

**GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)**  
**Competency-focused Outcome-based Green Curriculum-2023 (COGC-2023)**  
**Semester-VI**  
**Course Title: Fabrication Technology**  
**(Course Code: 4361907)**

Diploma program in which this course is offered	Semester in which offered
Mechanical Engineering / Mechanical Engineering (CAD/CAM)	6 <sup>th</sup> Semester

### 1. RATIONALE

This course focuses on fabrication of different types process plant equipment used in various refineries, chemical, petro-chemical, solid-liquid-gas handling industries. This course would help students how to interpret design drawings, code & standards used in fabrication industry. Student also acquainted with use of code & standards to various to prepare engineering documents. This course also provides opportunity for hands on practice for student to develop skill for process equipment fabrication with use of necessary desired safety norms.

### 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, prepare engineering documents, implement and supervise equipment fabrication with reference to fabrication code – standards, using appropriate methods – procedures along with safety norms.

### 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	Interpret term fabrication and weldability.
CO-2	Calculate the material requirements on basis of drawing interpretation.
CO-3	Apply suitable fabrication procedures for equipment manufacturing.
CO-4	Suggest testing & inspection procedures for pre-during-after fabrication work.
CO-5	Select suitable surface finishing and coating method for fabricated equipment.
CO-6	Plan process equipment erection & commissioning at site.

### 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 - ContinuousAssessment; ESE -End Semester Examination.**

## 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. /COs	Approx. Hrs. Required
01	<b>STUDY OF GENERAL ENGINEERING DRAWINGS &amp; DESIGNATION OF PHYSICAL ENGINEERING ITEMS</b>  PART-I Study any two drawing from following list. <ol style="list-style-type: none"> <li>Process Plant General Arrangement Drawing (GAD)</li> <li>Process plant process and instrumentation drawing (P&amp;ID)</li> <li>Process Flow Diagram (PFD)</li> <li>Detail and Assembly Drawing (D&amp;AD)</li> <li>Route sheet OR Operation sheet</li> <li>Structural Detail drawing</li> <li>Shop Lay out drawing</li> </ol> PART-II Find out the designation appeared on various items used inequipment fabrication from following list (any three). <ol style="list-style-type: none"> <li>Spiral wound gasket</li> <li>Scooter tyre and Car tyre</li> <li>Welding electrode and welding rods</li> <li>Piping</li> <li>Flanges</li> <li>Grinding wheels</li> <li>Gas bottles (acetylene, oxygen, LPG)</li> </ol>	I & II / CO-1 & CO-2	02
02	<b>DRAWING STUDY : BILL OF MATERIAL</b> Prepare bill of material from Pressure vessel equipment detail drawing.  <b>OR</b> Prepare bill of material from Shell tube type heat exchanger equipmentdetail drawing.	II / CO-2	02
03	<b>DRAWING STUDY : WELDING JOINT</b> Draw actual welding joint from location of weld symbol shown inpressure vessel drawing.  <b>OR</b> Draw actual welding joint from location of weld symbol shown in HeatExchanger drawing.	II / CO-2	02
04	<b>DRAWING STUDY : RAW MATERIAL REQUIREMENT CALULATION</b> Find out required raw material requirement like shell plate blank, dished end, end plate, skirt shell and related other parts, from pressurevessel drawing.  <b>OR</b> Find out required raw material requirement like Tube sheet plate blank,end plate, HE main shell, HE channel shell, dish end	II / CO-2	02

	supporting shell, baffles, tie rods, tubes from shell & tube type HE drawing.		
05	<b>DRAWING STUDY : DISH END BLANK DIA CALCULATION</b> Calculate dish end blank diameter for following type. <ol style="list-style-type: none"> <li>Torispherical type dish end</li> <li>Ellipsoidal type dish end</li> <li>Hemispherical type dish end</li> </ol>	II / CO-2	02
06	<b>DRAWING STUDY : NOZZLE SCHEDULE</b> Prepare Nozzle schedule with Location chart from pressure vessel drawing (different type of pipes / type of pipe size and type of flanges / flange size) <b>OR</b> Prepare Nozzle schedule with Location chart from HE drawing (different type of pipes / type of pipe size and type of flanges / flangesize)	II / CO-2	02
07	<b>DRAWING STUDY : PIPING ISOMETRICS</b> Find out following points from piping isometrics drawing. <ol style="list-style-type: none"> <li>Find Start and End point co-ordinates from drawing.</li> <li>Find different type of fittings used with size from drawing.</li> <li>Calculate Different type of pipes and type of pipe size from drawing.</li> <li>Calculate erection work in inch-meter</li> <li>Calculate welding work in inch-dia from drawing.</li> </ol>	II / CO-2	02
08	<b>STUDY OF ENGINEERING DOCUMENTATION - I</b> Prepare WPS and WPQ document for CS material pressure vessel <b>OR</b> shell & Tube type Heat Exchanger. (Take required data from ASME / AWS code)	II / CO-2	02
09	<b>STUDY OF ENGINEERING DOCUMENTATION - II</b> Prepare SWP and WTP document for typical pressure vessel <b>OR</b> shell & Tube type Heat Exchanger.	II / CO-2	02
10	<b>PRACTICE OF FABRICATION PROCEDURES</b> Practice (Whichever is possible in institute) (group of 5-6 students / minimum one demonstration per batch) <ol style="list-style-type: none"> <li>TWO shell making by rolling process and LONG SEAM tackwelding</li> <li>Measure ovality and rectify ovality by turn buckle type spiders.</li> <li>Measure peak in- peak out and rectify by triangular wedges.</li> <li>Two shell CIRC SEAM tack welding</li> <li>Shell Alignment at 0-90-180-270 degree angles (By L shape and string method).</li> <li>Measure practically dia. and circ. Of vessel shell and compare with theoretical equation.</li> <li>Reference line (vertical VRL by plumb and horizontal HRL by spirit level) marking on shell.</li> <li>Calculate arc length from zero degree VRL and Calculate height from HRL for nozzle orientation marking on shell.</li> <li>Erect pressure vessel <b>OR</b> install centrifugal pump at site.</li> </ol>	II, III & VI / CO-2, CO-3, CO-6	02

