Program Name : **Diploma in Mechanical Engineering**

Program Code : **ME**

Semester : **Fifth**

Course Title : **Power Plant Engineering (Elective)**

Course Code : **22566**

1. RATIONALE

Electrical power is the main resource for any type of industry. Economic growth of the nation essentially results into growth in power sector. Various conventional power plants such as Hydro, Steam, Gas, Diesel, Nuclear power plants are employed for power generation. Most of the power plants use mechanical engineering equipment and components. Hence, this course attempts to provide the basic knowledge of the components, operation and maintenance of power plants to the students and would also acquaint them with the latest technological advances taking place in this sector.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Maintain power generation systems related to mechanical engineering.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a. Identify various components of Hydro, Steam, Gas, Diesel power plants.
b. Select high pressure Boiler for power generation capacity of plants.
c. Identify components of Steam, Diesel and Gas turbine power plants.
d. Measure waste heat recovery in a typical thermal power plants.
e. Identify components of Nuclear power plants.
f. Estimate economic parameters of power plants.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory							Practical				
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **ESE** - End Semester Examination; **PA** - Progressive Assessment*

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the

course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

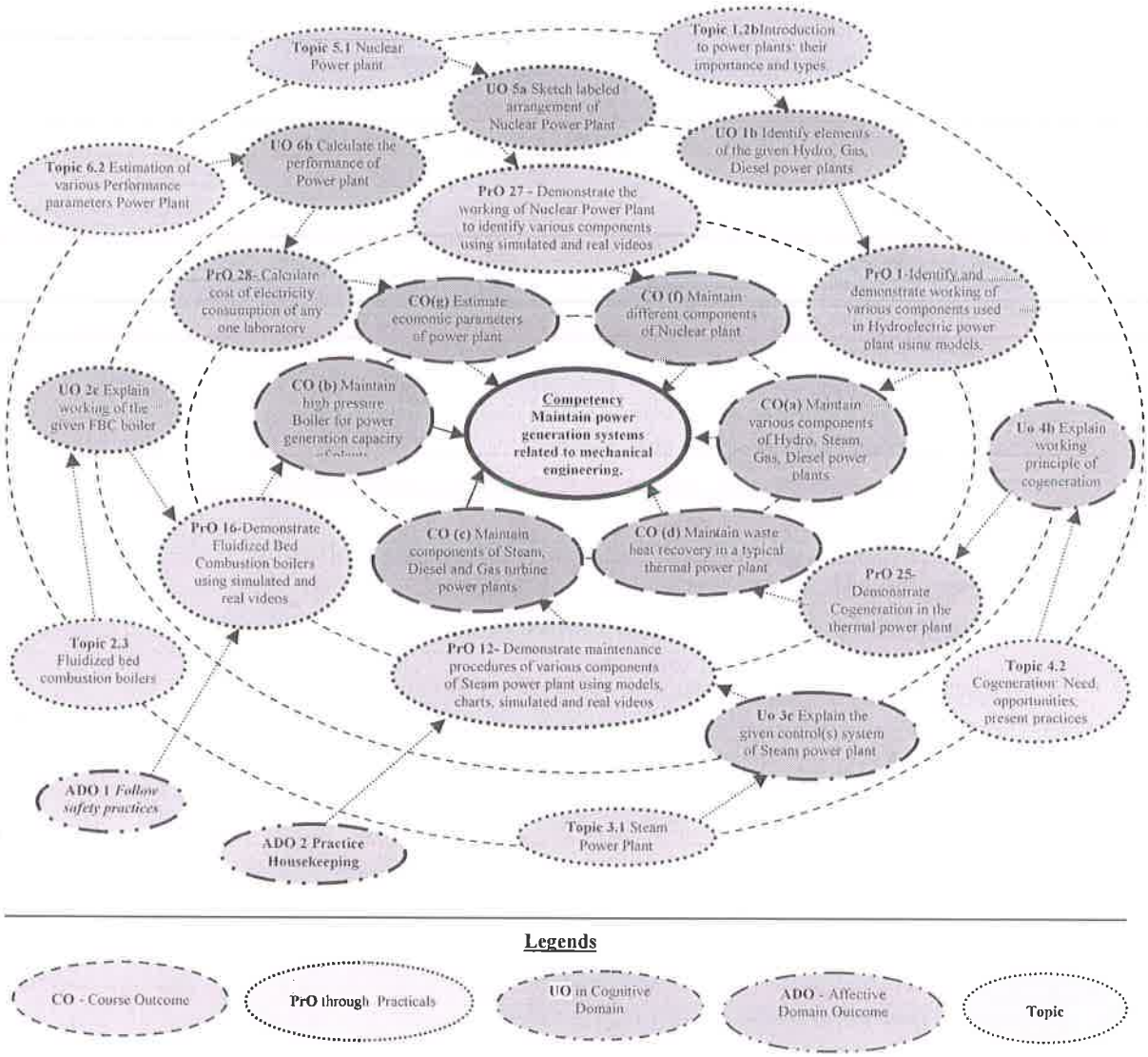

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency:

