GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2023 (COGC-2023)

Semester-VI

Course Title: Power Plant Engineering

(Course Code: 4361905)

Diploma program in which this course is offered	Semester in which offered
Mechanical Engineering	6th Semester

1. RATIONALE

Availability of power is the one key area where most of the Indian industry is facing problems. In India, even today, short fall of power generation is about 30 percent. Fuel supply and distribution is also an area where country is still developing smooth lines of supply. Since power and energy is required by every sector of economy, the growth in this sector is must if Indian economy grows in any sector. Many of the job opportunity in private as well as public sector are therefore waiting for students in this field. Hence, this course attempts to provide them basic knowledge of the technologies available at plant level and would also acquaint them with the latest technological advances taking place in this sector.

2. COMPETENCY

The course content should be taught and implemented to develop different skills so that students can acquire the following competency.

- **Apply knowledge of mechanical engineering related to power generation systems, their control and economics in different type of power plants for their operation and maintenance.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge, and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

CO-1	Outline factors affecting the power plants by analyzing its economy.
CO-2	Interpret layout of coal-based power plant and its components.
CO-3	Identify elements and their functions of Diesel, gas turbine, nuclear and hydro power plant.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	2	4	30*	70	25	25	150

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

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

5. SUGGESTED PRACTICAL EXERCISES

Following Practical Outcomes (PrOs) are the sub-components of the Course Outcomes (COs). Some **POs** marked **'*'** are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to the 'Psychomotor Domain'.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
01	Demonstrate various energy conversion Systems in different types of power plants. *	I	04
02	Calculate the cost of power for given data of power station. *	II	02
03	Calculate the Tariff of electric energy for (i) domestic (urban) usage, (ii) Tariff for electric energy, (iii) Industrial usages, and (iv) agriculture usage from given data.	II	04
04	Demonstrate various circuits of modern coal-based thermal power plants. *	II	04
05	Demonstrate various high-pressure boilers. *	II	04
06	Demonstrate coil fired boiler furnaces.	II	02
07	Demonstrate major components of the Diesel power plant. *	III	02
08	Demonstrate major components of nuclear power plants. *	IV	02
09	Demonstrate CANDU nuclear reactor. *	IV	02
10	Demonstrate major components of hydroelectric power plant. *	V	02
Total (Hours)		**-**	**28**

Note:

I. More **Practical Exercises** can be designed and offered by the concerned course teacher to develop the industry-relevant skills/outcomes to match the COs. The above table is only a representative list**.**

II. Care must be taken in assigning and assessing the study report as it is a Third-year study report. The study report, data collection, and analysis report must be assigned to a group. A teacher has to discuss the type of data before the group starts their market survey.

The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above-listed **Practical Exercises** of this course required,

which are embedded in the COs and, ultimately, the competency.

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
For Demonstration type PrOs (PrOs Number: 1, 4, 5, 6, 7, 8, 9 & 10)		
1	Knowledge	30
2	Quality of Report	30
3	Participation	20
4	Punctuality	20
Total		**100**
Calculation/ performance type PrOs (PrOs Number: 2 & 3)		
1	Knowledge	20
2	Procedure follows	15
3	Observation Skill	20
4	Analysis	10
5	Quality of Report	20
6	Punctuality	15
Total		**100**

Sample rubrics Performance Indicators for the PrOs

Demonstration type PrOs (PrOs Number: 1, 4, 5, 6, 7, 8, 9 & 10)					
Criteria	**%**	**10**	**9-8**	**7-6**	**5**
Knowledge	30%	Students give the correct answers 90% or more.	Student give the correct answers between 70-89%.	Student give the correct answers between 50-69%.	Student give the correct answers less than 50%.
Quality of Report	30%	Neat Handwriting, figure, and table. Complete labeling of figure and table.	Only formatting is improper (Location of figures/tables, use of pencil and scale).	A few required elements (labeling/ notations) are missing.	Several elements are missing (content in paragraph, labels, figures, tables).
Participation	25%	Excellent focused attention in the exercise.	Moderately focused attention on exercise.	Focused limited attention in the exercise.	Participation is minimum.
Punctuality	15%	Timely Submission.	Submission late by one laboratory.	Submission late by two laboratories.	Submission late by more than two laboratories.
Experimentation/performance type PrOs (PrOs Number: 2 & 3)					
Criteria	**%**	**10**	**9-8**	**7-6**	**5**
Knowledge	20%	Student give the correct answers 90% or	Student give the correct answers	Student give the correct answers	Student give the correct answers less

