INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE DESCRIPTOR

Course Title	**ELECTRICAL POWER GENERATION SYSTEMS**				
Course Code	AEEB14				
Programme	B.Tech				
Semester	IV				
Course Type	**Core**				
Regulation	IARE - R18				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Dr.V.Chandra Jagan Mohan, Associate Professor, EEE				
Course Faculty	Dr.V.Chandra Jagan Mohan, Associate Professor, EEE Ms. T. Saritha Kumari, 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
-	-	-	-	-

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Electrical 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 20 marks for Continuous Internal Examination (CIE), 05 marks for Quiz and 05 marks for Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	**Theory**			**Total Marks**
Type of Assessment	CIE Exam	Quiz	AAT	
CIA Marks	20	05	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

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.

Alternative Assessment Tool (AAT)

This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning centre. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc.

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.	3	Seminar
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	Five Minutes Video
PO 4	**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.	2	Assignment

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills:** To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	-	-

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 2	**Modelling and Simulation Practices:** An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	2	Assignments
PSO 3	**Successful Career and Entrepreneurship:** To build the nation, by imparting technological inputs and managerial skills to become Technocrats.	2	Term Paper

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES :

The course should enable the students to:	
I	Demonstrate various conventional power generation systems including major subsystems.
II	Understand hydroelectric power generation systems along with pumped storage plants and hydraulic turbines.
III	Apply knowledge of solar and wind power generation systems in design and implementation to obtain clean energy.
IV	Illustrate the economic aspects of power generation and power tariff methods.

IX. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	Discuss the principles and operation of thermal and nuclear power plants.	CLO 1	Demonstrate the layout and working principle of thermal power plant.
		CLO 2	Analyze the principle and operation of different energy conversion systems.
		CLO 3	Discuss the principles and operations of nuclear power plant.
CO 2	Demonstration of working of hydro power plant and its importance in the power system.	CLO 4	Discuss about different types of turbines.
		CLO 5	Explain about various hydro power plants.
		CLO 6	Explain the working of hydro power plant and its importance in the power system.
CO 3	Understand the principle, operation of photovoltaic effect and layout of solar power plant.	CLO 7	Discuss the principles and operations of photovoltaic effect.
		CLO 8	Describe the layout and working of solar power plant in electrical systems.
		CLO 9	Build the flow chart of maximum power point tracking system.
CO 4	Discuss the construction and working principle of wind energy systems.	CLO 10	Demonstrate the importance of wind energy system and types of turbines.
		CLO 11	Demonstrate the construction and working principle of wind energy systems.
		CLO 12	Discuss the principle and operation of induction generator in wind energy system.

COs	Course Outcome	CLOs	Course Learning Outcome
CO 5	Understand about economic aspects of power generation.	CLO 13	Discuss about different loads and their importance.
		CLO 14	Explain about different factors which are affecting cost of generation.
		CLO 15	Demonstrate different tariffs in power systems.

X. 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
AEEB14.01	CLO 1	Demonstrate the layout and working principle of thermal power plant.	PO1,PO2	3
AEEB14.02	CLO 2	Analyze the principle and operation of different energy conversion systems.	PO1	3
AEEB14.03	CLO 3	Discuss the principles and operations of nuclear power plant.	PO1	3
AEEB14.04	CLO 4	Discuss about different types of turbines.	PO1	3
AEEB14.05	CLO 5	Explain about various hydro power plants.	PO1,PO2	3
AEEB14.06	CLO 6	Explain the working of hydro power plant and its importance in the power system.	PO1	3
AEEB14.07	CLO 7	Discuss the principles and operations of photovoltaic effect.	PO1,PO2	3
AEEB14.08	CLO 8	Describe the layout and working of solar power plant in electrical systems.	PO1	3
AEEB14.09	CLO 9	Build the flow chart of maximum power point tracking system.	PO1,PO2, PO4	3
AEEB14.10	CLO 10	Demonstrate the importance of wind energy system and types of turbines.	PO1	3
AEEB14.11	CLO 11	Demonstrate the construction and working principle of wind energy systems.	PO1	3
AEEB14.12	CLO 12	Discuss the principle and operation of induction generator in wind energy system.	PO1,PO2	3
AEEB14.13	CLO 13	Discuss about different loads and their importance.	PO1	3
AEEB14.14	CLO 14	Explain about different factors which are affecting cost of generation.	PO1,PO2	3
AEEB14.15	CLO 15	Demonstrate different tariffs in power systems.	PO1,PO2	3

