INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE DESCRIPTOR

Course Title	**POWER GENERATION SYSTEMS**				
Course Code	AEE003				
Programme	B.Tech				
Semester	III	EEE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Mr. T Mahesh , Assistant Professor, EEE				
Course Faculty	Mr. T Mahesh , Assistant Professor, EEE				

I. COURSE OVERVIEW:

This course deals with conventional energy systems like thermal and nuclear power stations. This course also introduces non conventional energy systems like solar energy (radiation, collection, storage, and application), Hydro and Wind Energy.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AHS006	I	Engineering Physics	4

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Power Generation Systems	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✘	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✘	Videos
✘	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five modules and each module carries equal weight age in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz 05/Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	**Theory**		**Total Marks**
Type of Assessment	CIE Exam	Quiz/AAT	
CIA Marks	25	05	30

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 20 marks of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz - Online Examination/ATT
Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are to be answered by choosing the correct answer from a given set of choices (commonly four). Such a question paper shall be useful in testing of knowledge, skills, application, analysis, evaluation and understanding of the students. Marks shall be awarded considering the average of two quiz examinations for every course.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	1	Discussion and seminars
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	2	Discussion and seminars
PO3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	2	Discussion and seminars
PO4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	3	Discussion and seminars
PO6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	2	Discussion and seminars
PO7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	2	Discussion and seminars
PO12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	2	Discussion and seminars

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO1	Able to utilize the knowledge of high voltage engineering in collaboration with power systems in innovative, dynamic and challenging environment, for the research based team work.	-	-
PSO2	Can explore the scientific theories, ideas, methodologies and the new cutting edge technologies in renewable energy engineering, and use this erudition in their professional development and gain sufficient competence to solve the current and future energy problems universally	2	Discussion and seminars
PSO3	The understanding of technologies like PLC, PMC, process controllers, transducers and HMI one can analyze, design electrical and electronics principles to install, test , maintain power system and applications	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Demonstrate thermal power generation systems including major subsystems.
II	Illustrate hydroelectric power generation systems along with pumped storage plants.
III	Understand basic working principles of nuclear power generation systems.
IV	Apply knowledge of solar and wind power generation systems in design and implementation to obtain clean energy.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AEE003.01	CLO 1	Demonstrate the layout and working principle of thermal power plant.	PO1,PO3,PO6,PO7	2
AEE003.02	CLO 2	Analyze the principle and operation of different energy conversion systems.	PO1,PO6,PO7,PO12, PSO2	1
AEE003.03	CLO 3	Classify the various types of renewable energy sources.	PO6,PO7,PO12	1
AEE003.04	CLO 4	Compare the various hybrid energy systems in electrical system.	PO1,PO4, PO7, PO12,PSO2	4
AEE003.05	CLO 5	Use the renewable energy sources to meet the constraints in electrical and electronics engineering field.	PO1, PSO2	2
AEE003.06	CLO 6	Explain the working of hydro power plant and its importance in the power system	PO1, PO2, PO7, PO12	2
AEE003.07	CLO 7	Discuss the principles and operations of photovoltaic effect.	PO1, PO7, PO12	1
AEE003.08	CLO 8	Describe the layout and working of solar power plant in electrical systems.	PO1, PO2, PO7	2
AEE003.09	CLO 9	Build the flow chart of maximum power point tracking system.	PO1,PO2, PO3, PO4	2
AEE003.10	CLO 10	Illustrate the principle of various types of solar concentrators.	PO1, PO3	1
AEE003.11	CLO 11	Demonstrate the construction and working principle of wind energy systems.	PO1, PO2, PO3	2
AEE003.12	CLO 12	Discuss the principle and operation of induction generator in wind energy system.	PO1, PO3	2
AEE003.13	CLO 13	Demonstrate the importance of wind energy system and types of turbines.	PO1, PO2, PO7	2
AEE003.14	CLO 14	Generalize the construction and working of nuclear power plant in power systems.	PO1, PO3, PO6, PO7	2
AEE003.15	CLO 15	Illustrate the effect of non-renewable energy sources on the environment.	PO3, PO7	2
AEE003.16	CLO 16	Apply the concepts of renewable energy sources to solve real-world applications.	PO1, PO3, PO6, PO7	1
AEE003.17	CLO 17	Possess the knowledge and skills for employability and to succeed national and international level competitive examination.		