		more.	between 70-89%.	between 50-69%.	than 50%.
Procedure follows	15%	Students follow all the procedures with precaution in a logical order.	Students follow all the procedures with some precautions in a logical order.	Students follow all the procedures without precaution in a logical order.	Students follow all the procedures without precaution in an illogical order.
Observation Skill	20%	Excellent focused attention in the exercise.	Moderately focused attention on exercise.	Focused limited attention in the exercise.	Participation is minimum.
Analysis	10%	Student understand the data and analyze correctly the obtained test results.	Student understand most of the data and analyze the obtained test results with help or support.	Student need help to understand some of the data and also in analyzing the obtained test results.	Student always need help to understand the data and also in analyzing the obtained test results.
Quality of Report	20%	Neat Handwriting, figure, and table. Complete labeling of figure and table.	Only formatting is improper (Location of figures/tables , use of pencil and scale).	A few required elements (labeling/ notations) are missing.	Several elements are missing (content in paragraph, labels, figures, tables).
Punctuality	15%	Timely Submission.	Submission late by one laboratory.	Submission late by two laboratories.	Submission late by more than two laboratories.

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them bythe administrators to a user in uniformity of practice in all institutions across the state.

Sr. No.	Equipment Name	PrO. No.
1.	Model of coal-based thermal power plant (including all circuits).	II
2.	Models of high-pressure boilers: - Lamont boiler - Benson boiler - Loffler boiler - Velox boiler	II
3.	Models of boiler furnaces.	II

4.	Model of Diesel power plant.	III
5.	Model of gas turbine power plant.	III
6.	Model of cogeneration and combined cycle power plant.	III
7.	Model of nuclear power plant.	IV
8.	Models of nuclear reactors: - Pressurized water reactor - Boiling water reactor - CANDU reactor	IV
9.	Model of hydroelectric power plant.	V

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above COs and PrOs. More can be added to fulfill the development of this course competency.

a. Work as a leader/ team member.

b. Follow safety practices.

c. Follow ethical practices.

d. Maintain models and equipment.

e. Practice environment-friendly methods and processes. (Environment related)

The ADOs are best developed through laboratory/field-based exercises. Moreover, the level of achievement of the ADOs, according to Krathwohl's 'Affective Domain Taxonomy,' should gradually increase as planned below:

I. 'Valuing Level' in 1st year

II. 'Organization Level' in 2nd year.

III. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

Based on the higher-level UOs of Revised Bloom's taxonomy formulated for developing COs and competency, the primary underpinning theory is given below. If required, more such UOs could be included by the course teacher to focus on attaining COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I Introduction to Power Plant	1.a Describe power plants with Indian energy scenario. 1.b Explain various terminology used in plant economy 1.c Calculate the cost of power, rate of return, rate of interest and tariff for power generation.	1.1 Concept 1.2 Energy Scenario in India 1.3 Energy conversion steps in various power plants 1.4 Types of power plants 1.5 Terminology of plant economy - Peak load - Baseload - Load factor - Load curve - Load duration curve - Diversity factor