11	<b>FABRICATION OF SMALL WELD JOB</b> Prepare JOB of 5 mm thick x 200 mm length x 80 mm width two plates 60 degree 'V' included angle WEP weld joint with SMAW process. (group of 5-6 students / minimum one job per batch)	III / CO-3	02
12	<b>NON DESTRUCTIVE TESTING OF SMALL WELD JOB</b> Test the weld job by Liquid Penetrant Testing method and discuss the results. (group of 5-6 students / minimum one LPT testing per batch)	IV / CO-4	02
13	<b>FINISHING &amp; COATING OF SMALL WELD JOB</b> Finish weld job by hand grinding process and apply color coating on job. (group of 5-6 students / minimum one finishing & coating per batch)	V / CO-5	02
14	<b>MINI PROJECT</b> Prepare any one fabricated item from following list (group of 5-6 students / minimum one item per batch). Note: Course teacher may	I TO VI / CO-1 to CO-6	02
	select other than this list also, as per Institute convenience. 1. Podium 2. Shelf rack 3. Stool 4. Table with drawers 5. Bench-desk 6. Window grille 7. Door grille 8. Camera tripod 9. Mike stand 10. Display board stand 11. Performance Stage 12. Banner stand 13. Tipoi 14. Long height table 15. Welding Work table 16. Chair 17. Zulla 18. Cycle stand 19. Cycle scooter car parking shade 20. Storage tank		
<b>Total (Hours)</b>		<b>ALL UNITS ALL COs</b>	<b>28</b>

**Note:**

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.

**Sample rubrics Performance Indicators for the PrOs**

<b><u>PRACTICAL CA</u></b>							
<b><u>RUBRICS</u></b>							
<b>Fabrication Technology (Total marks = 50) (For Practical 1 to 9)</b>							<b>MA X 5 MA RKS</b>
<b>No</b>	<b>Marking Criteria</b>		<b>Poor (2 Marks)</b>	<b>Good (3 Marks)</b>	<b>Very Good (4 Marks)</b>	<b>Excellent (5 Marks)</b>	<b>OBTAINED</b>
<b>1</b>	<b>Regularity Level – 10 marks</b>	Punctual in work Reporting	Work reporting very less.	Partially punctual in work reporting.	Punctual in work reporting.	Punctual in work reporting and takes initiatives.	
		Discipline during lab work	undisciplined during lab work	Disciplined during lab work.	Very disciplined during lab work.	Very disciplined and strictly follow lab work norms.	
<b>2</b>	<b>Understanding Level – 15 marks</b>	Draw job drawing.	Draw but not perfect.	Draws with scale, but appearance is fair and not perfect nomenclature	Draws with scale, drawing appearance is good, nomenclature partially.	Draw with scale, excellent nomenclature and drawing appearance is very good.	
		Interpret the drawing and its Specification.	Cannot interpret.	Interpret partially and cannot answer.	Can Interpret but cannot answer with technical justification.	Interpret drawing and its specification with giving proper answer with technical justification.	
		Ability to calculate.	Cannot calculate.	Can Partially calculate.	Can calculate easily.	Can calculate and confident about calculation.	
<b>3</b>	<b>Assigned work skills Level – 15 marks</b>	Write practical	Partially Written practical & poor work	Practical writing work is moderate level and some work copied.	Practical work doing by self, but appearance wise moderate level	Excellent in Practical writing work and doing work by self.	
		Ability to prepare specifications	Not able to prepare, only copied.	Can prepare the specification partially.	Can prepare specification but not confident about specification.	Excellent in preparation of specification and very much confident about their work with justification.	

		Submiss ion of assigned work & report	Not submit or partially submit.	Submit but not perfect.	Submit within time limit but can't give answers about job operations.	Submit within timelimit and can give Right Answer with technical justification	
4	Documentation and Presentation skill level – 10 marks	Appeara nce & Mainten ance of Docume nt.	Copied and Unmaintai ned file or document, submitting incomplete file	Complete file but Poor appearance with multiple correction, Submission after final date.	Timely submission & Prepared document with Partial Correction	Finely Prepared document or Presentation along with all data within time limit.	
		Answers the experim ent related questions.	Cann ot prese nt.	Improper presentati on.	Well present, can answer, cannot give perfect justification of answer.	Well present and giving answer with proper technical justification.	
Total marks out of 50							
SIGN OF BATCH TEACHER							

<b><u>PRACTICAL CA</u></b> <b><u>RUBRICS</u></b>							
Fabrication Technology (Total marks = 50) (For Practical 10 to 14)							MAX MARKS
Sr. No.	OUT OF		Poor (2 Marks)	Good (3 Marks)	Very Good (4 Marks)	Excellent (5 Marks)	OBTAINED
1	Regularity Level – 10 marks	Punctual in work Reporting	Work reporting very less.	Partially punctual in work reporting.	Punctual in work reporting.	Punctual in work reporting and takes initiatives.	
		Discipline during lab work	undisciplined during lab work	Disciplined during lab work.	Very disciplined during lab work.	Very disciplined and strictly follow safety norms during lab work.	
2	Understanding Level – 15 marks	Draw job drawing.	Draw but not perfect.	Draws with scale, but appearance is fair and not perfect nomenclature.	Draws with scale, drawing appearance is good, nomenclature partially.	Draw with scale, excellent nomenclature and drawing appearance is very good.	

