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Department of Electrical Engineering	
Renewable Energy Systems (63425)	
Total Credits	**3**
major compulsory	
Prerequisites	P1 : Electrical Power Engineering (64395) OR Electric Power Systems I (63422)

Course Contents

Introduction to renewable energy.Solar energy: Solar astronomy, solar radiation, Solarthermal systems, Solar electric power systems. Storage batteries. Wind energy: wind mechanical converters, Wind electric converters. Biogas digesters

	Intended Learning Outcomes (ILO's)	Student Outcomes (SO's)	Contribution
1	Ability in understanding the solar geometry ,solar altitude angle, zenith angle, air mass, hour angle, declination angle, azimuth angle, equation of time and solar time.	A B C D E H K	15 %
2	Ability in calculation of sunrise , solar noon time ,sunset and day length.	A B C D E K	3 %
3	Learning the types of solar radiation and the related measuring equipment.	A B E J	7 %
4	Learning the construction and function of solar thermal water Heating systems	A B C K	5 %
5	Learning the technique of photovoltaic cells and modules and their characteristics according to climate parameters	A B C K	25 %
6	Understanding the function and characteristics of storage batteries	B C E K	10 %
7	Learning the fundamentals of wind energy ,wind turbine types their characteristics and efficiency	A B C	15 %
8	Ability in determination of wind energy potential, measuring Equipment, Rayleigh distribution and Weibull distribution	A B I J K	10 %
9	Ability in design and specifying of solar thermal and solar Electric systems and wind power systems	A B H K	10 %

Textbook and/ or Refrences

1-Goswami,Kreider , Solar Energy, 2-Duffie JA,Beckmann WA , Solar Engineering,Wiely Interscience 3-Buresch M ,Photovoltaic energy systems Design and Installation,McGrawHill

Assessment Criteria	Percent (%)
First Exam	20 %
Second Exam	20 %
Projects	10 %
Final Exam	50 %

Course Plan

Week	Topic
1	Introduction: Solar thermal systems, Solar thermal-electrical systems and their applications. Solar electrical systems and their applications. Wind energy mechanical and electrical systems and their applications. Biogas production
2	Solar Astronomy : Solar radiation spectrum, the solar constant, The extra terrestrial solar radiation, terrestrial radiation, the spectral irradiancy curve ,the air mass.

3	Solar Astronomy: Solar radiation geometry ,the equation of time, the sun motion algorithms ,the sun path diagram .
4	Measuring equipment for solar and wind energy
5	Solar Electric Power Systems : Photovoltaic cell and its characteristics ,PV-cell types types , the PV module
6	Solar Electric Power Systems: Design of PV arrays , Midterm Exam 1
7	Solar Electric Supplementary Equipment : DC/DC-Converter (Charge Regulators), inverters , dual converters, appropriate loads of PV systems.
8	Storage Batteries : Construction of a battery,battery type and characteristics, block batteries ,regular batteries, state of charge, depth of discharge.
9	Storage Batteries : Battery cycling, overcharge and deep discharge, design of battery storage systems of different size ,ampere hour efficiency,watthour efficiency Midterm Exam 2
10	Wind Energy: Wind speed and duration, wind energy potential,Rayleigh and Weibull distribution.
11	Wind Energy : Wind turbine types and their characteristics, design of wind electric power systems
12	Solar thermal systems: Solar water heaters, thermosyphonic systems, forced circulating systems, system efficiency, and design of solar water systems.
13	Solar thermal systems: Design of solar water systems. Biogas Digesters : The digestion materials and their characteristics, the digestion process, the biogas characteristics
14	Biogas Digesters: Design of bio gas digesters, biogas energy production.
15	Renewable energy projects
16	Final Exam