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Identify various components used in Hydroelectric power plant using models, charts, simulated and real videos.	I	02*
2	Maintain various components of Hydroelectric power plant using models, charts, simulated and real videos.	I	02
3	Identify various components used in Gas turbine power plant using models, charts, simulated and real videos.	I	02
4	Identify various components used in Gas turbine power plant using models, charts, simulated and real videos.	I	02
5	Maintain Fuel nozzles, Liners, Spark plugs, Flex hoses, Check valves etc. component of Gas turbine power plant	I	02*
6	Identify and demonstrate working of various components used in	I	02

	Diesel engine power plant using models, charts, simulated and real videos.		
7	Identify various components used in Diesel engine power plant using models, charts, simulated and real videos.	I	02
8	Maintain component like Diesel engine, Air filters, Super chargers, Engine starting system, Fuel system, Lubrication system, Cooling system, Governing system etc.of Diesel engine power plant	I	02*
9	Identify various components used in Diesel generating set using models, charts, simulated and real videos.	I	02
10	Maintain a typical small size Diesel generating set used in houses or shops	I	02*
11	Identify various components used in Steam power plant using models, charts, simulated and real videos.	III	02*
12	Maintain condenser, economizer etc. components of Steam power plant.	III	02*
13	Maintain working of any two types of High pressure Boilers using models, charts, simulated and real videos on High pressure Boilers.	II	02*
14	Maintain Fluidized Bed Combustion boilers using models, charts, simulated and real videos.	II	02*
15	Maintain the working of electro static precipitators using model, charts, simulated and real videos.	II	02
16	Maintain temperature and feed water control system using model, charts, simulated and real videos.	II	02*
17	Prepare model diagram of steam power plant by selecting various components for a given load. (Part-I)	III	02
18	Prepare model diagram of steam power plant by selecting various components for a given load. (Part-II)	III	02
19	Develop maintenance procedure for preventive and predictive maintenance of a typical Hydro Power Plant and its components.	I	02
20	Develop maintenance procedure for preventive and predictive maintenance of a typical Diesel power plant and its components.	I	02*
21	Develop maintenance procedure for preventive and predictive maintenance of typical FBC boilers and its components.	II	02*
22	Develop maintenance procedure for preventive and predictive maintenance of a typical High-pressure boiler and its components	II	02
23	Develop maintenance procedure for preventive and predictive maintenance of a typical Steam Power Plant and its components.	III	02*
24	Develop maintenance procedure for preventive and predictive maintenance of a typical Gas Power Plant and its components.	III	02
25	Demonstrate the concept of Cogeneration in the given thermal power plant using model, charts, simulated and real videos.	IV	02*
26	Maintain Trigeneration in the given thermal power plant using model, charts, simulated and real videos.	IV	02
27	Maintain the working of Nuclear Power Plant to identify various components using models, charts, simulated and real videos.	V	02*
28	Calculate cost of electricity consumption of any one Laboratory. (Part-I)	VI	02*
29	Calculate cost of electricity consumption of any one Laboratory. (Part-II)	VI	02*
	Total		32

Note

i. A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical needs to be performed, out of which, the practicals marked as '' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:

S.No.	Performance Indicators	Weightage in %
a.	Arrangement of available equipment / test rig or model	20
b.	Setting and operation	20
c.	Safety measures	10
d.	Observations and Recording	10
e.	Interpretation of result and Conclusion	20
f.	Answer to sample questions	10
g.	Submission of report in time	10
Total		**100**

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

a. Follow safety practices.
b. Practice good housekeeping.
c. Practice energy conservation.
d. Demonstrate working as a leader/a team member.
e. Follow ethical Practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of practicals, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Working Model of Hydro power plant- Small Turbine (capacity-0.25KW),lighting system as a load (min.10 bulbs of various capacity)	01
2	Model of gas power plant including all major components	02
3	Fuel nozzles, Liners, Spark plugs, Flex hoses, Check valves etc. component of Gas turbine power plant	04
4	5 KVA Diesel Generating set.	11
5	Working model of Steam Power plant- oil fired Boiler (min Capacity-0.5KW), Reaction steam Turbine, Surface Condenser, generator, power distribution system to power bank.	04,08,12

