GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: FABRICATION TECHNOLOGY
(COURSE CODE 3361905)

Diploma Programme in which this course is offered	Semester in which offered
Mechanical Engineering	Sixth

1. RATIONALE.

This course focuses on fabrication of different machine parts and process equipment used in various engineering application. This course would help students to learn application of different tools, equipment & machineries used in fabrication of process equipment and various fabrication works in deferent engineering application. This course also tries to develop safety consciousness in students for fabrication work. Students also become conversant with related manufacturing codes & standards of process equipment e.g. ASME, TEMA, BIS - 2825, BS - 5500. This also provides opportunity for hands on practice for student to develop skills and to understand basic technical requirement for process equipment fabrication. This course thus provides necessary knowledge and skills required in fabrication industry, and hence it is a key course for mechanical engineers.

2. COMPETENCY.

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

- **Plan and supervise fabrication of different process equipment using appropriate methods, various fabrication standards, codes and safety norms.**

3. COURSE OUTCOMES (COs).

The theory should be taught and practical should be carried out in such a manner that students are able to acquire different learning outcomes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

i. Interpret the fabrication drawings and plan the fabrication processes requirements and calculate the materials requirements.
ii. Develop welding documents like WPS, WPQ, SWP and WTP.
iii. Suggest steps for erection, installation and commissioning of fabricated equipment.
iv. Follow safety norms during fabrication process.