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X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	1		2			2	1								
CLO 2	1					1	2					1		1	
CLO 3												1			
CLO 4	1			2			2							2	
CLO 5	1													2	
CLO 6	1						3					1			
CLO 7	1						1					1			
CLO 8	1	2					1								
CLO 9	1	2		3										2	
CLO 10	1														
CLO 11	1	2	1												
CLO 12	1		2												
CLO 13	1	1					2								
CLO 14	1		2			2	1								
CLO 15			1				2								
CLO 16	1		1			1	2								
CLO 17															

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO1, PO2, PO4, PO6, PO7, PO12	SEE Exams	PO1, PO2, PO4, PO6, PO7, PO12	Assignments	PO4	Seminars	PO2
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	-						

XII. ASSESSMENT METHODOLOGIES - INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIII. SYLLABUS

UNIT -I	THERMAL POWER STATIONS
Thermal Power Stations: Line diagram of thermal power station, paths of coal, steam, water, air, ash and flue gasses, description of thermal power station components, economizers, boilers, super heaters, turbines, condensers, chimney and cooling towers.	
UNIT -II	**HYDROELECTRIC POWER STATIONS**
Hydroelectric Power Stations: Elements, types, concept of pumped storage plants, storage requirements, mass curve and estimation of power developed from a given catchment area, heads and efficiencies, simple problems.	
UNIT-III	**SOLAR ENERGY AND PHOTOVOLTAIC SYSTEMS**
Solar Energy: environmental impact of solar power, physics of the sun, solar constant, extraterrestrial and terrestrial solar radiation, solar radiation on tilted surface, instruments for measuring solar radiation, solar radiation data, solar concentrators, collectors, thermal applications, design of standalone solar systems, simple problems. Photovoltaic systems: Photovoltaic effect, semiconducting materials, band gap theory, photo emission of electrons, cell configuration, types of solar cells, cell properties, device physics, electrostatic field across the depletion layer, voltage developed, I-V characteristics, module structure and fabrication, output power and efficiency, fill factor, maximum power point tracking (MPPT), solar grid connected inverters, simple Problems	
UNIT-IV	**WIND ENERGY**
Wind Energy: sources and potential, power from wind, betz criterion, components of wind energy conversion system, types of turbines, horizontal and vertical axis wind turbines, aerodynamics, momentum theory (actuator disk concept), operational characteristics, blade element theory, types of generating systems for wind energy, permanent magnet generators, dc generators, induction generators, doubly fed induction generators, applications of wind energy, safety and environmental aspects, simple problems	
UNIT–V	**NUCLEAR POWER STATIONS**
Nuclear Power Stations: nuclear fission and chain reaction, nuclear fuels, principle of operation of nuclear reactor and components, types of nuclear reactors, pressurized water reactor, boiling water reactor and fast breeder reactor, radiation hazards, shielding and safety precautions, applications	
Text Books:	
1. C L Wadhawa,"Generation, Distribution and Utilization of Electrical Energy", New Age International Limited, New Delhi, 3rd Edition, 2010. 2. V.K Mehata, Rohit Mehta, "Principles Of Power Systems", 4th Edition, 2014. 3. G D Rai, "Non-Conventional Energy Sources", Khanna Publishers, 1st Edition, 2011. 4. G N Tiwari, M K Ghosal, "Fundamentals of Renewable Energy Sources", Narosa Publications, New Delhi, 1st Edition, 2007. 5. B.H Khan, "Non-conventional energy sources", Tata Mecgraw-hili, 2rd Edition, 2013. 6. Geoff Stapleton and Susan Neill"Grid Connected Solar Electric System", Earth Scan Expert series, 1st Edition,2014.	
Reference Books:	
1. J B Gupta, "A Course in Electrical Power", S K Kataria and Sons, New Delhi, 15th Edition, 2013. 2. M V Deshpande, "Elements of Power Station design", Prentice Hall India Learning Private Limited, New Delhi, 1st Edition, 1992. 3. Mukund R Patel, "Wind and Solar Power Systems", CRC Press, 1st Edition, 1999.	