		Interpret the drawing and its Specification.	Cannot interpret.	Interpret partially and cannot answer.	Can Interpret but cannot answer with technical justification.	Interpret drawing and its specification with giving proper answer with technical justification.	
		Ability to calculate job material requirement.	Cannot calculate.	Can Partially calculate.	Can calculate easily.	Can calculate and confident about calculation.	
3	Job work skills Level – 15 marks	Follows the safety measures during job work.	Not follows.	Partially follows	Follows safety measures for human but not aware about work place safety.	Follows strictly safety measure and aware about all types of safety measures.	
		Preparation of job work	Not prepare or partially prepare.	Prepare but not as per size.	Prepare within tolerance limit, appearance is fair.	Prepare job within tolerance limit and excellent in appearance.	
		Submission of job work & report	not submit or partially submit.	Submit but not perfect.	Submit within time limit but cannot give answers about job operations.	Submit within time limit and can give Right Answer with technical justification	
4	Documentation and Presentation skill level – 10 marks	Appearance & Maintenance of Document.	Copied and Unmaintained file or document, submitting incomplete file	Complete file but Poor appearance with multiple correction, Submission after final date.	Timely submission & Prepared document with Partial Correction	Finely Prepared document or Presentation along with all data within time limit.	
		Answers the experiment related questions .	Cannot present.	Improper presentation.	Well present, can answer, cannot give perfect justification of answer.	Well present and giving answer with proper technical justification.	
Total marks out of 50							
SIGN OF BATCH TEACHER							

## 6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

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

Sr. No.	Equipment Name	specification
1.	Welding power source rectifier	<ul style="list-style-type: none"> <li>➤ AC input 220 volts, single phase, 50 Hz</li> <li>➤ DC output 10-30 volt, 70-250Amp.</li> <li>➤ Output wattage (1 to 5 kW).</li> </ul>
2.	Portable Plate rolling machine	<ul style="list-style-type: none"> <li>➤ Three high rolling machine with 0.5 meter length with max. Plate thickness capacity up to 10mm.</li> <li>➤ 3-phase induction motor with 5kW capacity.</li> <li>➤ Suitable reduction gear box.</li> </ul>
3.	Gas cutting set	<ul style="list-style-type: none"> <li>➤ Acetylene and oxygen gas cylinder.</li> <li>➤ Pressure regulator and gas flow measuring device.</li> <li>➤ Cutting torch with back fire arrester.</li> <li>➤ Various nozzle tip set (2 to 6 mm).</li> </ul>
4.	Hand grinder	<ul style="list-style-type: none"> <li>➤ Disc Diameter 100 millimeter; 4 Inch</li> <li>➤ machine with 670W brush motor</li> <li>➤ Rated input power 660 W</li> <li>➤ No-load speed 12,000 rpm</li> <li>➤ dimensions (width) 77 mm</li> <li>➤ Tool dimensions (length) 263 mm</li> <li>➤ Tool dimensions (height) 95 mm</li> <li>➤ Weight 1,5 kg</li> </ul>
5.	Power hacksaw machine	<ul style="list-style-type: none"> <li>➤ Cutting Blade Size 14 Inch</li> <li>➤ Power Consumption HP</li> <li>➤ Type Of Saw Hydraulic</li> </ul>

## 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.

- Work as a leader/ team member.
- Follow safety practices.
- Follow ethical practices
- Maintain tools and equipment
- 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:

- 'Valuing Level' in 1<sup>st</sup> year
- 'Organization Level' in 2<sup>nd</sup> year.
- 'Characterization Level' in 3<sup>rd</sup> 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)	Topics and Sub-topics
<b>Unit – I Introducti on(CO-1)</b>	1a. List the factors affecting weldability.  1b. Explain importance of weldability.	1.1 Term fabrication 1.2 Need and scope of Fabrication technology 1.3 Weldability of materials 1.4 Term manufacturing and fabrication 1.5 List different code & standards (with full forms) used in fabrication & erection of equipment / piping. 1.6 Major national and international fabrication companies 1.7 Major national and international third party inspection agencies 1.8 General Designation used for various engineering items. ➤ Spiral wound gasket ➤ Vehicle Tyre ➤ Welding electrode and welding rods ➤ Piping ➤ Flanges ➤ Grinding wheels
<b>Unit– II Drawing Interpretati on(CO-2)</b>	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 Types of drawing ➤ Process Plant General Arrangement Drawing (GAD) ➤ Process plant process and instrumentation drawing (P&ID) ➤ Process Flow Diagram (PFD) ➤ Detail and Assembly Drawing (D&AD) ➤ Route sheet OR Operation sheet ➤ Structural Detail drawing ➤ Shop Lay out drawing ➤ Equipment detail drawing ➤ Piping isometrics drawing ➤ Welding detail drawing 2.2 Fabrication documentation preparation from drawing ➤ Shop Weld Plan (SWP) ➤ Weld Test Plan (WTP) ➤ Welding Procedure Specification & Procedure Qualification Record (WPS/PQR) ➤ Welder Performance Qualification & Welder Qualification Record (WPQ/WQR) 2.3 Raw material requirement calculation from drawing ➤ Plate calculation