		1.6 Cost of power - Fixed cost - Operational cost 1.7 Rate of return and rate of interest 1.8 Tariff for electric energy 1.9 National grid 1.10 Simple numerical
Unit– II Modern Coal-based Power Plants	2.a Analyze the Rankine cycle and its efficiency improvement methods. 2.b Describe various circuits of modern coal-based power plants. 2.c Explain various, boilers, boiler furnaces, fuel supply systems, and governing systems of coal-based power plants.	2.1 Rankine cycle - Simple cycle and analysis - Actual cycle 2.2 Efficiency Improvement Methods - Reheating - Regeneration 2.3 Layout of modern thermal power plant 2.4 Various Circuits - Coal and ash handling - Air and gas - Feed water and steam - Condenser and cooling water - Steam turbine lubrication 2.5 High-pressure boilers - Lamont boiler - Benson boiler - Loffler boiler - Velox boiler 2.6 Boiler Furnaces 2.7 Pulverized fuel supply system 2.8 Electrostatic precipitator (ESP) 2.9 Governing system 2.10 Simple numerical
Unit-III Diesel and Cogeneration Power Plant	3.a Describe the concept of Diesel power plant. 3.b List the essential elements and various systems of Diesel and gas turbine power plants. 3.c Explain the working of cogeneration and combine cycle power plant.	3.1 Diesel engine power plant - Applications - Merits and De-merits 3.2 Layout of Diesel engine power plant 3.3 Various systems of Diesel engine power plant 3.4 Comparison of diesel and gas turbine power plant 3.5 Auxiliary systems of gas turbine power plant 3.6 Cogeneration and combined cycle power plant 3.7 Simple numerical
Unit– IV Nuclear Power Plant	4.a Describe the nuclear physics. 4.b Identify major components of nuclear reactors, and explain the working of nuclear reactors. 4.c Choose the waste disposal methods, particularly for	4.1 Fundaments of nuclear physics - Fusion and fission - Chain reaction - Nuclear fuel 4.2 Nuclear reactor - Major Components 4.3 Construction and working of

	nuclear waste.	- Pressurized water reactor - Boiling water reactor - CANDU reactor 4.4 Nuclear waste and disposal 4.5 Site selection 4.6 Nuclear power scenario in India
Unit–V Hydro Power Plant	5.1 Describe hydroelectric power plant. 5.2 Identify the major components of hydro power plants.	5.1 Concept and purpose 5.2 Major elements 5.3 Classifications 5.4 Site selection

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
I	Introduction to Power Plant	10	3	7	7	17
II	Modern Coal-based Power Plants	14	7	7	7	21
III	Diesel and Cogeneration Power Plant	08	3	4	7	14
IV	Nuclear Power Plant	06	7	4	0	11
V	Hydro Power Plant	04	3	4	0	7
Total		**42**	**23**	**26**	**21**	**70**

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)

10. SUGGESTED STUDENT ACTIVITIES

Sr. No.	Activity.
1.	Collect data of new installed power plants (type, capacity, place etc) in last 10 years.
2.	Collect data for tariff for different types of consumer and explain it.
3.	Explain possible impact on environment for different types of power plant.
4.	Explain possible impact on economy for different types of power plant.
5.	Explain various circuits of thermal power plant from given layout of power plant.
6.	Collect data of diesel generating sets installed at nearby place.
7.	Find scope of municipal waste as a fuel in suitable power plant.
8.	Explain scope of micro hydel power plant in your state.
9.	Enlist coal-based thermal power plant specifications which is available nearby.

10.	Prepare a comparative analysis of high pressure boilers, super critical and sub critical boilers.
11.	Identify type of defect/ failure in high pressure boilers.
12.	Visit any coal-based/ Diesel engine/gas turbine/nuclear power plant.
13.	Prepare property table for different types of fuel/energy which is useful for power generation.
14.	Undertake 2 to 5 days of training in any power plant.
15.	Prepare a presentation on various control systems for modern power plant.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies that the course teacher can use to accelerate the attainment of the various outcomes in this course.

Unit	Unit Title	Strategies
I	Introduction to Power Plant	○ Real-life examples, demonstration of natural systems, movies /animations /chart /tables /models. ○ Numericals, Massive Open Online Courses (MOOCs).
II	Modern Coal-based Power Plants	
III	Diesel and Cogeneration Power Plant	
IV	Nuclear Power Plant	
V	Hydro Power Plant	

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned at the beginning of the semester. The number of students ınthe group should ***not exceed three.***

The micro-project could be literature survey based, data collection and its interpretation for existing power plant, site survey for new power plant, finding load curve of given area/ institute, finding peak load and peak hours of given area/ institute, internet-based, workshop-based, or field-based. Each micro-project should encompass at least COs with in integration of PrOs, UOs, and ADOs. The duration of the micro project should be about **4-5** ***(four to five) student engagement hours*** during the course. The students ought to submit a micro-project by the end of the semester to develop the industry-oriented COs.

