INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043

ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE DESCRIPTOR

Course Title	**POWER PLANT CONTROL AND INSTRUMENTATION**				
Course Code	AEE516				
Programme	B.Tech				
Semester	VI	EEE			
Course Type	Professional Elective/Accelerate Course				
Regulation	IARE - R16				
Course Structure	Theory			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	Mr.P Shivakumar, Assistant Professor, EEE				
Course Faculty	Mr.P Shivakumar, Assistant Professor, EEE				

I. COURSEOVERVIEW:

The course focuses on electric power generation concepts. In addition to the power generation technologies adopted to generate electric power, power plant instrumentation is also included. The various control techniques adopted in power plants are discussed. The course would provide an insight to the students who want to pursue research in power plant engineering.

II. COURSEPRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
UG	AEE003	III	Power Generation Systems
UG	AEE008	IV	Electrical Measurements and Instrumentation

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Power Plant Control and Instrumentation	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONALMETHODOLOGIES:

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

V. EVALUATIONMETHODOLOGY:

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 units and each unit carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each unit. 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/ 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 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five 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 / Alternative Assessment Tool (AAT):

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are be answered by choosing the correct answer from a given set of choices (commonly four). Marks shall be awarded considering the average of two quizzes for every course. The AAT may include seminars, assignments, term paper, open ended experiments, five minutes video and MOOCs.

VI. HOW PROGRAM OUTCOMES AREASSESSED:

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.	2	Assignment and 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	Assignment and Seminar
PO 3	**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.	3	Assignment and Seminar
PO 7	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	3	Assignment and Seminar

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES AREASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO1	**Problem Solving**: Exploit the knowledge of high voltage engineering in collaboration with power systems in innovative, dynamic and challenging environment, for the research based team work.	-	-
PSO2	**Professional Skills:** Identify 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.	3	Assignment and Seminar
PSO3	**Modern Tools in Electrical Engineering:** Comprehend the technologies like PLC, PMC, process controllers, transducers and HMI and design, install, test, maintain power systems and industrial applications.	2	Assignment and Seminar

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Assess different methods of power generation.
II	Discuss measurement of electrical and non-electrical parameters involved in power generation plants.
III	Illustrate the different types of devices used for data acquisition and analyze in power plants.
IV	Describe control system and control loops applied in power plants.
V	Integrate monitoring of different parameters like speed, vibration of turbines and their control.

IX. COURSE OUTCOMES(COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	Knowledge of the available sources of energy for electricity generation along with the working principle of the different power plants and cogeneration.	CLO 1	Describe power generation from non-renewable and renewable sources: Thermal, Hydel, nuclear, solar and wind power plants.
		CLO 2	Examine the importance of instrumentation in power generation.
		CLO 3	Interpret the importance of cogeneration in power production.
CO 2	Describe the measurement of electrical parameters and non-electrical parameters.	CLO 4	Discuss the measurement of electrical quantities.
		CLO 5	Discuss the measurement of non-electrical quantities.
		CLO 6	Recognize the environment related factors such as radiation, smoke and dust.
CO 3	Determine the importance of analyzers in power plants.	CLO 7	Examine the concept of gas analyzer.
		CLO 8	Analyze the pH meter and fuel analyzer.
		CLO 9	Illustrate the pollution monitoring instruments.
CO 4	Educate on boiler and advanced boiler control techniques.	CLO 10	Discuss the combustion control.
		CLO 11	Summarize the various methods available for steam temperature control.
		CLO 12	Evaluate the effect of distributed control and interlocks in boiler.
CO 5	Discuss the turbine control techniques and cooling methods.	CLO 13	Analyze the steam pressure control and lubricant oil, temperature control.
		CLO 14	Explore the methods of turbine control.
		CLO 15	Discuss the different methods of cooling 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
AEE516.01	CLO 1	Describe power generation from non-renewable and renewable sources: Thermal, Hydel, nuclear, solar and wind power plants.	PO1, PO2, PO3, PO7	3
AEE516.02	CLO 2	Examine the importance of instrumentation in power generation.	PO1, PO2	3
AEE516.03	CLO 3	Interpret the importance of cogeneration in power production.	PO1, PO2, PO7	2
AEE516.04	CLO 4	Discuss the measurement of electrical quantities.	PO1, PO2	3
AEE516.05	CLO 5	Discuss the measurement of non-electrical quantities.	PO1,PO2	3
AEE516.06	CLO 6	Recognize the environment related factors such as radiation, smoke and dust.	PO1, PO2, PO7	2
AEE516.07	CLO 7	Examine the concept of gas analyzer.	PO1, PO2	3
AEE516.08	CLO 8	Analyze the pH meter and fuel analyzer.	PO1, PO2	3
AEE516.09	CLO 9	Illustrate the pollution monitoring instruments.	PO1, PO2, PO7	2

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AEE516.10	CLO 10	Discuss the combustion control.	PO1, PO2, PO3	2
AEE516.11	CLO 11	Summarize the various methods available for steam temperature control.	PO1,PO2, PO3	2
AEE516.12	CLO 12	Evaluate the effect of distributed control and interlocks in boiler.	PO1, PO2, PO3	2
AEE516.13	CLO 13	Analyze the steam pressure control and lubricant oil, temperature control.	PO1, PO2, PO3	2
AEE516.14	CLO 14	Explore the methods of turbine control.	PO1, PO2, PO3	2
AEE516.15	CLO 15	Discuss the different methods of cooling systems.	PO1, PO2, PO3	2
AEE516.16	CLO 16	Apply the concepts of non-renewable and renewable generation, measurements and control in power plants to solve real world applications.	PO1, PO2, PO3, PO7	2
AEE516.17	CLO 17	Explore the knowledge and skills of employability to succeed in national and international level competitive examinations.	PO1,PO2	2

