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**Electrical Engineering Department**

**School of Engineering**

**University of Management and Technology**

**Course Outline**

**Course Code: EE 407 Course Title: Renewable Electrical Energy Resources**

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| --- | --- |
| Program | BSEE |
| Credit Hours | 3 |
| Duration | One semester |
| Prerequisites | Fundamentals of power systems and power electronics |
| Resource Person (s) | Dr. Muhammad Adnan  Mr. Waseem Iqbal |
| Counselling | Counselling hours: Meet the instructor ( SEN: Level 5) |
| Contact | Dr. Muhammad Adnan: [muhammad.adnan@umt.edu.pk](mailto:muhammad.adnan@umt.edu.pk)  Waseem Iqbal: [waseem.iqbal@umt.edu.pk](mailto:waseem.iqbal@umt.edu.pk) |

**CoD’s signature………………………………….**

**Dean’s signature……………………………**

**Date………………………………………….**

**Course Learning Outcomes (CLOs):**

**CLO: 1.** **Employ** thenonrenewable andrenewable energy resources such as: wind energy, solar energy (PV, CPV, and CSP, and solar thermal), micro-hydro energy, and biomass energy and indicate energy issues in the country. (C3)

**CLO: 2.** Explain power quality issues and **calculate** the total harmonic distortion and power in the wind. (C3)

**CLO: 3.** Explain wind energy conversion systems (WECS) & **calculate** various parameters of wind turbine for wind speed, energy and efficiency. (C3)

**CLO: 4.** Explain solar energy conversion system (SECS) and concentrated technologies for solar systems. **Analyze** I-V curves of different types of solar cells and appropriate systems for domestic and commercial requirements. (C4)

**CLO: 5. Relate** societal, health, safety and other relevant issues related to renewable energy solutions. (C3)

**CLO: 6.** **Explain** the impact of renewable energy solutions on environment for sustainable development. (C2)

**Mapping of CLOs to Program Learning Outcomes (PLOs):**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **CLOs/PLOs** | **CLO 1** | **CLO 2** | **CLO 3** | **CLO 4** | **CLO 5** | **CLO 6** |
| **PLO 1: Engineering Knowledge** | ✓ | ✓ | ✓ |  |  |  |
| **PLO 2: Problem Analysis** |  |  |  |  |  |  |
| **PLO 3: Design and Development of Solutions** |  |  |  |  |  |  |
| **PLO 4: Investigation** |  |  |  | ✓ |  |  |
| **PLO 5: Modern Tool Usage** |  |  |  |  |  |  |
| **PLO 6: The Engineer and Society** |  |  |  |  | ✓ |  |
| **PLO 7: Environment and Sustainability** |  |  |  |  |  | ✓ |
| **PLO 8: Ethics** |  |  |  |  |  |  |
| **PLO 9: Individual and Team Work** |  |  |  |  |  |  |
| **PLO 10: Communication** |  |  |  |  |  |  |
| **PLO 11: Project Management** |  |  |  |  |  |  |
| **PLO 12: Life Long Learning** |  |  |  |  |  |  |

**Learning Methodology:**

Classroom lectures, interactive, participative, software tools and videos.

**Grade Evaluation Criteria**

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| --- | --- |
| **Components** | **Marks** |
| Quizzes | 25 |
| Mid Term Exam | 25 |
| Final Exam | 50 |
| Total | 100 |

**Text Book:**

[1] Renewable and Efficient Electric Power Systems by Gilbert M. Masters 2013, 2ND EDITION by John Wiley & Sons.

**References:**

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

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

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

[4] Design of Smart Power Grid Renewable Energy Systems - Ali Keyhani, 592 pages July 2016, Wiley-IEEE Press.

**Calendar of Course Contents**

**Course code: EE 407 Course title: Renewable Electrical Energy Resources**

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| --- | --- | --- | --- |
| **Week** | **Topics** | **Book chapter** | **CLOs** |
| 1 | Lecture 1: Introduction to Renewable energy systems and resources, current status of Solar, biomass and Wind Power systems in Pakistan and future.  Lecture 2: Single and three phase power and power factor correction | Chap-1 [TB 1] | CLO1 |
| 2 | Lecture 3: Power Quality Issues such as Harmonics  Lecture-4 :Types of wind turbines and their characteristics | Chap- 3 [TB 1]  Chap- 3 [TB 1] | CLO2 |
| 3 | Lecture-5: Power in the wind,  Lecture-6: Impact of Tower Height | Chap-7 [TB 1] | CLO2 |
| 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-7 [TB 1] | CLO3 |
| 5 | Lecture 9: Power Electronics in Wind Energy Conversion Systems  Lecture 10: Wind energy conversion systems (WECS) and various configurations, Environmental Impacts of Wind Turbines | Chap-7 [TB 1] | CLO3, CLO5, CLO6 |
| 6 | Lecture11: The solar Radiation as Energy Source  Lecture 12: Photovoltaic materials and their characteristics | Chap-4 & 5 [TB 1] | CLO4-CLO6 |
| 7 | Lecture 13: Types of Photovoltaic cells and their efficiencies, I-V curves  Lecture 14: Photovoltaic cells to modules and Arrays | Chap-5 [TB 1] | CLO4-CLO6 |
| 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-5 [TB 1] | CLO4-CLO6 |
| 10 | Lecture 19: Stand Alone and Grid Connected Solar PV Energy Conversion Systems  Lecture 20: PV-Powered Water Pumping System Design, BIPV | Chap-6 [TB 1] | CLO4-CLO6 |
| 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-8 [TB 1 RB 1] | CLO4 |
| 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-8[RB 3] Chap-13[RB 1] Chap-2[RB 2] | CLO4 |
| 13 | Lecture 25: Nonimaging concentrators for solar thermal applications  Lecture 26: Solar tracking systems 1-D and 2-D | Chap-13[RB 1] | CLO4 |
| 14 | Lecture 27-28: Micro hydro Power and Components | Chap-3[RB 2] | CLO1 |
| 15 | Lecture 29-30: Biomass Energy (Bioenergy) | Chap-6[RB 2] Chap-8[RB 2] | CLO1 |
| 16 | **Final Exam** |  |  |

**Mapping of CLOs to Direct Assessments**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CLOs▼** | Quiz 1 | Quiz 2 | Quiz 3 | Quiz 4 | Quiz 5 | Quiz 6 | Midterm Exam | Final Exam |
| 1 | ✓ |  |  |  |  |  | ✓ | ✓ |
| 2 |  | ✓ |  |  |  |  | ✓ | ✓ |
| 3 |  |  | ✓ |  |  |  | ✓ | ✓ |
| 4 |  |  |  | ✓ |  |  |  | ✓ |
| 5 |  |  |  |  | ✓ |  |  | ✓ |
| 6 |  |  |  |  |  | ✓ |  | ✓ |