GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: WELDING INSPECTION & TESTING
(COURSE CODE: 3355505)

Diploma Programme in which this course is offered	Semester in which offered
Fabrication Technology	5th Semester

1. RATIONALE

Welding is one of the major manufacturing Processes which is extensively used in Fabrication Industries. The pass out student will be working in the field of Production, Quality Assurance, Operation and maintenance in Fabrication Industries. It is necessary for the student to learn Various Techniques and methods of welding inspection and Testing. By undergoing learning experiences under this subject, student will know the theory and practice of welding inspection & testing.

2. LIST OF COMPETENCY

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

- **Perform various destructive and non destructive inspection / tests on welded joints for quality assurance.**

3. COURSE OUTCOMES

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

i. Describe importance of welding inspection through third party inspection agency in fabrication industry.
ii. Prepare test plan for given welded job as per ASME / AWS.
iii. Prepare QA/QC plan for given welded job.
iv. Perform LPT / UT / MPT / Eddy current testing on given welded job as per ASME.
v. Describe RT / Acoustic Emission testing method as per ASME.
vi. Describe mechanical testing of weldments as per ASTM / ASME

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
4	0	2	6	70	30	20	30	

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

5. DETAILED COURSE CONTENTS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I Basics of Welding Inspection and Testing	1a. Describe basic elements & illustration of welding & testing symbols. 1b. Develop ethical and essential skills required for welding inspector 1c. Describe importance of welding metallurgy and heat treatment for quality welding	***Basics Of Welding Inspection And Testing :*** 1.1 Scope ,Definition, Application 1.2 Comparison of Welding Symbol with written explanation. 1.3 Basic elements of Testing Symbols as per AWS A2.4 1.4 Examples of typical NDT symbols. 1.5 Basic Testing Symbols 1.6 Illustration of Welding & Testing Symbols. 1.7 Ethical and essential requirements for the Welding Inspector. 1.8 Welding Inspection Operation. 1.9 Quality Assurance for WI&T. 1.10 Welding Metallurgy related to WI&T. - Temperature distribution during welding. - Crystal structure of cold rolled steel in weld area 1.11 Preheating and Post weld Heat Treatment
Unit– II Weld and Weld Related Discontinuities	2a. Describe different weld & weld related discontinuities 2b. Classify welding related Discontinuities 2c. Describe mechanical and chemical weld metal properties	***Weld And Weld Related Discontinuities*** 2.1 Classification of welding related Discontinuities. 2.2 Dimensional Discontinuities - Distortion - Overlap - Desirable, acceptable and unacceptable fillet weld profiles. - Acceptable and unacceptable Butt weld profiles. 2.3 Weldment & related discontinuities. - Porosity - Slag Inclusion - Tungsten inclusions. - Incomplete fusion. - Inadequate Joint Penetration. - Undercut. - Cracks. - Surface Irregularity

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
		2.4 Mechanical and chemical weld metal properties. - Filler metal properties - Base metal properties - Edge laminations - Lamellar Tearing - Arc Strikes
Unit– III Welding Procedure Specification (WPS & PQR)	3a. Describe meaning and application of WPS & PQR for quality welding 3b. Evaluate overall preparation, weld testing and end result.	***Welding Procedure Specifications (Wps & Pqr):*** 3.1 Description , Application important details , Example of Qualification WPS 3.2 Preparation of sample joints 3.3 Testing of representative samples 3.4 Evaluation of overall preparation, welding testing & end results 3.5 Changes in Qualified procedure 3.6 Approval of Test and WPS
Unit– IV Qualification of Welder and Welding Operators	4a. Describe meaning and application of WPQ for quality welding. 4b. Describe performance qualification requirements. 4c. Describe standardisation of tests 4d. Explain importance of test for welder training and retest.	***Qualification Of Welders And Welding Operators (Wpq):*** 4.1 Welding performance qualification 4.2 Performance qualification requirements 4.3 Test specimen 4.4 Testing of qualification welds 4.5 Qualification records 4.6 Standardization of tests 4.7 Relation of qualification tests to welder training 4.8 Retests 4.9 Sample welder qualification test record
Unit-V Destructive Testing of Welds	5a. Describe different destructive test procedures for measurement of different qualities of weldments.	***Destructive Testing Of Welds :*** 5.1 Chemical tests 5.2 Corrosion tests 5.3 Metallographic test 5.4 Tensile test : Introduction, preparation of test specimen, test procedure, results 5.5 Bend test : Introduction & purpose, Types of test & specimen, procedure 5.6 Impact test : Introduction, types, procedure, results 5.7 Nick break test : Purpose, test specimen, procedure 5.8 Hardness test : Purpose, types,