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XI. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course Outcomes (COs)	Program Outcomes (POs)			Program Specific Outcomes (PSOs)	
	PO 1	PO 2	PO 4	PSO2	PSO3
CO 1	3	2			
CO 2	3	2			
CO 3	3	2	2	2	2
CO 4	3	2		2	2
CO 5	2	3			

XII. 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	3	2													
CLO 2	2	2													
CLO 3	3	1													
CLO 4	3	2													
CLO 5	3	2													
CLO 6	2	1													
CLO 7	3	2		2										2	2
CLO 8	3	2		2										1	2
CLO 9	2	1		1										2	1
CLO 10	3	2												2	2
CLO 11	2	1												1	1
CLO 12	3	2												2	2
CLO 13	2	2													
CLO 14	2	3													
CLO 15	2	3													

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XIII. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO1, PO2, PO4,PSO2, PSO3	SEE Exams	PO1, PO2, PO4,PSO2, PSO3	Assignments	PO1, PSO 2	Seminars	PO1,PSO3
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO1,PO2, PSO3						

XIV. ASSESSMENT METHODOLOGIES – INDIRECT

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

XV. SYLLABUS

MODULE-I	**CONVENTIONAL POWER GENERATION SYSTEMS**	**Classes: 09**
Thermal Power Stations: Evaluation of power systems, present day scenario, Line diagram of thermal power station (TPS) showing paths of coal, steam, water, air, ash and flue gasses; Brief description of TPS components: Economizers, boilers, super heaters, turbines, condensers, chimney and cooling towers. Nuclear power stations: Nuclear fission and chain reaction, nuclear fuels, principle of operation of nuclear reactor, reactor components, moderators, control rods, reflectors and coolants, radiation hazards, shielding and safety precautions, types of nuclear reactors and brief description of PWR, BWR and FBR; Gas power stations: Principle of operation and components (Block diagram approach only).		
MODULE-II	**HYDROELECTRIC POWER STATIONS**	**Classes: 09**
Hydroelectric Power Stations: Elements of hydro electric power station, types, concept of pumped storage plants, storage requirements, mass curve (explanation only), estimation of power developed from a given catchment area, heads and efficiencies; Hydraulic turbines: Classification of turbines, impulse and reaction turbines, Pelton wheel, Francis turbine and Kaplan turbine, working proportions, work done, efficiencies, hydraulic design, draft tube theory, functions and efficiency.		
MODULE-III	**SOLAR ENERGY**	**Classes: 09**
Solar radiation: 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.		
MODULE-IV	**WIND ENERGY**	**Classes: 09**
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, 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.		
MODULE-V	**ECONOMIC ASPECTS OF POWER GENERATION**	**Classes: 09**
Terms commonly used in system operation, various factors affecting cost of generations; load curves, connected load, maximum demand, peak load, base load and peak load power plants, load factors, plant capacity factor, plant use factor, demand factors, diversity factor, cost of power plant, tariffs.		

Text Books:
1. C L Wadhawa, "Generation, Distribution and Utilization of Electrical Energy", New Age International Limited, New Delhi, 3rd Edition,2005 2. G D Rai, "Non-Conventional Energy Sources", Khanna Publishers, 1st Edition, 2011. 3. G N Tiwari, M K Ghosal, "Fundamentals of Renewable Energy Sources", Narosa Publications, New Delhi, 1st Edition, 2007. 4. Chetan Singh Solanki, "Solar Photovoltaics", PHI Publications, 2nd Edition, 2011. 5. M L Soni, P V Gupta, U S Bhatnagar and A Chakraborti, "A text book on Power system engineering", Dhanpat Rai and Co. Pvt. Ltd, 1999.
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 Learning Private Limited New Delhi, 1st Edition, 1992. 3. Mukund R Patel, "Wind and Solar Power Systems", CRC Press, 1st Edition, 1999. 4. V K Mehta and Rohit Mehta, "Principle of Power Systems", S Chand & Company, Ltd, New Delhi, 3rd Edition,2005.

