Syllabus

CODE	COURSE NAME	CATEGORY	L	T	P	CREDITS
EET284	Energy Systems	Minor	3	1	0	4

Preamble : This course introduces various types of renewable energy sources. It discusses various means of generating and storing energy and the importance of renewable energy. Various energy standards and means to improve efficiency of systems are also introduced

Prerequisites : EST 130Basics of Electrical & Electronics Engineering

EET 253 Introduction to Power Engineering

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

CO 1	Illustrate Indian and global energy scenario
CO 2	Elaborate different conventional and non-conventional energy generation schemes and the economics of generation
CO 3	Analyse principle of operation and performance comparison of various energy storage schemes
CO 4	Identify major Global and Indian standards for Energy Management
CO 5	Perform a preliminary Energy Audit
CO 6	Appraise various aspects of energy economics

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	PO 10	PO 11	PO 12
CO 1	3	3										2
CO 2	3	3										2
CO 3	3	3										2
CO 4	3	3										2
CO 5	3	3										2
CO 6	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 contains 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 (CO 1):

1. Discuss Indian and world energy scenario (K1)
2. Describe Indian energy sector reforms (K2)
3. Discuss energy and environment, energy security (K2)
4. Explain the features of Energy Conservation Act (K3)

Course Outcome 2 (CO 2):

1. Describe various sources of non conventional energy (K2)
2. Problems on calculating efficiency of Solar Photovoltaic Systems (K3)
3. Problems on energy availability from wind(K3)
4. Discuss the generation of energy from wave, tide, OTEC and Biomass (K2)

Course Outcome 3 (CO 3):

1. Describe various means of energy storage (K2,)
2. Explain the working of batteries (K2)
3. Calculate the efficiency of fuel cells (K3).

Course Outcome 4 (CO 4):

1. Identify ISO 50001 for Energy Management. (K2)
2. Describe the activities of BEE in India and star rating of equipment (K2).

Course Outcome 5 (CO 5):

1. Give the steps involved in Energy Audit (K1)
2. Calculate the payback period (K3).

Course Outcome 6 (CO 6):

1. Classify different types of tariff (K3)
2. Compare models for demand forecasting (K3)
3. Explain how economic analysis of energy investment is done (K2)

Model Question paper

QPCODE: PAGES: 2

Reg.No:_____

Name:_____

APJABDULKALAMTECHNOLOGICALUNIVERSITY

FOURTH SEMESTERB.TECHDEGREEEXAMINATION, MONTH &YEAR

Course Code: EET 284

Course Name: Energy Systems

Max.Marks:100 **Duration: 3Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1. Enumerate the important features of Energy Conservation act.
2. Illustrate the concept of green buildings.
3. Find the maximum power and efficiency of a 100 x 100 mm sq. solar cell having an open circuit voltage is 0.611 V, Short circuit current of 3.5 A, Fill factor of 0.7 when input power is 10 W.
4. Draw and explain the block diagram of the ocean thermal energy system.
5. Derive the expression for the power output and efficiency of a fuel cell.
6. Give the relative advantages and disadvantages of battery storage.
7. Discuss the structure of a detailed energy audit report.
8. What is the significance of the energy audit?
9. What is the difference between long term and short forecasting? What is MAED?
10. Differentiate between cost of capital and discount rate.

(10x3=30)

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module 1

11. (a) Compare Energy Scenario of India and the world. **(10)**

    (b) The luminous efficiency of a lamp is 8.8 Lumens/Watt and its luminous intensity is 700 Cd. What is the power of the lamp? **(4)**

12. (a) Compare any four types of lamps. Give their approximate efficiencies as well. **(8)**

    (b) Discuss the energy system reforms in India and illustrate their effect. **(6)**

Module 2

13. (a) Explain how energy can be extracted from the heat and light of sun. **(10)**

    (b) Determine the power in the wind if the wind speed is 20 m/s and blade length is 50 m and air density = 1.23 kg/m^3. **(4)**

14. (a) Compare the schemes for extraction of energy from waves and tides. **(8)**

    (b) Explain with the help of a schematic, extraction of energy from biomass. **(6)**

Module 3

15. (a) Differentiate between primary and secondary cells. **(4)**

    (b) Explain the working of any one primary and secondary cell with the help of diagrams **(10)**

16. (a) Give the importance of energy storage. **(4)**

    (b)Compare compressed air and fly wheel energy storage systems. **(10)**

Module 4

17. (a) Explain the important features of ISO 50001. **(6)**

    (b) Discuss are the functions of Bureau of Energy efficiency. What is the significance of star ratings? **(8)**

18. (a) Explain the types of energy audit and their procedure. **(9)**

    (b) Explain various instruments used for energy audit. **(5)**

Module 5

19. (a) Explain LEAP energy planning system with the help of block diagram. **(6)**

    (b) A company is planning to install an energy-efficient motor requiring an initial investment of Rs 10.5 lakh. The motor is expected to save 2.5 lakh per year in net cash flows for 7 years. Calculate the payback period. **(8)**

20. (a) Explain one part, two part and three part tariff. **(9)**

    (b) A machine can reduce annual cost by Rs 40,000. The cost of the machine is Rs 223,000 and the useful life is 15 years with zero residual value. Calculate the Internal Rate of Return. **(5)**

(14x5=70)

Syllabus

Module 1

Energy Scenario: Indian Energy Scenario, World Energy Scenario, Indian Energy Sector Reforms, Energy and Environment, Energy Security, Energy conservation act