		<ul style="list-style-type: none"> <li>➤ Piping , tube and fittings calculation</li> <li>➤ Nozzle (flange and pipe/tube) calculation</li> <li>➤ Dish end plate blank dia. calculation</li> <li>➤ Weld consumable requirement calculation</li> </ul>
		<ul style="list-style-type: none"> <li>➤ Structural items angle, I section, T section, C section, square solid/hollow bar, hexagonal solid/hollow bar, triangle solid/hollow bar calculation</li> <li>➤ Lifting lug, support, impingement plate, reinforcement pad, dished end, limpet coil, tubesheet calculation</li> <li>➤ Piping erection calculation in inch-meter and pipingwelding calculation in inch-dia.</li> </ul> <p>2.4 Welding detailing preparation from drawing</p> <ul style="list-style-type: none"> <li>➤ Weld Joint (WJ) nomenclature of groove and filletweld</li> <li>➤ Weld Edge preparation (WEP) nomenclature</li> <li>➤ Weld joint (WJ) and WJ symbol</li> <li>➤ Weld Edge preparation (WEP) and WEP symbol</li> <li>➤ Weld Location of Elements and its symbol</li> <li>➤ Weld pass and Weld Layers</li> <li>➤ Welding position</li> <li>➤ Welding technique (forward and backward)</li> <li>➤ Welding electrode designation (SMAW and GTAW electrode)</li> <li>➤ Welding weaving patterns</li> </ul> <p>2.5 Introduction to Code and standards used for fabrication</p> <ul style="list-style-type: none"> <li>➤ ASME section 2A, 2B, 2C, 2D, section 5, section 8div.1, 8 div.2, 8 div.3, section-9.</li> <li>➤ AWS vol. 1,2,3,4,5</li> <li>➤ ASTM, TEMA, EJMA, Piping standard B 31.1 and B31.3</li> </ul>
<b>Unit-III Fabrication Processes (CO-3)</b>	<p>3a. Use equipment/ machineries for edgepreparation.</p> <p>3b. Select preheating, post heating and PWHT method.</p> <p>3c. Explain different methods of relieving thermal stresses.</p> <p>3d. Set different arc weldingparameters.</p> <p>3e. Explain various fabrication procedures.</p>	<p>3.1 Welding Process requirements</p> <ul style="list-style-type: none"> <li>➤ Arc Welding parameters setting (Voltage, Current, welding speed, consumable feed and arc length)</li> <li>➤ Gas welding parameters setting (gas pressure, gas flow, type of nozzle and optimized nozzle number)</li> <li>➤ Preheating before starting welding</li> <li>➤ Interpass during welding</li> <li>➤ Post heating after welding</li> <li>➤ Preheat, Interpass and post heat temperaturemeasuring by thermal sticks</li> <li>➤ PWHT for thermal stress relieving</li> </ul> <p>3.2 Fabrication procedures</p> <ul style="list-style-type: none"> <li>➤ Plate Edge bending for rolling</li> <li>➤ Plate rolling</li> <li>➤ Weld edge preparation</li> </ul>

	<p>3f. Calculate Ovality, shellplate orientation and arc length.</p> <p>3g. Identify fabrication stages for equipment to be fabricated.</p>	<ul style="list-style-type: none"> <li>➤ Plate marking for shell, dished end, tube sheet, RFpad etc.</li> <li>➤ Plate cutting by gas cutting and plasma cutting</li> <li>➤ Shell alignment by string and laser technology</li> <li>➤ Nozzle Orientation marking on shell</li> <li>➤ Reference line marking on shell by dumpy level</li> <li>➤ Ovality measurement of shell and it's rectification by spiders.</li> </ul>
	<p>3h. Describe safety norms to be followed during fabrication</p>	<ul style="list-style-type: none"> <li>➤ Profile checking by template (peak in / peak out)</li> <li>➤ Circularity measurement by swing arm method.</li> <li>➤ Offset rectification by wedge.</li> <li>➤ Strip cladding and overlay</li> <li>➤ Limpet coil marking on shell</li> <li>➤ shell to shell /dish end Long seam setup</li> <li>➤ shell to shell /dish end circ. seam setup</li> <li>➤ method used to control thermal distortion</li> <li>➤ dish end manufacturing technique</li> </ul> <p>3.3 Fabrication steps for with equipment function, name of parts,</p> <ul style="list-style-type: none"> <li>➤ pressure vessel / storage vessel</li> <li>➤ shell and tube type heat exchanger</li> <li>➤ piping spools / multi-tier piping arrangement</li> <li>➤ industrial shed / electrical power transmission tower</li> </ul> <p>3.4 safety norms for,</p> <ul style="list-style-type: none"> <li>➤ work at heights</li> <li>➤ before, during and after welding work</li> <li>➤ PPEs for welding work</li> <li>➤ work safety equipment</li> </ul>
<p><b>Unit-IV</b></p> <p><b>Inspection and Testing</b></p> <p><b>(CO-4)</b></p>	<p>4a. Distinguish weld defects and thermal distortion.</p> <p>4b. Identify factors affecting weld quality.</p> <p>4c. Explain testing and inspection procedures.</p> <p>4d. Suggest process parameters for DT, NDT and special type of testing procedures.</p>	<p>4.1 general terms regarding weld quality</p> <ul style="list-style-type: none"> <li>➤ weld quality</li> <li>➤ Weld defects</li> <li>➤ stages of inspection</li> <li>➤ types of inspection</li> <li>➤ types of testing</li> <li>➤ difference between inspection and testing</li> <li>➤ failure analysis</li> </ul> <p>4.2 destructive testing (procedure as per ASTM / ASME sec. v and Acceptance criteria as per ASME sec. viii div.1)</p> <ul style="list-style-type: none"> <li>➤ tensile testing</li> <li>➤ compressive testing</li> <li>➤ impact testing</li> <li>➤ hardness testing</li> <li>➤ weld bend testing</li> <li>➤ fracture toughness testing</li> </ul> <p>4.3 nondestructive testing (procedure as per ASTM / ASME</p>