XVI. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Evaluation of power systems, present day scenario	CLO 2	T2: 1.2-1.8 R2:1.1
2-3	Line diagram of thermal power station (TPS) showing paths of coal, steam, water, air, ash and flue gasses	CLO 1	T2: 1.9 R2:1.5
4-5	Brief description of TPS components: Economizers, boilers, super heaters, turbines, condensers, chimney and cooling towers	CLO 1	T2:1.10 R2:1.2&1.4
6	Problems	CLO 1	T2: 2.3-2.5 R2:1.6
7	Nuclear fission and chain reaction, nuclear fuels, principle of operation of nuclear reactor	CLO 3	T2: 1.12 R2:1.14
8	Reactor components, moderators, control rods, reflectors and coolants, radiation hazards, shielding and safety precautions	CLO 3	T2: 2.6 R2:1.7&1.8
9-10	Types of nuclear reactors and brief description of PWR, BWR and FBR	CLO 3	T2: 2.7 R2:1.12
11	Gas power stations: Principle of operation and components (Block diagram approach only)	CLO 3	T2: 2.6 R2:1.7&1.8
12	Elements of hydro electric power station	CLO 4	T2: 1.11 R2:6.2
13	Types, concept of pumped storage plants	CLO 4	T2: 10.4 R2:4.0
14	Storage requirements, mass curve (explanation only)	CLO 4	T2: 10.5.1.1 R2:4.0
15-16	Estimation of power developed from a given catchment area, heads and efficiencies	CLO 5	T2: 10.5.1.3 R2:4.0
17	Hydraulic turbines: Classification of turbines, impulse and reaction turbines	CLO 5	T2: 7.1 R2:5.2
18	Pelton wheel, Francis turbine and Kaplan turbine	CLO 6	T2: 7.6 R2:5.3
19-20	Working proportions, work done, efficiencies	CLO 6	T2: 7.2 R2:5.4
21	Hydraulic design, draft tube theory, functions and efficiency	CLO 6	T2: 7.6.1 R2:5.7

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
22	Environmental impact of solar power, physics of the sun, solar constant, extraterrestrial and terrestrial solar radiation	CLO 7	T2: 7.6.3 R2:5.10,5.11,
23-24	Solar radiation on tilted surface, instruments for measuring solar radiation	CLO 7	T2: 7.7 R2:5.16
25-26	Solar concentrators, collectors, thermal applications	CLO 7	T2: 7.7.6 R2:5.21,5.22
27	Design of standalone solar systems	CLO 8	T2:7.7.5 R2:5.20
28	Simple problems	CLO 8	T2: 4.1 R2:2.1
30	Photovoltaic effect, semiconducting materials, band gap theory	CLO 8	T:4.5-4.6 R2:2.2
31-32	Photo emission of electrons, cell configuration, types of solar cells	CLO 8	T2: 5.2.4.1 R2:3.2
33	Cell properties, device physics, electrostatic field across the depletion layer	CLO 9	T2: 6.5 R2:602
34	Voltage developed, I-V characteristics, module structure and fabrication	CLO 9	T2: 6.6.1 R2:6.6
35	Output power and efficiency	CLO 9	T2: 6.9-6.10 R2:6.13&6.15
36	Fill factor, maximum power point tracking (MPPT), solar grid connected inverters	CLO 9	T2: 9.3 R2:7.2
37	Simple Problems	CLO 9	T2: 9.3.1 R2:7.8
38	Sources and potential, power from wind, Betz criterion	CLO 10	T2: 8.4 R2:7.11
39	Components of wind energy conversion system, types of turbines	CLO 10	T2: 8.4 R2:7.13
40	Horizontal and vertical axis wind turbines, aerodynamics, operational characteristics	CLO 10	T2: 8.8 R2:7.16
41-42	Blade element theory, types of generating systems for wind energy	CLO 11	T2: 8.8 R2:7.21
43-44	Permanent magnet generators, DC generator	CLO 11	T4: 4.11 R2:8.1
45-46	Induction generators, doubly fed induction generators	CLO 11	T4: 4.23 R2:8.8,8.17
47-48	Applications of wind energy, safety and environmental aspects	CLO 12	T4: 4.19,5.2 R2:8.22.5
49-50	Simple Problems	CLO 12	T4: 4.23 R2:8.23
51-52	Terms commonly used in system operation, various factors affecting cost of generations	CLO 13	T4: 6.4-6.5 R2:9.1
53-54	Load curves, connected load, maximum demand, peak load	CLO 13	T4: 6.6 R2:9.21,9.22,
55-56	Base load and peak load power plants, load factors	CLO 14	T4: 6.3 R2:9.3
57-58	Plant capacity factor, plant use factor, demand factors, diversity factor, cost of power plant	CLO 14	T4: 6.7 R2:9.5
59-60	Tariffs	CLO 15	T4: 6.6 R2:9.7

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

S. no	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	To improve power quality standards and analyze the concepts.	Guest lectures	PO2	PSO2
2	Facilitating the integration of new clean generation technologies	Seminar/ NPTEL	PO1	PSO3
3	Different methods to improve the efficiency and cost-effectiveness of solar cells	NPTEL	PO1	PSO3

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