XIV. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No	Topic/s to be covered	Course Learning Outcomes (CLOs)	Reference
1-2	Explain Thermal power station line diagram	CLO 1	T2 :10-13
3	Describe the function of economizer in a thermal power plant	CLO 1	T2:15
4	Compare the types of different boilers	CLO 2	T2:14
5-6	Describe the Functions of super heater and condenser	CLO 3	T2:14-15
7-8	Differentiate the Types of steam turbine with neat diagram	CLO 2	T2:12
9-11	Illustrate the operation of chimney and cooling tower	CLO 3	T2:15
12	Explain the operation of Hydroelectric Power Stations	CLO 4	T2:18-23
13-14	Identify the types of pumped storage plants	CLO 4	T2:18-22
15	Explain the importance of mass curve	CLO 4	T2:18-22
16-17	Estimate the power developed from a given catchment area	CLO 4	T2:18-22
18	Calculate the power developed in hydro power station	CLO 5	T2:23-27
19-21	Explain the importance of Different heads in hydro power station	CLO 6	T2:21-23
22	Estimate the efficiency of hydro power station	CLO 5	T2:18-25
23	List out the Various hydro power stations in India	CLO 7	T2:18-25
24	Tabulate the effects hydro power station on environment.	CLO 7	T2:18-25
25	Choose the solar energy as a renewable source	CLO 7	T3:47
26	Explain the Role and potential of Solar energy	CLO 7	T3:47
27-28	Illustrate the effect environmental impact of solar power	CLO 9	T3:47
29	Discuss the physics of the sun	CLO 9	T3:73
30-31	Understand the solar constant, extra- terrestrial and terrestrial solar radiation	CLO 9	T3:47
32	Describe the solar radiations	CLO 8	T3:49-64
33-34	Understand instruments used for measuring solar radiation and sun shine	CLO 10	T3:60-64
35	List different types of collectors	CLO 10	T3:73-123
36	Classify different concentrating collectors	CLO 11	T3:102
37	Understand the orientation and thermal analysis	CLO 11	T3:94
38-39	Discuss about the advanced collectors	CLO 10	T3:111

Lecture No	Topic/s to be covered	Course Learning Outcomes (CLOs)	Reference
40-43	Illustrate the methods of solar energy storage	CLO 12	T3:123-146
44	Understand the solar ponds	CLO 12	T3:138-145
45	Understand the Photovoltaic cell output power and efficiency and Fill factor.	CLO 12	T3:146-224
46	Discuss the solar heating/cooling technique	CLO 13	T5:182
47	Explain maximum solar radiation dragging by using maximum power point tracking (MPPT).	CLO 13	T5:182
48	Understand the photovoltaic energy conversion	CLO 13	T3:146-224
49	Explain how to connect solar system to power grid.	CLO 14	T6:217
50	Understand Potential of wind energy sources	CLO 14	T3:227
51	Classify the types of windmills	CLO 14	T3:262
52	Interpret the performance characteristics	CLO 14	T3:287
53	Understand the Betz criteria	CLO 14	T3:287
54-55	Illustrate the different schemes of electric generation and control	CLO 15	T3:292

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S. No	Description	Proposed actions	Relevance with Pos	Relevance with PSOs
1	Design of modern boilers to reduce pollution in view of environment.	Seminars / NPTEL	PO1,PO7,PO3,P08	PSO1
2	Hybrid energy conversion systems to improve overall efficiency of power stations.	Term Paper / NPTEL	PO1, PO2	PSO1,PSO2
3	Interfacing the solar system to the grid and its operation.	NPTEL / Laboratory Practices	PO1, PO2, PO5	PSO2

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