A representative list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher or using suggested student activity.

A representative list of micro-projects is given here. The concerned faculty can add similar micro-projects based on student activities (chart/presentation/report/model/animation):

1. Prepare a demonstration model of coal-based thermal power plant on wooden board.
2. Prepare a demonstration model of Diesel engine power plant on wooden board.
3. Prepare a demonstration model of gas turbine power plant on wooden board.
4. Prepare a demonstration model of nuclear power plant on wooden board.
5. Prepare a demonstration model of hydroelectric power plant on wooden board.
6. Prepare a display chart of different coal-based thermal power plant circuits.

7. Prepare a display chart of different types of high pressure boilers.
8. Prepare a display chart of different types of nuclear reactors.
9. Make a PowerPoint presentation on Indian energy scenario.
10. Prepare a tabulated summary of the coal-based thermal power plants installed in a Gujarat. (Summary includes capacity, location, types of boilers, fuel, furnace, coal handling system, ash handling system, etc).
11. Prepare a tabulated summary of the gas turbine power plants installed in a Gujarat. (Summary includes capacity, location, types of combustion chamber, type of compressor, fuel, etc).
12. Prepare a tabulated summary of the nuclear power plants installed in a Gujarat. (Summary includes capacity, location, types of reactors, fuel, waste disposal method, cooling system, etc).
13. Prepare a tabulated summary of the hydroelectric power plants installed in a Gujarat. (Summary includes capacity, location, types turbine, reservoir height, draft system, etc).
14. Prepare a chart of possible major and minor fault and remedies of high-pressure boiler.
15. Make a PowerPoint presentation on the latest trends in nuclear power plant.
16. Make a PowerPoint presentation on the latest industry trends in gas turbines.
17. Carry out a comparative study of coal-based thermal power plant, Diesel engine power plant, gas turbine power plant, nuclear power plant and hydroelectric power plant based.
18. Carry out a comparative analysis pollution impact due to coal-based thermal power plant, Diesel engine power plant, gas turbine power plant, nuclear power plant and hydroelectric power plant.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication
1.	Power Plant Engineering	P K Nag	Tata Mc Graw Hill
2.	Power Plant Engineering	Domkundwar	Dhanpat Rai & Co. Limited
3.	Power Plant Engineering	Dr. P. C. Sharma	S. K. Kataria & Sons
4.	Power Plant Engineering	R. K. Rajput	Laxmi Publications
5.	Power Plant Engineering	Black & Veatch	Springer Publication
6.	Power Station Engineering and Economy	Bernhardt G A Sarotzki, William A Vopat	Tata Mc Graw Hill

14. SOFTWARE/LEARNING WEBSITES

1. http://nptel.ac.in/courses/112105051/
2. https://www.nrc.gov/reactors.html
3. https://www.energy.gov/eere/water/types-hydropower-plants
4. https://www.ntpc.co.in/
5. https://powermin.gov.in/

15. PO-COMPETENCY-CO MAPPING

Semester V	Power Plant Engineering (4361905)						
	POs						
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
Competency & Course Outcomes	Basic & Discipline-specific knowledge	Problem Analysis	Design/ developmentof	Engineering Tools, Experimentation& Testing	Engineering practices for society, sustainability &	Project Management	Life-longLearning
Competency	Apply knowledge of mechanical engineering related to power generation systems, their control and economics in different type of power plants for their operation and maintenance						
CO-1: Outline factors affecting the power plants by analyzing its economy.	3	3	2	-	2	-	2
CO-2: Interpret layout of coal-based power plant and its components.	3	-	3	-	2	-	-
CO-3: Identify elements and their functions of Diesel, gas turbine, nuclear and hydro power plant.	3	-	-	-	2	-	-

Legend: '3' for high, '2' for medium, '1' for low, and '-' for no correlation of each CO with PO

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE (GTU RESOURCE PERSONS)

Sr. No.	Name and Designation	Institute	Contact No.	Email
1.	Prof. (Dr.) Rakesh Bumataria	Government Polytechnic, Porbandar	9924402808	rakesh.bumataria@gmail.com
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17. BOS RESOURCE PERSONS

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