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

Course Outcomes (COs)	Program Outcomes (POs)					
	PO1	PO 2	PO 3	PO 7	PSO2	PSO3
CO 1	2	3		2	3	3
CO 2	2	3	3			2
CO 3	2	3	3			2
CO 4	2	2	3			
CO 5	2	2	3			

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XII. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFICOUTCOMES:

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	3	3				2							3	
CLO 2	2	3													3
CLO 3	2	2					2								
CLO 4	2	3													

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

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XIII. ASSESSMENT METHODOLOGIES –DIRECT

CIE Exams	PO1,PO2 PO3,PO7 PSO2, PSO3	SEE Exams	PO1,PO2, PO3,PO7 PSO2, PSO3	Assignments	PO1,PO2 PO3,PO7 PSO2, PSO3	Seminars	PO1,PO, PO3,PO7 PSO2, PSO3
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	-						

XIV. ASSESSMENT METHODOLOGIES –INDIRECT

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

XV. SYLLABUS

UNIT - I	OVERVIEW OF POWER GENERATION
Brief survey of methods of power generation, hydro, thermal, nuclear, solar and wind power, importance of instrumentation in power generation, thermal power plants, block diagram, details of boiler processes, Piping and Instrumentation diagram of boiler, cogeneration.	
UNIT - II	MEASUREMENTS IN POWER PLANTS

Electrical measurements, current, voltage, power, frequency, power factor, etc, non-electrical parameters, flow of feed water, fuel, air and steam with correction factor for temperature, steam pressure and steam temperature, drum level measurement, radiation detector, smoke density measurement, dust monitor.
UNIT - III ANALYSERS IN POWER PLANTS
Flue gas oxygen analyzer: Analysis of impurities in feed water and steam, dissolved oxygen analyzer, Chromatography, pH meter, fuel analyzer, pollution monitoring instruments.
UNIT - IV CONTROL LOOPS IN BOILER
Combustion control, air / fuel ratio control, furnace draft control, drum level control, main steam and reheat steam temperature control, super heater control, air temperature, distributed control system in power plants, interlocks in boiler operation.
UNIT - V TURBINE MONITORING AND CONTROL
Speed, vibration, shell temperature monitoring and control, steam pressure control, lubricant oil temperature control, cooling system.
Text Books:
1. Sam G. Dukelow, 'The Control of Boilers', Instrument Society of America, 2nd Edition,2010. 2. P.K. Nag, 'Power Plant Engineering', Tata McGraw-Hill, 1st Edition,2001.
Reference Books:
1. S.M. Elonka and A.L. Kohal, "Standard Boiler Operations", Tata McGraw-Hill, 1st Edition,1994. 2. R K Jain, "Mechanical and Industrial Measurements", Khanna Publishers, 1st Edition,1995. 3. E Al Wakil, "Power Plant Engineering", Tata McGraw-Hill, 1st Edition,1984.

XVI. COURSE PLAN:

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

Lecture No.	Topics to be covered	CLOs	Reference
1-3	Overview of the generation scenario, explain the non-renewable sources of electric power generation and the technologies available to generate them.	CLO 1	T2:2.1
4-5	Explain the concept of electric power generation from renewable sources.	CLO 1	T2:9,T2:10
6-7	Piping and Instrumentation in power generation systems.	CLO 2	R2:11.1
8-9	Explain the construction and working principle of thermal power plants.	CLO 1	R2:3.4
10-11	Detail the boiler operation and types of boiler processes available.	CLO 1	T1:2.1
12	Discuss in detail the concept of cogeneration.	CLO 3	T2:3.1
13	Measurement of electrical quantities like voltage, current, power, frequency and power factor.	CLO 4	R2:3.2
14-15	Measurement of non-electrical quantities like flow of feed water, fuel and air.	CLO 5	T1:13
16-17	Measurement of non-electrical quantities like steam, temperature, pressure, radiation, smoke and dust.	CLO 5	R2:11.3
18	Measurement of non-electrical quantities like radiation, smoke and dust.	CLO 6	R2:11.3
19-20	Examine flue gas oxygen analyzer.	CLO 7	R2: 11.8
21-22	Outline the method of chromatography.	CLO 7	R2: 11.9
23-24	Explain the concept of fuel analyzer and pH meter.	CLO 8	R2:11.7
25-26	Illustrate the pollution monitoring instruments.	CLO 9	R2:11.12.2

Lecture No.	Topics to be covered	CLOs	Reference
27-28	Describe the boiler operation and explain combustion control, air/fuel control, furnace draft control.	CLO 10	T1:5 T1:15 T1:16
29-31	Explain the control of drum level, main steam and reheat steam temperature.	CLO 11	T1:10
32-33	Explain super heater control, air temperature control.	CLO 12	T1:10.2
34-35	Explain distributed control system in power plants, interlocks in boiler operation.	CLO 13	T1:11
36-38	Describe the turbine operation to control the speed, vibration and shell temperature.	CLO 14	T1:9.6
39-41	Describe the turbine operation to control the steam pressure, lubrication oil and temperature.	CLO 14	T2:7
42-43	Detail the different cooling systems available.	CLO 15	T2:8.6

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

S No	Description	Proposed Actions	Relevance With POs	Relevance With PSOs
1	Power generation from fuel cells	Seminars / NPTEL	PO1, PO2	PSO2

Prepared by:

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