CODE	COURSE NAME	CATEGORY	L	T	P	CREDITS
EET383	SOLAR AND WIND ENERGY CONVERSION SYSTEMS	VAC	3	1	0	4

Preamble: This course introduces about solar and wind energy conversion systems. Design of wind and solar power systems are also discussed.

Prerequisite: Introduction to Power Engineering/ Energy Systems

Course Outcomes : After the completion of the course the student will be able to:

CO 1	Explain the basics of solar energy conversion systems.
CO 2	Design a standalone PV system.
CO 3	Describe different wind energy conversion systems.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO 1	3	3										2
CO 2	3	3	1									2
CO 3	3	3										2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember (K1)	10	10	10
Understand (K2)	20	20	40
Apply (K3)	20	20	50
Analyse (K4)	-	-	-
Evaluate (K5)	-	-	-
Create (K6)	-	-	-

End Semester Examination Pattern :There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain what do you mean by solar constant (K1)
2. Discuss about the different instruments used for measuring solar radiation and sun shine (K2)

Course Outcome 2 (CO2):

1. Design a standalone PV system. (K3)
2. Design a grid connected PV system. (K3)

Course Outcome 3 (CO3):

1. Compare the performance of different types of wind turbines. (K3).
2. Compare the performance of different types of generators used in wind turbines. (K3).

Model Question paper

QP CODE:

PAGES:2

Reg. No:_____
Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
FIFTH SEMESTER B.TECH DEGREE EXAMINATION,
MONTH & YEAR
Course Code: EET383

Course Name: SOLAR AND WIND ENERGY CONVERSION SYSTEMS

Max. Marks: 100 Duration: 3 Hours

PART A (3 x 10 = 30 Marks)

Answer all Questions. Each question carries 3 Marks

1. Explain briefly what do you mean by solar azimuth angle and zenith angle.
2. Differentiate between extraterrestrial and terrestrial solar radiation.
3. Write notes on the working of a solar cooker.
4. Discuss what do you mean by a solar green house.
5. Write notes on the different materials used for making solar cells.
6. Discuss the characteristics of a solar cell.
7. Differentiate between lift and drag forces.
8. Explain what do you mean by pitch control of wind turbines.
9. Write notes on the environmental impacts of wind power generation.

10. Discuss about the wind energy program in India

PART B (14 x 5 = 70 Marks)
Answer any one full question from each module. Each question carries 14 Marks

Module 1

11. a. With the help of a neat diagram, explain the working of a pyrheliometer. **(7)**
    b. Explain how monthly average solar radiation on inclined surfaces can be calculated. **(7)**

12. a. State the reasons for variation in the amount of solar energy reaching earth surface. **(4)**
    b. With the help of a neat diagram, explain the working of a sunshine recorder. **(6)**
    c. Explain the difference in the working of pyrheliometer and pyranometer. **(4)**

Module 2

13. a. Explain the different types of solar collectors based on the way they collect solarradiation. **(7)**
    b. Explain in detail, the working of a solar air conditioning system **(7)**

14. a. With the help of a diagram, explain the function of different components of a flat plate solar collector. **(7)**
    b. Design a solar water heater for domestic application. **(7)**

Module 3

15. a. Write notes on the efficiency of a solar cell. **(3)**
    b. Discuss the effect of shadowing on the performance of solar cells. **(3)**
    c. Explain how maximum power point tracking can be done using buck-boostconverter. **(8)**

16. a. Compare the performance of single junction and multijunction PV modules. **(4)**
    b. Write notes on packing factor of a PV module. **(3)**
    c. Explain with a neat sketch, the working principle of a grid connected solar system. **(7)**

Module 4

17. a. Discuss the application of Weibull distribution in wind power generation **(3)**
    b. Explain the characteristics of a wind turbine. **(4)**
    c. Explain the different modes of wind power generation. **(7)**

18. a. Compare the performance of different types of wind turbines **(6)**
    b. Derive an expression for wind turbine power. **(4)**

c. What do you mean by Betz's Law? Why wind turbines are not 100% efficient? **(4)**

Module 5

19. a. With the help of a diagram, explain the working of a wind energy conversion system. **(7)**

    b. Compare the performance of different types of generators used in wind mills. **(7)**

20. a. With the help of a diagram, explain the working of a variable speed constant frequency wind energy conversion system. **(7)**

    b. Discuss about the different types of converter used in renewable energy systems. **(7)**

Syllabus

Module 1

Introduction - Basic Concept of Energy -Source of Solar Energy -Formation of the Atmosphere - Solar Spectrum. Solar Constant -Air Mass -Solar Time-Sun–Earth Angles-Solar Radiation-Instruments to Measure Solar Radiation-Pyrheliometer –Pyranometer - Sunshine Recorder -Solar Radiation on a Horizontal Surface - Extraterrestrial Region.-Terrestrial Region -Solar Radiation on an Inclined Surface -Conversion Factors -Total Solar Radiation on an Inclined/Tilted Surface -Monthly Average Daily Solar Radiation on Inclined Surfaces .