4. TEACHING AND EXAMINATION SCHEME.

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	150
3	0	2	5	70	30	20	30	

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

5. COURSE CONTENT DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I **Introduction**	1a. List the factors affecting weldability. 1b. Explain importance of weldability. 1c. Compare different power sources. 1d. List national and international level third party agencies.	1.1 Need and scope of fabrication technology in industries. 1.2 Weldability-concept, meaning, definition and factors affecting it and its importance. 1.3 Power source-classification, advantages, limitations, features, applications and selection criteria. 1.4 List of national and international fabrication industries and third party inspection agencies.
Unit – II **Drawing Interpretation.**	2a. Interpret manufacturing/ welding drawings. 2b. Prepare bill of materials, parts list and quantity. 2c. Explain procedure for weld edge preparation. 2d. Develop WPS, WPQ, WTP and SWP documents. 2e. Interpret different terms of code.	2.1 Welding location of elements, welding general nomenclature, welding symbols as per IS: 696-1972, welding supplementary symbols, abbreviations used for welding processes and welding position. 2.2 Interpretation and method to work out bill of material for following types of drawings: i. Welding / fabrication. ii. Process and instrumentation. iii. Piping isometric. 2.3 Types, sketch, edge preparation and applications of weld - square butt, groove, fillet, plug, Types of joint butt, lap, corner, tee and edge, Types of weld edge preparation 2.4 Welding documents - Weld Test Plan (WTP) and Shop Weld Plan (SWP). 2.5 Introduction to ASME section IX Welding Procedure Specification (WPS) and Welder Performance Qualification (WPQ). 2.6 Need and application areas of different codes used in fabrication industries remaining ASME sections, ASTM, AWS, IS, BIS, JIS, EN, DIN, TEMA, EJMA.
Unit – III	3a. Use equipment/ machineries for edge preparation.	3.1 Equipment/machines used for edge preparation, their working & features. 3.2 Preheating and inter-pass: need, method and applications.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Fabrication Processes and Safety.	3b. Select preheating, post heating and PWHT method. 3c. Explain different methods of relieving thermal stresses. 3d. Set different arc welding parameters. 3e. Explain advance welding methods and welding automation. 3f. Explain various fabrication procedures. 3g. Calculate Ovality, shell plate orientation and arc length. 3h. Identify fabrication stages for equipment to be fabricated. 3i. Describe safety norms to be followed during fabrication activities.	3.3 Post heating-need, method and applications. 3.4 Post Weld Heat Treatment (PWHT)-need, methods, applications and selection criteria. 3.5 Methods of relieving thermal stresses. 3.6 Arc welding parameters-setting criteria: i. Voltage. ii. Current. iii. Welding speed. iv. Welding feed. v. Arc length. 3.7 Advance welding methods and their applications. i. Ultrasonic welding. ii. Laser beam welding. iii. Electron beam welding. iv. Friction stir welding. 3.8 Welding automation. 3.9 Process equipment fabrication procedures: i. Plate edge bending and rolling. ii. Weld edge preparation. iii. Marking procedures of shell and dish end. iv. Plate cutting by gas and plasma arc with automation. v. Shell alignment by string and laser beams. vi. Orientation marking on shell for nozzles. vii. Reference line marking by dumpy level. viii. Ovality measurement of shell and it's rectification by spiders. ix. Profile checking by template. x. Circularity measurement by swing arm method. xi. Offset rectification by wedge. xii. Strip cladding and overlay 3.10 Fabrication steps/stages of: i. Electrical power/communication transmission tower. ii. Pressure vessel. iii. Heat exchanger. 3.11 Need, precautions and safety norms during welding and fabrication process.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – IV Inspection and Testing.	4a. Distinguish weld defects and thermal distortion. 4b. Identify factors affecting weld quality. 4c. Explain testing and inspection procedures.	4.1 Common weld defects, their causes and remedies; 4.2 Thermal distortion-concept, meaning, definition, causes, effect and types. 4.3 Methods and equipments used to control thermal distortion. 4.4 Weld quality-concept, meaning, definition, importance and affecting factors 4.5 Introduction to inspection and testing. 4.6 Stages of inspection. 4.7 Types, methods of testing and importance of destructive testing (DT).(tensile test, compressive test, impact test, bend test, hardness test.) 4.8 Types, methods of testing and importance of Non Destructive Testing (NDT). (Liquid penetrate testing, Magnetic Particle Testing, Ultrasonic Testing, Radiography Testing, Eddy Current Testing) 4.9 Special types of test like Hydro test, Pneumatic test, and Leak test by soap water and helium gas.
Unit – V **Surface preparation, Finishing and Coating Methods.**	5a. Explain surface preparation, finishing and coating method.	5.1 Surface preparation methods, sand blasting and ball blasting. 5.2 Surface finishing methods, brushing and grinding. 5.3 Surface colour coating by brush, roller and spray applications.
Unit – VI **Installation, Erection and Commissioning.**	6c. Describe steps for erection, installation and commissioning of various fabricated equipment. 6c. Suggest steps for erection, installation and commissioning for given equipment.	6.1 Erection steps for common fabrication structure. 6.2 Erection steps for equipment to be fabricated. 6.3 Erection steps for piping. 6.4 Installation and commissioning procedures for plant machineries and fabricated equipment.

6. SUGGESTED SPECIFICATION TABLE WITH HOURS AND MARKS (THEORY)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction.	4	6	0	0	6
II	Drawing Interpretation	14	9	5	6	20
III	Fabrication Processes and Safety.	8	5	5	4	14
IV	Inspection and Testing.	8	7	3	4	14
V	Surface Preparation, Finishing and Coating Methods	4	0	8	0	8
VI	Installation, Erection and Commissioning.	4	0	3	5	8
	Total	**42**	**27**	**24**	**19**	**70**

Legends: R = Remember U= Understand; A= Apply and above levels (Bloom's revised taxonomy)

Notes:

a) This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

b) If mid-sem test is part of continuous evaluation, unit numbers I,II (Up to 2.3 only),III and V are to be considered.

c) Ask the questions from each topic as per marks weightage. Numerical questions are to be asked only if it is specified. Optional questions must be asked from the same topic.

7. SUGGESTED LIST OF EXERCISES/PRACTICALS.

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills **(outcomes in psychomotor and affective domain)** so that students are able to acquire the competencies/programme outcomes. Following is the list of practical exercises for guidance.