		sec. v and Acceptance criteria as per ASME sec. viii div.1) <ul style="list-style-type: none"> <li>➤ LPT</li> <li>➤ MPT</li> <li>➤ UT</li> <li>➤ RT</li> <li>➤ ECT</li> </ul> 4.4 Special type of testing for equipment / piping operation <ul style="list-style-type: none"> <li>➤ Hydro test of pressure vessel</li> <li>➤ Hydro test of piping spools</li> <li>➤ Pneumatic test</li> <li>➤ Helium Leak test</li> </ul> 4.5 Running inspection methods <ul style="list-style-type: none"> <li>➤ visual inspection by eye contact</li> </ul>
		<ul style="list-style-type: none"> <li>➤ visual inspection by smell</li> <li>➤ visual inspection by hand touch</li> <li>➤ visual inspection by earing</li> </ul>
<b>Unit-V Surface preparation, Finishing and Coating Methods (CO-5)</b>	5a. Explain surface preparation, finishing and coating methods.  5b. Measure thickness coating layers.  5c. suggest appropriate coating method for mechanical equipment.	5.1 Surface preparation methods <ul style="list-style-type: none"> <li>➤ sand blasting / ball blasting</li> <li>➤ surface grinding</li> </ul> 5.2 surface finishing methods <ul style="list-style-type: none"> <li>➤ emery papering</li> <li>➤ wire brushing</li> <li>➤ buffing wheel machining</li> <li>➤ acetone / kerosene / petrol / diesel cleaning</li> </ul> 5.3 surface color coating methods <ul style="list-style-type: none"> <li>➤ brush application</li> <li>➤ roller application</li> <li>➤ cotton application</li> <li>➤ spray application</li> </ul> 5.4 coating film thickness measurement techniques <ul style="list-style-type: none"> <li>➤ dry film thickness</li> <li>➤ wet film thickness</li> </ul>
<b>Unit-VI Installation, erection and commissioning of process equipment (CO-6)</b>	6a. Describe steps for erection, installation and commissioning of various fabricated equipment.  6b. Suggest steps for erection, installation and commissioning for given equipment.	6.1 term installation, erection and commissioning 6.2 difference between installation and erection 6.3 installation of centrifugal pump and valves at site 6.4 erection of vessel at site 6.5 erection and mechanical clearance of piping spools at site 6.6 commissioning of process plant

## 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.	04	4	3	0	07
II	Drawing Interpretation	10	5	6	6	17

III	Fabrication processes	10	5	5	6	16
IV	Inspection and Testing	10	3	6	7	16
V	Surface preparation, Finishing and Coating Methods	04	1	4	2	07
VI	Installation, erection and commissioning of process equipment	04	2	3	2	07
<b>Total</b>		<b>42</b>	<b>20</b>	<b>27</b>	<b>23</b>	<b>70</b>

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

#### MST SYLLABUS / MICRO PROJEC CUM TOPIC DISTRIBUTION

DESCRIPTION	L1	L2	L3
MST-1 SYLLABUS (20 MARKS)	UNIT-1 (CO-1) & UNIT-2.1, 2.2 (CO-2)	UNIT- 3.1, 3.2 (CO-3)	UNIT- 4.1, 4.2 (CO-4)
MST-2 SYLLABUS (20 MARKS)	UNIT - 2.3, 2.4, 2.5 (CO-2)	UNIT-6 (CO-6) & UNIT-3.3, 3.4 (CO-3)	UNIT-5 (CO-5) & UNIT-4.3, 4.4, 4.5 (CO-4)
MICRO PROJECT (10 MARKS)	Student can prepare any such type of PPT PRESENTATION, ANIMATION VIDEO OF PROCESS EQUIPMENT, PREPARATION OF DEMONSTRATION CHARTS, SOLUTION OF INDUSTRY DEFINED PROBLEM, etc. assigned by Theory teacher.		

#### NOTES :

1. The Best of two MST result Marks, may be counted as Theory CA.
2. The MST exam can be conducted as descriptive paper, as MCQ paper with Physical OMR sheet, as MCQ quiz ONLINE google forms in any manner.
3. The MST syllabus / Micro project shown here is just as example, The institute is fully empowered to do changes, but the changes should be in term starting and the change instructions to be pass on students well in advance.

#### 10. SUGGESTED STUDENT ACTIVITIES

##### ENGINEERING QUIZ (OFFLINE / ONLINE / BLENDED MODE)

MCQ quiz from given fabrication drawing.

