GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester-III

Course Title: Plant Equipment Erection and Maintenance
(Course Code: 4335502)

Diploma programmer in which this course is offered	Semester in which offered
Fabrication Technology	Third

1. RATIONALE

For satisfactory performance of any plant / industry, it is necessary that all the plant equipment should be in a good working condition.Corrosive environment and wear produce adverse effect on the performance of the plant equipment, so it is necessary to perform various maintenance activities in the plant / industry.In a process plant / industry,proper functioning of different plant equipment depends on its appropriate foundation, erection and installation.Maintenance of the plant equipment plays a vital role for achieving qualitative and competitive product.This course develops theoretically and hands on skills of maintenance of various plant equipment.This course also develops safety consciousness among the students for the industrial environment.It gives knowledge about different health &safety acts and rules implemented by government in industry.

2. COMPETENCY

The course content should be taught and curriculum should be implemented with the aim to develop required skills in the students so that they are able to acquire following competency:

- **Plan and Supervise foundation, erection, installation &maintenanceof process plant equipment.**
- **Inculcate safety in industry.**

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:

a) Describestatic and rotary plant equipment.
b) Describe foundation, erection and installation procedure for given machine/equipment.
c) Select suitable corrosion prevention method according to working environment of plant equipment.
d) Use appropriate tools for maintenance of given plant equipment.
e) Apply industrialsafety rules to avoid accident.

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	
4	0	2	5	30*	70	25	25	150

(*): 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.

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

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the sub-components of the COs. *These PrOs need to be attained to achieve COs.*

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Prepare list of tools and equipment required for erection and maintenance work.	4	02
2	Perform maintenance activity for given static plant equipment.	1,4	02
3	Perform maintenance activity for given rotary plant equipment.	1,4	02
4	Perform Vertical alignment of given object using Plumb-bob	2	02
5	Perform Levelling of given object using Spirit Level.	2	02
6	Perform Levelling and mark points on wall of a building using Transparent Water Tube.	2	02
7	Identify type of corrosion and describe its remedies for given object.	3	02
8	Perform corrosion prevention exercise for a given job.	3	04
9	Remove given corrode and broken bolt from any plant equipment.*	3,4	02
10	Use appropriate recovery method to maintain / repair given product.*	4	04
11	Perform maintenance activity of bench vice.*	4	02
12	Perform maintenance activity of given lathe chuck.*	4	02
13	Demonstrate metal spraying methods to recover wear parts of machine/equipment.*	4	02

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
14	Demonstrate various personal protective equipment.	5	01
15	Demonstrate use of fire fighting and safety related equipment.	5	01
16	Prepare a typical accident report for given plant accident situation.	5	02
	Total		**28**

Note

**** Any two / three practical to be performed of six practical hours.***

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

ii. *Boiler suit, safety shoes and necessary tools & instruments are compulsory while attending laboratory and has to be brought by students (Annexure-1).*

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.

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
For Pros No. 2,3,4,5,6,8,9,10,11,12		
1	Knowledge	20
2	Performance	30
3	Procedure Followed	30
4	Quality of Report	10
5	Punctuality	10
Total		**100**

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
For Pros No. 1,7, 13,14,15,16		
1	Knowledge	30
2	Quality of Report	30
3	Participation	20
4	Punctuality	10
5	Originality	10
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

These major equipment/ instruments with broad specificationsfor the PrOsis a guide to procure them by the administrators to user in uniformity of practical's in all institutions across the state.

No.	Equipment Name with Broad Specifications	PrO. No.
1	Maintenance tool kit	1,2,3,8,9,11,12
2	Marking and Measuring instruments	1,2,3,4,6,11,12
3	Power and portable tools	1,2,3,9,11,12
4	Static and rotary plant equipment	2,3,12
5	Plumb-Bob	4
6	Spirit level	5
7	Transparent Water tube	6
8	Painting tools	8
9	Screw extractor	9
10	Welding machines	10
11	Metal spraying gun with gas welding equipment	10,13
12	Air compressor	4,13
13	Bench wise	1,11
14	Personal protective equipment	1,14
15	Firefighting and safety related equipment	15

7. AFFECTIVE DOMAIN OUTCOMES

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

a) Follow safety practices in laboratory.
b) Practice good housekeeping.
c) Work as a leader/a team member.
d) Maintain tools/equipment
e) Follow ethical practices
f) Practice environmental friendly methods and processes. (Environment related)