Module 2

Solar Thermal system-Principle of Conversion of Solar Radiation into Heat, –Solar thermal collectors –General description and characteristics –Flat plate collectors –Heat transfer processes –Solar concentrators (parabolic trough, parabolic dish, Central Tower Collector) – performance evaluation. Applications -Solar heating system, Air conditioning and Refrigeration system, Pumping system, solar cooker, Solar Furnace, Solar Greenhouse - Design of solar water heater

Module 3

Solar PV Systems-Introduction -Fundamentals of Semiconductor and Solar Cells - Photovoltaic Effect -Solar Cell (Photovoltaic) Materials - Basic Parameters of the Solar Cell - Generation of Solar Cell (Photovoltaic) Materials-.Photovoltaic (PV) Module and PV Array - Single-Crystal Solar Cell Module, Thin-Film PV Modules, III-V Single Junction and Multijunction PV Modules-Emerging and New PV Systems -Packing Factor of the PV Module - Efficiency of the PV Module -Energy Balance Equations for PV Modules -Series and Parallel Combination of PV Modules.- Effect of shadowing-Maximum Power Point Tracker (MPPT) using buck-boost converter. Solar PV Systems –stand-alone and grid connected -Design steps for a Stand-Alone system –Storage batteries and Ultra capacitors.

Module 4

Wind Turbines - Introduction -Origin of Winds- Nature of Winds – Classification of Wind Turbines -Wind Turbine Aerodynamics - Basic principles of wind energy extraction – Extraction of wind turbine power(Numerical problems)- Weibull distribution-Wind power generation curve-Betz's Law-Modes of wind power generation.

Module 5

Wind Energy Conversion Systems-Introduction-Components of WECS - Fixed speed drive scheme- Variable speed drive scheme - Wind–Diesel Hybrid System –Induction generators-Doubly Fed Induction Generator(DFIG)-Squirrel Cage Induction Generator(SCIG)-Power converters in renewable energy system-AC-DC Converters, DC-DC Converters, DC-AC Converters(Block Diagram Only)-Effects of Wind Speed and Grid Condition (System Integration) -Environmental Aspects -Wind Energy Program in India

References:

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6. Siraj Ahmed, *Wind Energy- Theory and Practice*, Prentice Hall of India, New Delhi,2010
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16. Boyle G. (ed.), Renewable Energy -Power for Sustainable Future, Oxford University Press, 1996.
17. Johansson T. B., H. Kelly, A. K. N. Reddy and R. H. Williams, Renewable Energy – Sources for Fuel and Electricity, Earth scan Publications, London, 1993.

Course Contents and Lecture Schedule:

No	Topic	No. of Lectures
1	**Solar energy (8 hours)**	
1.1	Introduction - Basic Concept of Energy -Source of Solar Energy - Formation of the Atmosphere - Solar Spectrum.	2
1.2	Solar Constant -Air Mass -Solar Time-Sun–Earth Angles-Solar Radiation-Instruments to Measure Solar Radiation-Pyrheliometer – Pyranometer -Sunshine Recorder	2
1.3	Solar Radiation on a Horizontal Surface –Extraterrestrial Region.- Terrestrial Region -Solar Radiation on an Inclined Surface -Conversion Factors	2
1.4	Total Solar Radiation on an Inclined/Tilted Surface -Monthly Average Daily Solar Radiation on Inclined Surfaces.	2
2	**Solar Thermal Systems (8 hours)**	
2.1	Principle of Conversion of Solar Radiation into Heat, –Solar thermal collectors –General description and characteristics	1
2.2	Flat plate collectors –Heat transfer processes –Solar concentrators (parabolic trough, parabolic dish, Central Tower Collector) – performance evaluation.	2
2.3	Applications -Solar heating system, Air conditioning and Refrigeration system	1
2.4	Pumping system, solar cooker, Solar Furnace, Solar Greenhouse	2
2.5	Design of solar water heater	2
3	**Solar PV systems (8 Hours)**	
3.1	Introduction -Fundamentals of Semiconductor and Solar Cells - Photovoltaic Effect -Solar Cell (Photovoltaic) Materials - Basic Parameters of the Solar Cell -Generation of Solar Cell (Photovoltaic) Materials	2
3.2	Photovoltaic (PV) Module and PV Array - Single-Crystal Solar Cell Module, Thin-Film PV Modules, III-V Single Junction and Multijunction PV Modules -Emerging and New PV Systems	1
3.3	Packing Factor of the PV Module - Efficiency of the PV Module - Energy Balance Equations for PV Modules	1
3.4	Series and Parallel Combination of PV Modules.- Effect of shadowing- Maximum Power Point Tracker (MPPT) using buck-boost converter.	2
3.5	Solar PV Systems –stand-alone and grid connected -Design steps for a	2

	Stand-Alone system –Storage batteries and Ultra capacitors.	
4	**Wind energy (9 Hours)**	
4.1	Wind Turbines - Introduction -Origin of Winds- Nature of Winds	1
4.2	Classification of Wind Turbines -Wind Turbine Aerodynamics - Basic principles of wind energy extraction	2
4.3	Extraction of wind turbine power(Numerical problems)	2
4.4	Weibull distribution-Wind power generation curve - Betz's Law	2
4.5	Modes of wind power generation.	2
5	Wind energy conversion systems (9)	
5.1	Introduction-Components of WECS - Fixed speed drive scheme-Variable speed drive scheme	2
5.2	Wind–Diesel Hybrid System –Induction generators-Doubly Fed Induction Generator(DFIG)-Squirrel Cage Induction Generator(SCIG)	3
5.3	Power converters in renewable energy system-AC-DC Converters, DC-DC Converters, DC-AC Converters(Block Diagram Only)	2
5.4	Effects of Wind Speed and Grid Condition (System Integration) - Environmental Aspects -Wind Energy Program in India	2