Physical copy of drawing and answering in Physical OMR sheet. (FULLY OFFLINE MODE)

**OR**

Online drawing and answering in Online google forms. (FULLY ONLINE MODE)

**OR**

Physical copy of drawing and answering in Online google forms. (BLENDED MODE)

#### 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.	Lecture on fabrication technology and its uses.
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	Fabrication processes	Use video/animations available on internet related to various fabrication processes, industrial visits, demonstration.
IV	Inspection and Testing	Use various inspection and testing related presentations from various websites, movies, actual demonstration, and industrial visits.
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	Installation, erection and commissioning of process equipment	Show operational manuals for installation, erecting and commissioning procedures for equipment and visit industry site where actual installation, erection and commissioning activities ongoing.

## 12. SUGGESTED MICRO-PROJECTS

**Only one micro-project** is planned to be undertaken by a student that needs to be assigned to him/her at the beginning of the semester. The number of students in the group should **not exceed three**. The students ought to submit a micro-project by the end of the semester to develop the industry-oriented COs.

**\*PPT PRESENTATION** Prepare PPT on assigned topic by teacher AND Present on behalf of another Division/batch students/teachers. **\*ANIMATION VIDEO OF PROCESS EQUIPMENT**

Prepare animation on assigned topic by teacher AND publish on department knowledge website /youtube channel.

**\*PREPARATION OF DEMONSTRATION CHARTS**

Prepare charts on assigned topic by teacher AND display in annual exhibition.

**\*INDUSTRY DEFINED PROBLEM**

Take any real industry problem related to fabrication and suggest probable solutions.

## 13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication
1	Welding technology	Khanna, O.P	Dhanpat Rai Publications, New Delhi
2	Welding engineering and technology	Parmar, R.S.	Khanna Publishers, New Delhi
3	Modern arc welding Technology	Nadkarni, S.V.	Advani oerlikon, Mumbai
4	Structural steel fabrication and erection	Saxena, S.K.; Asthana, R.B.	Somaiya Publishers, New Delhi
5	Metal cutting science and production technology	Jain, K.C.; Agrawal L.N.	Khanna Publishers, New Delhi
6	Manufacturing processes (Foundry, Forming and Welding)	Rao P.N.	Mc GRAW HILL
7	Metal Fabrication Technology	Shyamal Mukharjee	PHI
8	Fabrication processes	Sudhir Gadhi	Nexus Stories publication, Surat

9	Fabrication Technology at a glance	Sudhir Gadhi	Nexus Stories publication, Surat
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#### 14. SOFTWARE/LEARNING WEBSITES

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

Unit	Unit Title	LEARNING VIDEOS
I	Introduction.	<p>Concept of weldability  <a href="https://youtu.be/4UHqL7zxVQs?si=11Qzjfe1822rmnT">https://youtu.be/4UHqL7zxVQs?si=11Qzjfe1822rmnT</a>            _ types of electrode  <a href="https://youtu.be/24UHx0dhv-Y?si=c_P7TvPzrYJ0ISvU">https://youtu.be/24UHx0dhv-Y?si=c_P7TvPzrYJ0ISvU</a> PRESSURE VESSEL FABRICATION  <a href="https://youtu.be/Xnje2Iq6sRI?si=Pt4WnlfZoWW7GFPz">https://youtu.be/Xnje2Iq6sRI?si=Pt4WnlfZoWW7GFPz</a></p>
II	Drawing Interpretation	<p>READING OF PRESSURE VESSEL DRAWING  <a href="https://youtu.be/-t2FYGaH5IQ?si=mgTwXi0iwOoi3A5W">https://youtu.be/-t2FYGaH5IQ?si=mgTwXi0iwOoi3A5W</a> READING OF P &amp; ID DRAWING  <a href="https://youtu.be/2VLpV1dpUho?si=0OQJ2vtT6z2QNd8V">https://youtu.be/2VLpV1dpUho?si=0OQJ2vtT6z2QNd8V</a> READING OF P &amp; ID DRAWING  <a href="https://youtu.be/lBJnU1MJAts?si=i4kOFCOd8T9jLtnF">https://youtu.be/lBJnU1MJAts?si=i4kOFCOd8T9jLtnF</a> READING OF PFD  <a href="https://youtu.be/AJjl_eTWyFY?si=vHumHSL8yEyVF">https://youtu.be/AJjl_eTWyFY?si=vHumHSL8yEyVF</a> CII DIFFERENCE BETWEEN PFD AND P&amp;ID  <a href="https://youtu.be/xVQs3aAA1KY?si=0NpEhery8PS0yw">https://youtu.be/xVQs3aAA1KY?si=0NpEhery8PS0yw</a> EM DIFFERENT TYPE OF VALVES  <a href="https://youtu.be/ZAB6LezNJJA?si=KJVNy8UVw2CqJ2wy">https://youtu.be/ZAB6LezNJJA?si=KJVNy8UVw2CqJ2wy</a></p>