The ADOs are best developed through the 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 and 4th year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit-I **Plant Equipment**	1a. ClassifyPlants 1b. Classify Plant equipment 1c. Describe different static plant equipment 1d. Describe different rotary plant equipment	1.1 Definition of Plant 1.2 Classification chart of plants 1.3 Classification of Plant equipment 1.4 Boilers 1.4.1 Definition as per IBR 1.4.2 Classification Chart 1.4.3 Difference between Fire tubeand Water tube Boiler 1.4.4 Factors affecting for selection of boiler 1.4.5 Constructional figure and Working of Cochran Boiler 1.4.6 Constructional figure and Working of Lancashire boiler 1.4.7 Constructional figure and Working of High Pressure LaMount Boiler 1.4.8 List of different Mountings and Accessories of Boiler and theirFunctions 1.5 Valves – Definition, types, construction and its function 1.6 Cooling tower– Definition, construction and its function 1.7 Pumps 1.7.1 Definition 1.7.2 Classification 1.7.3 Applications 1.7.4 Working of Reciprocating Pump 1.7.5 Construction/ working of Centrifugal Pump 1.7.6 Installationof Centrifugal Pump 1.7.7 Priming 1.7.8 Gear Pump 1.7.9 Difference between Centrifugal and Reciprocating pump 1.8 Air Compressors 1.8.1 Definition 1.8.2 Classification chart

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
		1.8.3 Construction & working of Reciprocating Air Compressor 1.8.4 Construction & working of Centrifugal Air Compressor 1.8.5 Applications of compressed air 1.9 Fans & Blowers 1.9.1 Definition of Fan 1.9.2 Definition of Blower 1.9.3 Difference between Fan & Blower 1.9.4 Types of Fan 1.9.5 Types of Blower 1.9.6 Industrial applications of Fan & Blower
Unit– II **Foundation, Erection and Installation**	2a. Describe foundation plan for given industrial equipment 2b. Identify foundation bolt to be used in foundation of given equipment 2c. Describe erection procedure of machine / equipment 2d. Describe installation procedure of machine / equipment	2.1 Design and planning of foundation 2.1.1 Definitionof foundation 2.1.2 Effect of the proper foundation 2.1.3 Function of foundation 2.1.4 Types of foundation 2.1.5 Design consideration of foundation 2.1.6 Foundation materials 2.1.7 Concrete mixture for industrial equipment 2.1.8 Foundation size and plan of industrial equipment 2.1.9 Types of foundation bolts 2.2 Erection& Installation of equipment 2.2.1 Definition of Erection 2.2.2 Erection Procedure 2.2.3 Erection equipment 2.2.4 Definitionof Installation 2.2.5 Installation procedure of machine / equipment 2.2.6 Grouting, alignment and acceptance test for industrial equipment
Unit-III	3a. Describe factors affecting corrosion	3.1 Definition of corrosion 3.2 Principle of surface corrosion

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Corrosion & its Prevention in process plant	3b. Classify different types of corrosion 3c. Select suitable corrosion prevention method 3d. ListPainting codes and standards	3.3 Factors affecting the corrosion 3.4 Types of corrosion 3.5 Corrosion prevention methods 3.6 Selection of corrosion prevention method 3.7 Corrosion control in chemical / petro chemical plant 3.8 List of painting codes and standards applicable to process plant equipment
Unit-IV **Maintenance in Process Plant**	4a. Describe aims, functions and responsibilities of maintenance department 4b. Explain types of maintenance 4c. Select tools for maintenance of given plant equipment 4d. Describe causes, effects and reduction methods of wear 4e. Select appropriate lubricants and lubrication method 4f. Select appropriate recovery method for machine elements	4.1 Definition of maintenance and maintenance engineering 4.2 Aims of maintenance programme 4.3 Functions of maintenance department 4.4 Responsibilities of maintenance department 4.5 Types of maintenance 4.6 Tools used for maintenance 4.7 Wear and Lubrication 4.7.1 Wear – Definition, types, causes and its effects 4.7.2 Wear reduction methods 4.7.3 Lubricant –Definition, types and applications 4.7.4 Lubrication methods 4.8 Recovery methods and their applications
Unit-V **Industrial Safety**	5a. Describe different types of accidents and hazards 5b. Explain salient points of Factories act 1948 for health and safety 5c. Explain salient points of The Gujarat Factories Rules, 1963, Chapter IV - Safety 5d. Describe Fire prevention and firefighting, equipment and methods	5.1 Accident: - Causes, Types, Results and Control. 5.2 Mechanical and electrical hazards-types, causes and preventive steps/procedure. 5.3 Salient points of Factories act 1948 for health and safety 5.4 Salient points of The Gujarat Factories Rules, 1963, Chapter IV –Safety 5.5 Safety colour codes 5.6 Fire prevention and firefighting, equipment and methods. 5.7 Accident report 5.8 Duties of safety inspector and fire inspector