***Note**: Here only outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of **Course Outcomes** related to affective domain. Thus over all development of **Programme Outcomes (**as given in a common list at the beginning of curriculum document for this programme) would be assured.*

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

Sr. No.	Unit No.	Practical Exercises (outcomes in Psychomotor Domain**)**	Approx. Hours. Required
1	II	**Interpretation of fabrication drawing:**	04

		Teacher will issue one fabrication drawing and one piping drawing for interpretation. a. For fabrication / welding drawing: Students would: i. Name the item which has been drawn and given for interpretation. ii. Prepare bill of materials. (Parts name, part material, raw material size and quantity). iii. Tabulate welding / fabrication symbols used with interpretation of each. iv. Calculate shell plate size, dish end plate and pipe and flange sizes for nozzle (as applicable). v. Orientation marking of nozzle on shell and dish end, if applicable. b. For piping isometrics drawings : Students would calculate i. Start-end point co-ordinates. ii. Pipe length and size required for loop. iii. Total no. of joints required for loop. iv. Total no. of supports required for loop. v. Total no. of elbows, T joints, reducers for loop etc. vi. Erection in inch-meter. vii. Weld joints in inch-dia.	
2	III	**Prepare WPS and WPQ:** Prepare one WPS (Welding Procedure Specification) and one WPQ (Welder Performance Qualification) based on given variables and data.	2 Hrs
3	I to V	**Complex job as mini project work:** Fabricate one complex job by using welding processes in group of 4 to 6 students, from the following suggested areas. i. Model fabrication of industrial shade. ii. Model fabrication transmission tower. iii. Heat exchanger. iv. Condenser, radiator. v. Bridge structure. vi. Model of ship. vii. Domestic applications (car shades, grills, gate, sign boards, etc.). viii. Frames/truss. ix. Food processing vessels. x. Piping for transferring oil, gas, water, etc. xi. EOT crane structure. xii. Other equivalent structure assigned by teacher. This includes followings:	18 Hrs

		a. Sketches. b. Bill of material. c. Steps to fabricate. d. Method employed for weld edge preparation. e. Selection of welding process and process parameters. f. List of consumables used with specifications and quantity. g. Pre and/or post weld heat treatment processes used. h. WPS and WPQ. i. Presentation including photographs/video of actual work being carried out. (Option of flexi time based work can also be practiced. For this option, it may not be necessary to exactly follow the time table slots. This can be on continuous base also).	
4	V	**Prepare SWP and WTP:** Prepare one Shop Weld Plan (SWP) and one Weld Test Plan (WTP) for typical pressure vessel job. a. Sketch the job. b. List the steps followed to prepare plans. c. Prepare plans.	2 Hrs
5	VI	**Liquid penetrate testing:** a. Demonstrate liquid penetrate testing of weldment. b. Write specification of test liquid. c. List steps followed. d. Sketch the path tested. e. Write conclusion with interpretation. f. Attach photograph.	2 Hrs
		Total Hours	**28 Hrs**

Notes:

a. It is compulsory to prepare log book of exercises. It is also required to get each exercise recorded in logbook, checked and duly dated signed by teacher. PA component of practical marks is dependent on continuous and timely evaluation and submission of exercises.
b. Term work report must not include any photocopy/ies, printed manual/pages, litho, etc. It must be hand written / hand drawn by student only.
c. Mini project and presentation topic/area has to be assigned to the group of specified students in the beginning of the term by batch teacher, if applicable.
d. For practical ESE part, students are to be assessed for competencies achieved. They should be given experience/part of experience to perform.

8. SUGGESTED LIST OF STUDENT ACTIVITIES:

SR.NO.	ACTIVITY

i.	Visit fabrication industry and prepare report on equipment/machineries specification, problem faced in operating equipment/machineries and safety precautions.
ii.	Submit assignment given by subject teacher.

9. SPECIAL INSTRUCTIONAL STRATEGIES (if any).

Sr.No.	Unit	Unit Name	Strategies
i.	I	Introduction to Fabrication Technology.	Lecture on fabrication technology and it's uses.
ii.	II	Drawing interpretation.	Use drawings from various fabrication industries related to equipment fabrication, structural fabrication, piping isometrics etc. and explain to students, movies, industrial visits.
iii.	III	Fabrication processes and safety.	Use video/animations available on internet related to various fabrication processes, industrial visits, demonstration.
iv.	IV	Inspection and testing.	Use various inspection and testing related presentations from various websites, movies, actual demonstration, and industrial visits.
v.	V	Surface preparation, finishing and coating methods.	Use charts and posters to show the surface preparation, finishing and coating activity, movies, industrial visits, demonstration.
vi.	VI	Installation, erection and commissioning.	Show operational manuals for installation, erecting and commissioning procedures for equipments and visit industry site where actual installation, erection and commissioning activities ongoing.