III	Fabrication processes	<p>NOZZLE ORIENTATION MARKING ON SHELL  <a href="https://youtu.be/fNahADYpItM?si=8hRHbF2ZSh_ysgI">https://youtu.be/fNahADYpItM?si=8hRHbF2ZSh_ysgI</a>          W NOZZLE SETUP ON DISH END  <a href="https://youtu.be/xWOWsZvdHSc?si=ec8QTKIKpI9ig6zk">https://youtu.be/xWOWsZvdHSc?si=ec8QTKIKpI9ig6zk</a>          NOZZLE SETUP ON PRESSURE VESSEL  <a href="https://youtu.be/W1eohCV1kuM?si=rFb-MYqX4YwRLAYY">https://youtu.be/W1eohCV1kuM?si=rFb-MYqX4YwRLAYY</a>          LIMPET COIL MARKING  <a href="https://youtu.be/KbhbyoWVyLk?si=Pcpu76kWLc5sbEs7">https://youtu.be/KbhbyoWVyLk?si=Pcpu76kWLc5sbEs7</a>          PLATE ROLLING  <a href="https://youtu.be/50DfkV9Y4Dk?si=Hy098E82LfDdLfSh">https://youtu.be/50DfkV9Y4Dk?si=Hy098E82LfDdLfSh</a>          SHELL MAKING FROM PLATE  <a href="https://youtu.be/r9d37h-xaaw?si=2M0SB6ZjgPI3Zo6g">https://youtu.be/r9d37h-xaaw?si=2M0SB6ZjgPI3Zo6g</a>          dish end manufacturing  <a href="https://youtu.be/xFjdnBKOXzI?si=t8wuW0uUirkHuCgj">https://youtu.be/xFjdnBKOXzI?si=t8wuW0uUirkHuCgj</a>          steel structure weight calculation  <a href="https://youtu.be/yI_7B6XEu9o?si=GVPh0qXRL_6fuSg4">https://youtu.be/yI_7B6XEu9o?si=GVPh0qXRL_6fuSg4</a></p>
IV	Inspection and Testing	<p>LPT  <a href="https://youtu.be/bHTRmTQDZzg?si=E2MWITxpKmlg_hl">https://youtu.be/bHTRmTQDZzg?si=E2MWITxpKmlg_hl</a>          MPT  <a href="https://youtu.be/sfjK1GZ2W9A?si=GS7tpM4VSjgc7nB">https://youtu.be/sfjK1GZ2W9A?si=GS7tpM4VSjgc7nB</a>          UT  <a href="https://youtu.be/0SK250WUuNs?si=BMgZXDaEL_esamKL">https://youtu.be/0SK250WUuNs?si=BMgZXDaEL_esamKL</a>          RT  <a href="https://youtu.be/2RwV4AOmM4o?si=W2-Bj5b8RBpRe7_f">https://youtu.be/2RwV4AOmM4o?si=W2-Bj5b8RBpRe7_f</a>          Eddy current testing (ECT)  <a href="https://youtu.be/3fnVjLjDCUw?si=c7xA8t2U8OqAPZU9">https://youtu.be/3fnVjLjDCUw?si=c7xA8t2U8OqAPZU9</a>          hydro test of heat exchanger  <a href="https://youtu.be/ph3oOGABIG4?si=cHqm7m8ZQRN7whz2">https://youtu.be/ph3oOGABIG4?si=cHqm7m8ZQRN7whz2</a>          Helium leak testing  <a href="https://youtu.be/3PLN0K_tTck?si=QT0tIk572D7KCfCg">https://youtu.be/3PLN0K_tTck?si=QT0tIk572D7KCfCg</a></p>
V	Surface preparation, Finishing and Coating Methods	<p>Sand blasting  <a href="https://youtu.be/NBzNCB_HZIE?si=UA63Iw_4MTYcHyMQ">https://youtu.be/NBzNCB_HZIE?si=UA63Iw_4MTYcHyMQ</a>          surface preparation of vessel  <a href="https://youtu.be/VMZXn2PHXaM?si=UMI2Ooa713i5Bk87">https://youtu.be/VMZXn2PHXaM?si=UMI2Ooa713i5Bk87</a>          epoxy coating of structure  <a href="https://youtube.com/shorts/IZQH-3N9bmI?si=8cqqj-2ybH6r70FF">https://youtube.com/shorts/IZQH-3N9bmI?si=8cqqj-2ybH6r70FF</a></p>
VI	Installation, erection and commissioning of process equipment	<p>Pressure vessel equipment erection  <a href="https://youtu.be/bk0gygJR19E?si=QPbq1quR9_80RN0k">https://youtu.be/bk0gygJR19E?si=QPbq1quR9_80RN0k</a>          Pressure vessel equipment erection  <a href="https://youtu.be/zFB1-84Olfw?si=8Zwop-ZR8kjDFI8S">https://youtu.be/zFB1-84Olfw?si=8Zwop-ZR8kjDFI8S</a>          erection of steel structure  <a href="https://youtu.be/PorCp4mslcI?si=QLE_K51AsR7V8tkc">https://youtu.be/PorCp4mslcI?si=QLE_K51AsR7V8tkc</a>          erection of pumps  <a href="https://youtu.be/CDj3HgPD5I8?si=U3n6oyB8JSy3HK9h">https://youtu.be/CDj3HgPD5I8?si=U3n6oyB8JSy3HK9h</a>  <a href="https://youtu.be/uw0T1bp4MbQ?si=8xeaQsUoPWYN">https://youtu.be/uw0T1bp4MbQ?si=8xeaQsUoPWYN</a>  <a href="https://youtu.be/uw0T1bp4MbQ?si=W0hqkrwKKDN0MDU-">https://youtu.be/uw0T1bp4MbQ?si=W0hqkrwKKDN0MDU-</a></p>