S. No.	Equipment Name with Broad Specifications	PrO. No.
6	Condenser, economizer etc. components of Steam power plant.	14
7	Working model of Loffler Boiler	05,12
8	Working model of Benson Boiler	05,12
9	Working model of Electro static Precipitator	07,12
10	Model of FBC Boiler	06,12
11	Working model of Feed water control system	04,08,12
12	Temperature sensor and temperature sensing system	04,08,12
13	Model of Nuclear Power plant	09
14	AxCYCLE Software:Thermodynamic Simulation Software for heat balance calculations of heat production and energy conversion cycles.	All

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit– I Introduction to Power Plants	1a. Explain energy conversion in the given power plant. 1b. Identify elements of the given Hydro, Gas, Diesel power plant(s). 1c. Explain preventive procedure of the given power plants. 1d. Explain predictive maintenance procedure of the given power plants.	1.1 World and national scenario of demand and supply of energy. 1.2 Introduction to power plants: their importance and types. 1.3 Hydroelectric power plant: Classification, General arrangement, operating principle, advantages and limitations, Maintenance. 1.4 Diesel power plant: Introduction, components, advantages and limitations, Diesel generating set, Maintenance.
Unit– II High Pressure Boilers	2a. Explain with sketches of the working of the given type of boiler 2b. Compare the salient features of the given types of high pressure boilers. 2c. Explain Preventive maintenance of the given High pressure boilers. 2d. Explain Predictive maintenance of the given High pressure boilers.	2.1 High Pressure Boilers – Classification. 2.2 Construction and principle of working of Lamont boiler, Benson boiler, Loeffler boiler, Velox boiler, Schmidt Hartman boiler, Ramsin boiler 2.3 Fluidized bed combustion boilers (FBC): principle, need, types, various arrangement, control system and advantages over other boiler systems. 2.4 Comparison of various types of boilers 2.5 Indian Boiler Regulation Act 2.6 Maintenance procedure of major components of high pressure and FBC boilers
Unit-III Steam and Gas Power Plants	3a. Explain with sketches the given Fuel handling system. 3b. Identify various elements of the given Steam power plant and its control system. 3c. Explain with sketches the given control(s) system of	**Steam Power Plants** 3.1 Steam power plant: Introduction, components, advantages and limitations 3.2 Fuel handling systems in power plants: types, components 3.3 Electro-Static Precipitators 3.4 Control systems of power plant –

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	Steam power plant. 3d. Identify the given Component(s) of Gas Power Plant. 3e. Explain preventive maintenance of the given major component of given turbine power plants. 3f. Explain predictive maintenance of the given major component of given turbine power plants	Elements, Types, desirable characteristics. 3.5 Steam temperature control and feed water control systems. 3.6 Maintenance procedure of major components of Steam power plant. **Gas Turbine Power Plants** 3.7 Open and close cycle with constant pressure gas turbine power plant 3.8 Components of gas turbine power plant 3.9 Methods to improve the thermal efficiency of a simple open cycle constant pressure gas turbine power plan 3.10 Advantages of gas turbine power plant over others. 3.11 Maintenance procedure of major components of Gas turbine power plants.
Unit –IV Waste Heat Recovery, Cogeneration and Trigeneration	4a. Explain the need of waste heat recovery of the given thermal power plants. 4b. Explain with sketches working principle of cogeneration and trigeneration in the given thermal power plant.	4.1 Waste heat recovery in thermal power plants: Need, opportunities, present practices 4.2 Cogeneration: Need, opportunities, present practices 4.3 Trigeneration: Need, opportunities, present practices
Unit-V Nuclear Power Plants	5a. Sketch labeled arrangement of the given nuclear power plant. 5b. Explain with sketches working of the given reactors. 5c. Compare the calorific values of the given types of fuels. 5d. Interpret the regulations for nuclear power plants.	5.1 Nuclear power plant: Classification, General arrangement, operating principles 5.2 Nuclear Fuels and Reactors 5.3 Advantages and limitations 5.4 Introduction to regulating agencies and regulations: Atomic Energy Regulatory Board (AERB), International Atomic Energy Agency (IAEA)
Unit-VI Economic Analysis of Power Plants.	6a. Estimate Cost of Electricity in the given situation using simple numerical problems. 6b. Calculate performance parameters for the given power plant using simple numerical problems.	6.1 Estimation of production cost of electrical energy in various types of power plants. 6.2 Estimation of various Performance parameters. 6.3 Factors affecting choice of a power plant.