10. SUGGESTED LEARNING RESOURCES.

A) List of Books:

S. No.	Title of Book	Author	Publication
i.	Welding technology.	Khanna,O.P	Dhanpat Rai Publications, New Delhi - 22nd Edition
ii.	Welding engineering and technology.	Parmar, R.S.	Khanna Publishers, New Delhi - 1st edition
iii.	Modern arc welding Technology.	Nadkarni, S.V.	Advani oerlikon, Mumbai – 6th edition
iv.	Structural steel fabrication and erection	Saxena, S.K.; Asthana, R.B.	Somaiya Publishers, New Delhi – 3rd edition

v.	Metal cutting science and production technology	Jain, K.C.; Agrawal L.N.	Khanna Publishers, New Delhi - 4th edition

B) List of Major Equipment/ Instrument with Broad Specifications:

SR.NO.	Resource with brief specification.	
i.	Welding power source rectifier.	1. AC input 440 volts, 3 ph, 50 Hz. 2. DC output 115 volts- 230 volts. 3. Output wattage (1 to 5 kW).
ii.	Portable Plate rolling machine.	1. Three high rolling machine with 0.5 meter length with max. plate thickness capacity up to 10mm. 2. 3-phase induction motor with 5kW capacity. 3. Suitable reduction gear box.
iii.	Gas cutting set.	1. Acetylene and oxygen gas cylinder. 2. Pressure regulator and gas flow measuring device. 3. Cutting torch with back fire arrester. 4. Various nozzle tip set (2 to 6 mm).

C) List of Software/Learning Websites.

i. https://www.engineering.osu.edu
ii. www.aws.org
iii. www.careersinwelding.com
iv. www.weldingalloys.com
v. www.adorweldingacademy.com
vi. www.themanufacturinginstitute.org
vii. www.asme.org
viii. www.weldingdesign.com
ix. www.engineeringtoolbox.com
x. www.asnt.org
xi. www.twi-global.com
xii. http:///www.vlab.com

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics.

- **Prof. D. R. Katariya,**Lecturer in Mechanical Engineering, G.P.Bhuj.

- **Prof. P. L. Bhogayata,** Lecturer in Mechanical Engineering, Sir B.P.Institute, Bhavnagar.
- **Prof. D. M.Patel,**Principal, Shree V & K Patel Institute of Engineering, Kadi, Dist.: Mehsana.

Coordinator and Faculty Members from NITTTR Bhopal.

- **Dr. Vandana Somkuwar,** Associate Professor, Department of Mechanical Engineering,
- **Dr. K.K. Jain,** Professor, Department of Mechanical Engineering,

SUGGESTED QUESTION PAPER FORMAT

(This is for reference only and is in suggestive form. Paper setter may opt for other marks distribution pattern maintaining distribution of marks as per specification table)

Q.NO.	SUB Q.NO.	QUESTION	MARKS DISTRIBUTION			UNIT
			R	U	A	
1		Answer ANY seven from following.				14
	i.		2			I
	ii.		2			II
	iii.		2			II
	iv.				2	II
	v.				2	IV
	vi.				2	IV
	vii.			2		V
	viii.			2		V
	ix.			2		VI
	x.			2		VI
2	a.		5			II
		OR				
	a.		5			II
	b.			5		II
		OR				
	b.			5		II
	c.				4	II
		OR				
	c.				4	II
3	a.		5			III
		OR				
	a.		5			III
	b.			5		III
		OR				
	b.			5		III
	c.				4	III
		OR				
	c.				4	III
4	a.		7			IV
		OR				
	a.		7			IV
	b.			3		IV
	c.		4			II

5	a.		5			V
	b.		5			VI
	c.		4			I