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Plant Equipment	18	8	8	7	23
II	Foundation, Erection and Installation	14	4	7	6	17
III	Corrosion & its Prevention in process plant	8	3	7	0	10
IV	Maintenance in Process Plant	10	3	7	3	13
V	Industrial Safety	6	4	3	0	7
Total		**56**	**22**	**32**	**16**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*
Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks and marks at different taxonomy levels (of R, U and A) in the question paper may vary slightly 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 perform following activities in group and prepare reports of about 5 pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

a) Prepare solutions of different assignments given by subject faculty.
b) Report writing on various topics from syllabus and beyond syllabus.
c) Prepare sketchbook of Tools and Equipment required for Erection and Maintenance.
d) PPT presentation (10 minutes) on given Sub-topic of subject beyond the syllabus.
e) Prepare chart showing various static and rotary equipment.
f) Prepare a model of foundation plan for machine /equipment.
g) Prepare chart showing various types of corrosion and corrosion prevention methods.
h) Prepare chart showing various types of maintenance and maintenance activity.
i) Prepare chart showing various safety Rules/ guidelines to be followed in industry.
j) Show video/animation films of different process plants and discuss their operations and if possible show films related to erection commissioning of these plants.
k) Arrange visit to process plant and show various erections/commissioning and maintenance activities being carried out.
l) Perform maintenance activity of different laboratory equipment.

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) Guide student(s) in undertaking micro-projects.

c) ***'L' in section No. 4*** means different types of teaching methods that is to be employed by teachers to develop the outcomes.
d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
e) With respect to ***section No.10***, teachers should create opportunities and provisions for ***co-curricular activities***.
f) Aware students about industrial factory act 1948 & Gujarat factory rules 1963.

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 (group of 3 to 5). However, **in the fifth and eighth semesters**, 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 duration of the micro project should be about **14-16 (fourteen to sixteen) student engagement hours** during the course. The students 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. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a) **Creating Digital Portfolio:** Students should observe and collect photographs and images of industrial/domestic components/items/equipment etc. and make a report on it.
b) **Chart making:** Prepare chart / drawing of various static equipment, rotary equipment, foundation plan, installation - erection procedure, corrosion, maintenance, safety,etc.given by the subject teacher.
c) **Model Making:** Students should build 3D model of various object as per shape and dimension from thermocol, hardboard scrap, wooden scrap, plastic or metal scrap or drawing sheet etc.
   - Prepare a model of various types of process/power plant.
   - Prepare model of various types of static and rotary equipment.
   - Prepare a model of foundation for machine /equipment.
d) **Video Preparation:** Student have to prepare his/her video on demonstrating different maintenance tools, measuring instruments, different static and rotary equipment, erection equipment, maintenance activities performed in laboratory etc. given by the subject teacher.
e) **E-learning projects:** Students have to use internet and other online resources for preparation of report and/or download video on the topic given by the subject teacher within the syllabus or beyond the syllabus.

f) **Report preparation:** Student has to use different books, technical magazine, journals etc. for preparation of a report on the topic given by the subject teacher within the syllabus or beyond the syllabus.

g) **Power point presentation**: Students has to prepare a power point presentation of 10 to 15 slides on the topic given by the subject teacher within the syllabus or beyond the syllabus. In the end of presentation student has to ask at least 3 to 5 MCQ based question to identify the gain of listeners at the end presentation.

h) **Collect and study brochure**of different maintenance tools and accessories from local vendor/ online vendor.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Structural steel: fabrication & erection	S.K.Saxena& R.B.Asthana	Somaiya Publication Pvt. Ltd. ISBN 81-7039-207-1
2	D.L.Material of P.M.& S.M-504	-	C.E.C., C.T.E., Gandhinagar
3	Elements of Mechanical Engineering	P.S.Desai & S.B.Soni	AtulPrakashan, Ahmedabad ISBN – 81-89736-02-7
4	Elements of Mechanical Engineering	N.M.Bhatt & J. R. Mehta	Mahajan Book Depot, Ahmedabad
5	Corrosion Engineering	Mars G. Fontana	Tata McGraw-Hill Publishing Company Limited, ISBN:- 0-07-021463-8
6	Maintenance Engineering Handbook	Higgins & Morrow	McGraw Hill Publication ISBN 0-07-028755-4
7	Maintenance Engineering	H.P.Garg	S. Chand and Company Ltd. ISBN :
8	Pump-hydraulic Compressors	Audels.	McGraw Hill Publication
9	Foundation Engineering Handbook	Winterkorn, Hans.	Chapman & Hall London
10	Corrosion handbook	-	-
11	Engineering Chemistry with experiments	Sunita Rattan	S. K. Katariya & Sons
12	Pump Operation and Maintenance	Tyler G. Hicks, BME	Tata McGraw-Hill Publishing Company Limited, ISBN 0-07-099349-1
13	Pumps Principles & Practices	Board of Editors	Jaico Publishing House ISBN 978-81-7992-897-4
14	Valves Principles & Practices	Board of Editors	Jaico Publishing House ISBN 978-81-7992-895-0
15	Factories act 1948 for health and safety	-	-