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to Power plants	08	02	04	06	12
II	High Pressure Boilers	08	02	04	06	12
III	Steam and Gas Power Plants	10	02	04	08	14
IV	Waste Heat Recovery, Cogeneration and Trigeneration	06	02	02	04	08
V	Nuclear Power Plants	08	02	04	06	12
VI	Economic Analysis of Power Plants	08	02	04	06	12
Total		48	**12**	**22**	**36**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
Note*: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a) Prepare journal based on practical performed in Power Plant Engineering laboratory. Journal consists of drawing, observations, required equipment, date of performance with teacher signature.
b) Prepare/Download the specifications of followings:
   i. Power plant equipment.
   ii. Steam power plant equipment and elements.
   iii. Gas turbine power plant equipment and elements.
   iv. Hydro power plant equipment and elements.
   v. Diesel power plant equipment and elements.
c) Visit to any Power plant and prepare a report consisting of
   i. Various advanced systems
   ii. Various standards
   iii. Maintenance of components of power plant observed.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c) About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d) With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.

e) Guide student(s) in undertaking micro-projects.
f) Correlate subtopics with power plant system and equipments.
g) Use proper equivalent analogy to explain different concepts.
h) Use Flash/Animations to explain various components, operation and maintenance of power plants.
i) Before starting practical, teacher should demonstrate the working of power plant.
j) Instructions to students regarding care and maintenance of measuring equipments.
k) Show video/animation films to explain functioning of various power plants
l) Teacher should ask the students to go through instruction and Technical manuals

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects is given here. Similar micro-projects could be added by the concerned faculty:

a) Collection of information of control systems of power plant.
b) Collection of information about nearby cogeneration plant.
c) Comparative study of various parameters of performance evaluation of a power plant.
d) Measure operating parameters of Boiler using appropriate instruments.
e) Maintenance of a diesel generator set (DG set).
f) Collect information regarding preventive, predictive and breakdown maintenance of various power plants.
g) Develop maintenance procedure for preventive and predictive maintenance of a typical Hydro Power Plant and its components.
h) Develop maintenance procedure for preventive and predictive maintenance of a typical Diesel power plant and its components.
i) Develop maintenance procedure for preventive and predictive maintenance of typical FBC boilers and its components.
j) Develop maintenance procedure for preventive and predictive maintenance of a typical High-pressure boiler and its components
k) Develop maintenance procedure for preventive and predictive maintenance of a typical Steam Power Plant and its components.
l) Develop maintenance procedure for preventive and predictive maintenance of a typical Gas Power Plant and its components.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Power Plant Engineering	Nag, P. K.	Tata McGraw Hill India, 2007 ISBN: 9789339204044
2	Power Plant Technology	El-Wakil M. M.	McGraw Hill Education, (India).

S. No.	Title of Book	Author	Publication
			2010 ISBN: 9780070702448
3	Power Plant Engineering	Raja, A. K.	Prentice Hall, 2006 ISBN : 9788122418316
4	A Text Book of Power Plant Engineering	Sharma, P. C. and Nagpal	McGraw Hill Education, (India) ISBN : 9789350143841
5	Steam and Gas Turbine and Power plant Engineering	Yadav, R	Central Publication house ISBN : 9788185444352

14. SOFTWARE/LEARNING WEBSITES

a. https://www.youtube.com/watch?v=-hooifWJ1jY
b. https://www.youtube.com/watch?v=Uhjhufhg3Xk
c. https://www.youtube.com/watch?v=_UwexvaCMWA
d. https://www.youtube.com/watch?v=_AdA5d_8Hm
e. https://www.youtube.com/watch?v=ChvI2v85fsU
f. https://www.youtube.com/watch?v=IdPTuwKEfmA
g. https://www.youtube.com/watch?v=XjbczcFNrNU
h. https://www.youtube.com/watch?v=0rsPFdkwR0
i. https://www.youtube.com/watch?v=gDVukHOxURc
j. https://www.youtube.com/watch?v=02p5AKP6W0Q
k. https://www.youtube.com/watch?v=FXBqvLWxbr0
l. https://www.youtube.com/watch?v=dCPfHifMbOk
m. https://www.youtube.com/watch?v=b6-n0pFu5d4
n. https://www.youtube.com/watch?v=iUXHzYLgrB0
o. https://www.youtube.com/watch?v=ZssGiY6rfYE
p. https://www.youtube.com/watch?v=F01AFJe2j2A
q. https://www.youtube.com/watch?v=c6wDRQMD-YE
r. https://www.youtube.com/watch?v=ks-G4FYVtg
s. https://www.youtube.com/watch?v=H6EClYcfXKw
t. https://www.youtube.com/watch?v=KmYbupS4u-k
u. https://www.youtube.com/watch?v=rEJKiUYjW1E
v. https://arupatan.in/info/959/coal_mill_operation_power_plant/
w. https://www.youtube.com/watch?v=KmYbupS4u-k