (WECS) and various configurations, Environmental Impacts of Wind Turbines	Chap-6,[1]
6	Lecture11: The solar Radiation as Energy Source Lecture 12: Photovoltaic materials and their characteristics	Chap-8 [1]
7	Lecture 13: Types of Photovoltaic cells and their efficiencies, I-V curves Lecture 14: Photovoltaic cells to modules and Arrays	Chap-8[1]
8	**MIDTERM EXAM**	
9	Lecture 17: Effect of shadows on Photovoltaic systems Lecture 18 : I-V curves for loads, I-V and P-V curve of solar modules	Chap-9 [1]
10	Lecture 19: Stand Alone and Grid Connected PV Systems Lecture 20: PV-Powered Water Pumping System Design, BIPV	Chap-9 [1]
11	Lecture 21: concentrated photovoltaics (CPV), Concentration ratio and edge-ray principle Lecture 22: Requirements for Solar Concentrators, Optical Performance of Concentrating Collectors, Optical Characteristics of Nonimaging Concentrators	Chap-1[2] Chap-4[2] , Chap-7[4]
12	Lecture 23: Solar concentrators: Parabolic reflector, Fresnel lens, compound parabolic concentrator (CPC), parabolic trough, Tower Systems (Central receiver), Sterling/Dish type Concentrating Solar Power (CSP) Lecture 24 Solar Thermal Versus Photovoltaic Concentrator Specifications	Chap-7[4] , Chap-13[2] , Chap-2[3]
13	Lecture 25: Nonimaging concentrators for solar thermal applications, Solar tracking systems 1-D and 2-D Lecture 26: Micro hydro Power and components	Chap-13[2] Chap-3[3]
14	Lecture 27: Biomass Energy (Bioenergy) Lecture 28: Hydrogen Energy and Fuel Cells	Chap-6[3], Chap-8[3]
15	Lecture 29: Introduction to Geothermal Energy Systems Lecture-30 Introduction to Ocean Energy	Chap-4[3], Chap-5[3]
16	**FINAL EXAM**	