Energy Efficient Systems: Reducing pollution and improving efficiency in buildings, Green Building Standards, Types of lamps and their efficiencies

Module 2

Renewable Energy Resources: Solar Thermal System-Working Principle-Block diagram, Solar Photovoltaic System- Working Principle-Block diagram, Solar cell efficiency calculation, Wind Energy Systems- Working Principle-Block diagram, wind power equation, Energy from Waves and tides- Working Principle-Block diagram, Ocean Thermal Energy System- Working Principle-Block diagram, Energy from Biomass

Module 3

Energy Storage: Importance of Energy Storage- Means of Storing Energy- Principle of operation and performance comparison. Compressed air storage, Fly wheel Energy Storage, Battery Storage-**Battery:** Specification, Charging/Discharging rate, Primary and secondary cells-Dry cell, lead acid, lithium ion, Lithium air, Nickel Cadmium, Nickel Metal Hydride

Fuel Cell: Working Principle, efficiency

Module 4

Energy Standards – International Energy Standards-ISO50001, Bureau of Energy Efficiency, star rating

Energy Management: Significance and general principles of Energy Management, Energy audit-types and procedure, Energy audit report, Instruments for energy auditing

Study of various governmental agencies related to energy conservation and management.

Module 5

Energy Economics: Traditional Types of Rates - Single-Part Rates - Two-Part Rates - Three-Part Rates – Numerical problems

Energy demand forecasting: Introduction –Forecasting using simple indicators- trend analysis- end use method - MAED Model - LEAP Model

Economic Analysis of Energy Investments - calculation of energy efficiency and payback period - Characteristics of Energy Projects - Identification of Costs and Benefits - Valuation of Costs and Benefits - Indicators of Cost-Benefit Comparison:Methods Without Time Value - Net Present Value Based Indicators - Role of Discount Rates - Internal Rate of Return – Numerical Problems

Text Books

1. A.G.Ter-Gazarian, "Energy Storage for Power Systems", Second Edition, The Institution of Engineering and Technology (IET) Publication, UK, (ISBN - 978-1-84919-219-4), 2011.
2. Barney L. Capehart, Wayne C. Turner and William J. Kennedy, "Guide to Energy Management", Seventh Edition, The Fairmont Press Inc., 2012.
3. S. Pabla, "Electric Power Systems Planning", Mac Millan India Ltd., 1998

References:

1. K.C. Kothari, D.P.Ranjan, Rakeshsingal "Renewable Energy Sources and Emerging Technology"- PHI; 2nd Revised edition (1 December 2011)
2. M.V.R. Koteswara Rao, Energy Resources: Conventional & Non-Conventional BS Publications/BSP Books (2017)
3. Albert Thumann, Scott Dunning, "EFFICIENT LIGHTING APPLICATIONS & CASE STUDIES"; The Fairmont Press, Inc. (16 April 2013)
4. "Energy Efficiency in Electrical Utilities"-Guide book for National Certificate Examination for Energy Managers and Energy Auditors : Bureau of Energy Efficiency
5. Subhes C. Bhattacharyya, "Energy Economics-Concepts, Issues, Markets and Governance," Springer, 2011
6. ISO50001

Course Contents and Lecture Schedule:

No	Topic	No. of Lectures
1	**Energy Scenario (9hours)**	
1.1	Indian and world Energy Scenario	2
1.2	Indian Energy Sector reforms	1
1.3	Energy, Environment, Energy Security	1
1.4	Green Building Standards, Industries and electrical Power System	2
1.5	Energy Conservation Act 2001 features	1
1.6	Green Building Standards	1
1.7	Types of lamps and their efficiencies	1
2	**Non-Conventional Energy Sources. (9hours)**	
2.1	Solar Thermal System, Working Principle- Solar cell efficiency Calculation	2
2.2	Solar Photovoltaic System-Working Principle	1
2.3	Wind Energy Systems-Working Principle	2

2.4	Energy From waves and Tides-Block diagram	2
2.5	Energy from Biomass and Ocean Thermal Energy Systems	2
3	**Energy Storage (9 Hours)**	
3.1	Specification, Discharging time calculation	1
3.2	Compressed air storage, Fly wheel Energy Storage, Battery Storage-Advantages	2
3.3	Primary and secondary cells-Dry cell	1
3.4	lead acid, lithium ion, Lithium air, Nickel Cadmium, Nickel Metal Hydride	3
3.5	Fuel Cells, Working Principle, efficiency calculation	2
4	**Energy Management (9 Hours)**	
4.1	International Energy Standards-ISO50001	2
4.2	Bureau of Energy Efficiency, star rating	2
4.3	Significance and general principles of Energy Management, Energy audit-types, procedure, instruments and reports	4
4.4	Study of various governmental agencies related to energy conservation and management.	1
5	**Energy Economics (9 Hours)**	
5.1	Traditional Types of Rates - Single-Part Rates - Two-Part Rates - Three-Part Rates – Numerical problems	3
5.2	Energy demand forecasting: Introduction –Forecasting using simple indicators- trend analysis- end use method - MAED Model - LEAP Model	2
5.3	Economic Analysis of Energy Investments - Characteristics of Energy Projects - Identification of Costs and Benefits - Valuation of Costs and Benefits - Indicators of Cost-Benefit Comparison:Methods Without Time Value - Net Present Value Based Indicators - Role of Discount Rates	3
5.4	Internal Rate of Return – Numerical Problems	1