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
16	The Gujarat Factories Rules, 1963	-	-

14. SOFTWARE/LEARNING WEBSITES

- https://youtu.be/elUIbOnJc7c
- https://youtu.be/H1AsPLYCyWk
- https://youtu.be/UYMDm4yB1QA
- https://youtu.be/4eMNFBB1StQ
- https://youtu.be/gYyg8m9mntg
- https://youtu.be/uVPp8wml9iU
- https://youtu.be/lKBqTOgOQTM
- https://youtu.be/2__g1Fntx4o
- https://youtu.be/f58SW0Hwcf0
- https://youtu.be/o7jb6VhzhqY
- https://youtu.be/Vd8Kvz39msQ
- https://youtu.be/g163n8rB3mM
- https://youtu.be/5OxdXq91TV0

15. PO-COMPETENCY-CO MAPPING

Semester II	Plant Equipment Erection and Maintenance(Course Code: 4335502)						
	POs						
Competency & Course Outcomes	**PO 1 Basic & Discipline specific knowledge**	**PO 2 Problem Analysis**	**PO 3 Design/ develop-ment of solutions**	**PO 4 Engineering Tools, Experimen-tation&Testing**	**PO 5 Engineering practices for society, sustainability & environment**	**PO 6 Project Manage-ment**	**PO 7 Life-long learning**
Competency	• **Plan and Supervise foundation, erection, installation & maintenance of process plant equipment.** • **Inculcate safety in industry.**						
Course Outcomes **CO1)**Describe static and rotary plant equipment.	3			1			1
CO2) Describe foundation, erection and installation procedure for given machine/equipment.	3	1		1			1
CO3) Selectsuitable corrosion prevention method according to working environment of plant equipment.	3	1		1	1	-	2
CO4) Use appropriate tools for maintenance of given plant equipment.	3	1		2			2
CO5) Apply industrial safety rules to avoid accident.	3	1			2		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

S. No.	Name and Designation	Institute	Contact No.	Email
1.	Shri Kapilkumar B. Pipavat, Lecturer in Fabrication Technology.	Sir Bhavsinhji Polytechnic Institute, Bhavnagar	9427343525	kapil.pipavat@gmail.com
2.	Shri Rohankumar B. Zapadiya, Lecturer in Fabrication Technology.	Sir Bhavsinhji Polytechnic Institute, Bhavnagar	9033219351	rohan.zapadiya@gmail.com

ANNEXURE-1

❖ SAMPLE SEFTY CONTRACT:

(To be filled by the students and submitted to concerned faculty/staff)

-- Use for reference purposes only –

1. You have to read and sign the safety contract.
2. The safety contract says that you understand that safety is your responsibility.
3. The safety contract to be signed before you carry out any work in the laboratory and if youdon't observe and obey the safety rules, you will not be allowed in the laboratory.

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Safety Contract

Date: ________________

Name of Institute: ____
Name of Course with Code: Plant Equipment Erection and Maintenance (4335502)
Name of Faculty/Staff with Designation: 1. _____________________________________
2. _____________________________________
3. _____________________________________

I RECOGNIZE THAT:

1. Safety is my responsibility when using a tool.
2. Safety regulations have been provided to me.
3. The possibility of accident and injury increases if I do not follow all the safety guidelines.
4. I must act responsibly to ensure my own safety & the safety of others in the work area.

I AGREE TO:

1. Never work in the shop without my faculty's/ instructor'ssupervision.
2. Read and practice all the safety regulations that have been distributed to me in this course or have been posted in the work areas.
3. Act in a responsible manner at all times in the laboratory.
4. Follow all instructions given by the faculty.
5. Immediately report any unsafe condition or activity to my faculty / instructor.
6. Wear eye protection at all times when working with tools or working anywhere near someone who is using tools.
7. Cut or Tie back long hair, remove jewellery, secure loosed clothing, and wear boiler suit & safety shoes in the laboratory.
8. Clean all work areas and put equipment away before leaving the laboratory.

I, ____, have read and agree with all the safety instructions.

Particulars:

Programme: ______________________ Student Signature
Batch No.: ______________________ ________________________
Enrollment No.: __________________