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
		machines, procedure 5.9 Etch test : Introduction, types, concept & purpose, preparation of test specimen
Unit-VI Non-Desctructive Testing of Welds	6a. Describe procedure for different non-destructive tests of weldments. 6b. Distinguish between destructive and non-destructive tests. 6c. Describe codes and standards for passing different non destructive tests. 6d. List national and international standards for NDT. 6e. Compare different non-destructive tests	***Non Destructive Testing Of Welds:*** 6.1 Comparison of destructive & non destructive test 6.2 Visual inspection : - Basic principle, -Defects detected, -Optical aids, -Application 6.3 Liquid Penetrant Testing: -Principle, -Procedure, -Testing materials, -Testing methods, -Sensitivity, -Application, -Limitation, -Codes & Standards 6.4 Magnetic Particle Testing : - -Definition & principle, -Magnetising techniques, -Pprocedure, -Equipment, -Sensitivity, -Limitation, -Codes & Standards 6.5 Eddy Current Testing: -Principle, -Instrumentation, -Techniques, -Sensitivity, -Applications, -Limitations, -Codes & Standards 6.6 Radiographic Testing: -Principle, -Radiation sources, -Radiation attenuation, -Effect of radiation on film, -Radiographic imaging, -Inspection techniques, -Application, -Limitation, -Typical examples, -Safety in industrial radiography,

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
		-Codes & standards 6.7 Ultrasonic testing: -Properties of sound beam, -Transducers, -Inspection methods, -Techniques for normal beam inspection, -Techniques for angle beam inspection, -Flaw characterization techniques, -Equipment, -Modes of display, -Immersion testing, -Application, -Advantages, -Llimitations, -Codes & Standards. 6.8 Acoustic Emission Testing: - -Principle, -Technique, -Instrumentation, -Sensitivity, -Applications, -Codes & standards, -Aacoustic emission testing for leak test 6.9 Leak testing: -Measurement of leakage, -Bubble leak testing, -Helium leak detection, -Codes & Standards 6.10 Comparison of NDT methods 6.11 Selection of NDT of methods 6.12 Codes & standards for NDT 1) Meaning of codes, standard, specification, procedures 2) National & international standards for NDT

6. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (Theory)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total
I	Basics of welding inspection and testing	8	4	4	0	8
II	Weld and weld related discontinuities	6	4	4	0	8
III	Welding procedure specification (WPS & PQR)	6	2	2	4	8
IV	Qualification of welder and welding operators	6	2	2	4	8
V	Destructive testing of welds	8	2	2	4	8
VI	Non-destructive testing of welds	28	6	6	18	30
	Total	**56**	**20**	**20**	**30**	**70**

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

Note : suggested specification table shall be treated as a general guidance for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

7. SUGGESTED LIST OF EXERCISE/PRACTICAL

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 mainly 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

S. No.	Unit No.	EXERCISE / PRACTICAL (Outcomes in psychomotor domain)	Approx. Hours
1	I	a) Compare Welding Symbol with written explanation. Page no.-8 b) Draw Basic elements of Testing Symbols as per AWS A2.4. Page no-8 c) Draw typical NDT and Basic Testing Symbols. Page.no-	8