**15. PO-COMPETENCY-CO MAPPING**

Semester VI	FABRICATION TECHNOLOGY						
	POs						
Competency  & Course Outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
	Basic & Discipline-	Problem Analysis	Design/ development of	Engineering Tools, Experimentation & Testing	Engineering practices for society, sustainability &	Project Management	Life-long Learning
Competency	Plan, prepare engineering documents, implement and supervise equipment fabrication with reference to fabrication code – standards, using appropriate methods – procedures along with safety norms.						
CO-1 : Interpret term fabrication and weldability.	3	-	-	-	1	-	1
CO-2 : Calculate the material requirements on basis of drawing interpretation.	2	3	3	-	1	2	2
CO-3 : Apply suitable fabrication procedures for equipment manufacturing.	2	1	3	-	2	2	-
CO-4 : Suggest testing & inspection procedures for pre-during-after fabrication work.	3	2	-	3	2	1	2
CO-5: Select suitable surface finishing and coating method for fabricated equipment.	2	-	-	1	3	1	3
CO-6 : Plan process equipment erection & commissioning at site.	2	-	2	1	1	2	1

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

Suggested GTU External exam Question Paper format

MAIN QUE. NO.	SUB QUE. NO.	QUESTION	Marks	CO (Course Outcome)	Cognitive Level (As per Revised Bloom's Taxonomy)
Q.1	(a)	UNIT-1 INTRODUCTION	03	CO-1	R/U/A
પ્રશ્ન.1	(૨૫)		૦૩		

	(b)	UNIT-1 INTRODUCTION	04	CO-1	R/U/A
	(4)		08		
	(c)	MIXED QUESTION FROM UNIT-2. UNIT-3. UNIT-4	07	CO-2,3,4	R/U/A
	(5)		09		
		OR			
	(c)	MIXED QUESTION FROM UNIT-2. UNIT-3. UNIT-4	07	CO-2,3,4	R/U/A
	(5)		09		
Q.2	(a)	UNIT-2 DRAWING INTERPRETATION	03	CO-2	R/U/A
புன்க.2	(24)		03		
	(b)	UNIT-2 DRAWING INTERPRETATION	04	CO-2	R/U/A
	(4)		08		
	(c)	UNIT-2 DRAWING INTERPRETATION	07	CO-2	R/U/A
	(5)		09		
		OR			
Q.2	(a)	UNIT-2 DRAWING INTERPRETATION	03	CO-2	R/U/A
புன்க.2	(24)		03		
	(b)	UNIT-2 DRAWING INTERPRETATION	04	CO-2	R/U/A
	(4)		08		
	(c)	UNIT-2 DRAWING INTERPRETATION	07	CO-2	R/U/A
	(5)		09		
Q.3	(a)	UNIT-3 FABRICATION PROCESSES	03	CO-3	R/U/A
புன்க.3	(24)		03		
	(b)	UNIT-3 FABRICATION PROCESSES	04	CO-3	R/U/A
	(4)		08		
	(c)	UNIT-3 FABRICATION PROCESSES	07	CO-3	R/U/A
	(5)		09		
		OR			
Q.3	(a)	UNIT-3 FABRICATION PROCESSES	03	CO-3	R/U/A
புன்க.3	(24)		03		
	(b)	UNIT-3 FABRICATION PROCESSES	04	CO-3	R/U/A
	(4)		08		
	(c)	UNIT-3 FABRICATION PROCESSES	07	CO-3	R/U/A
	(5)		09		
Q.4	(a)	UNIT-4 INSPECTION AND TESTING	03	CO-4	R/U/A
புன்க.4	(24)		03		
	(b)	UNIT-4 INSPECTION AND TESTING	04	CO-4	R/U/A
	(4)		08		
	(c)	UNIT-4 INSPECTION AND TESTING	07	CO-4	R/U/A

	(5)		09		
		<b>OR</b>			
<b>Q. 4</b>	<b>(a)</b>	UNIT-4 INSPECTION AND TESTING	<b>03</b>	<b>CO-4</b>	<b>R/U/A</b>
પ્રશ્ન.4	(૨૫)		03		
	<b>(b)</b>	UNIT-4 INSPECTION AND TESTING	<b>04</b>	<b>CO-4</b>	<b>R/U/A</b>
	(૫)		04		
	<b>(c)</b>	UNIT-4 INSPECTION AND TESTING	<b>07</b>	<b>CO-4</b>	<b>R/U/A</b>
	(5)		09		
<b>Q.5</b>	<b>(a)</b>	UNIT-5 SURFACE PREPARATION, FINISHING, COATING	<b>03</b>	<b>CO-5</b>	<b>R/U/A</b>
પ્રશ્ન.5	(૨૫)		03		
	<b>(b)</b>	UNIT-5 SURFACE PREPARATION, FINISHING, COATING	<b>04</b>	<b>CO-5</b>	<b>R/U/A</b>
	(૫)		04		
	<b>(c)</b>	UNIT-6 INSTALLATION, ERECTION, COMMISSIONING	<b>07</b>	<b>CO-6</b>	<b>R/U/A</b>
	(5)		09		
		<b>OR</b>			
<b>Q.5</b>	<b>(a)</b>	UNIT-6 INSTALLATION, ERECTION, COMMISSIONING	<b>03</b>	<b>CO-6</b>	<b>R/U/A</b>
પ્રશ્ન.5	(૨૫)		03		
	<b>(b)</b>	UNIT-6 INSTALLATION, ERECTION, COMMISSIONING	<b>04</b>	<b>CO-5</b>	<b>R/U/A</b>
	(૫)		04		
	<b>(c)</b>	UNIT-5 SURFACE PREPARATION, FINISHING, COATING	<b>07</b>	<b>CO-5</b>	<b>R/U/A</b>
	(5)		09		

## 16. COURSE CURRICULUM DEVELOPMENT COMMITTEE (GTU Resource Persons)

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### BOS Resource Persons

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