		11 d) Illustrate Welding & Testing Symbols. Page. No.13	
2	II	a) Draw Desirable, acceptable and unacceptable fillet weld profiles.(Fig.9.2,A,B,&C, Page-43) b) Draw Acceptable and unacceptable Butt weld profiles. (Fig.9.2,D&E, Page-43)	4
3	III	a) Prepare Example of WPS (Fig.10.1& table 10.1, Page-64&65) b) Prepare Qualification data of WPS (Fig.9.19 to 9.22, Page-54)	4
4	IV	Prepare Sample welder qualification test record (Fig. 12.8, Page-84)	2
5	V	Perform Tensile Test on given Job	2
6	V	Perform Impact Test on given Job.	2
7	V	Perform Hardness Test on given Job.	2
8	VI	Perform Liquid Penetrant Test on given Job.	2
9	VI	Perform Magnetic Particle Test on given Job.	2
10	VI	Perform Eddy Current Test on given Job.	2
11	VI	Perform Ultrasonic Test on given Job.	2
12	VI	Prepare Report on: a) Rediograpy Test b) Acoustic Emission Test c) Leak Test d) Visual Test	2
		Total	**34**

8. SUGGESTED LIST OF PROPOSED STUDENT ACTIVITIES

Following is the list of proposed student activities:

i. Prepare sketchbook of drawing of various Welding process, joint details, welding symbol etc
ii. Explore internet and prepare PPT presentation from the topic of syllabus and beyond the syllabus

9. SPECIAL INSTRUCTIONAL STRATEGIES (if any)

i. Arrange visit to nearby industries and show different testing procedures.
ii. Organise workshop for welding inspection & testing.
iii. Arrange expert lectures on latest welding inspection & testing technologies.
iv. Expert video lectures on welding inspection & testing technologies.

10. SUGGESTED LEARNING RESOURCES

A. List of Books

S. No.	Title of Books	Author	Publication
1	Welding Inspection	AWS Committee	American Welding Society
2	Practical Non Destructive Testing	Baldev Raj T.Jaykumar M.Thavasimuthu	Narosa Publishing House
3	NDT Hand BookVol.1&3	ASNT Committee	American Society of Non Destructive Test.
4	Non Destructive Testing Techniques	Ravi Prakash	New Age Science Publication
5	ASME Sec-II,V,VIII,X	ASME Committee	American Society of Mechanical Engineers
6	Welding Technology	O.P.Khanna	Dhanpatrai publication
7	Welding Engineering & Technology	Dr. R.S.Parmar	Khanna Publishers
8	Welding Processes & Technology	Dr. R.S.Parmar	Khanna Publishers
9	Mechanical Design and Fabrication of Process Equipment	B C Bhattacharya	Oscar Publication
10	Welding Technology for Engineers	Baldev raj	Narosha Publishing House
11	Vedio Series on Welding and its Testing	----------	BHEL Trichi and NITTTR Bhopal

B. List of Major Equipment/ Instrument

i. Tensile Test Equipment
ii. Impact Test Equipment
iii. Hardness Test Equipment
iv. Liquid Penetrant Test Kit
v. Magnetic Particle Test Equipment
vi. Eddy Current Test Equipment.
vii. Ultrasonic Test Equipment.
viii. Magnetic Crack Detector Equipment.

C. List of Software/Learning Websites

i. www.nondestructive.co.za
ii. www.globalspec.com
iii. www.aws.org
iv. www.inspecta.com
v. www.iiwindia.com
vi. www.asme.org
vii. www.kusakabekikai.co.jp

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. P.B. Pathak,** Convener & HOD**,** Dept of Fabrication Technology, Sir B.P.I., Bhavnagar
- **Prof. B. K. Gandhi,** Sr. Lecturer, Dept of Fabrication Technology, Sir B.P.I., Bhavnagar
- **Prof. S.Y. Merchant**, Sr. Lecturer, Dept of Fabrication Technology, Sir B.P.I., Bhavnagar

Co-coordinator and Faculty Members from NITTTR Bhopal

- **Dr. A. K. Sarathe,** Associate Professor Deptt. of Mechanical Engineering
- **Dr. C. K. Chugh**, Professor Deptt. of Mechanical Engineering