

**GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT**

**COURSE CURRICULUM  
COURSE TITLE: TESTING OF METALS  
(Code: 3342103)**

<b>Diploma Programme in which this course is offered</b>	<b>Semester in which offered</b>
Metallurgy Engineering	4 <sup>th</sup> Semester

### 1. RATIONALE

Engineers use different materials for various engineering purposes. These materials and solid objects are subjected to various kinds of forces and stresses and often involve the risk of breaking in service and in that situation they cannot be welded or molded instantly. It may take long to further rework on the same to give them shape or they may not be re-shaped at all. Hence, it is necessary to make the material and objects strong enough. To ensure this, these solid objects require various types of destructive and non destructive testing during the manufacturing process so that the risk factor is reduced, facilitating durability and long lasting capacity(or endurance). This course deals with various types of destructive and non destructive test.

### 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:

- **Test and identify various defects in metals and alloys**

### 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 required learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

- Enlist various Testing methods as per IS and ASTM standards.
- Describe various destructive testing methods
- Identify defects by using relevant NDT methods.
- Classify various material characterisation techniques.

### 4 TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	PA	ESE	PA	200
04	00	04	08	70	30	40	60	

**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
<b>Unit – I Importance of Testing</b>	1a. Describe importance of Testing of metals 1b. Explain importance of IS and ASTM standards 1c. Enlist various Testing methods as per IS and ASTM standards.	1.1 Importance of testing of materials. 1.2 Types of testing. 1.3 Merits and demerits of destructive test (DT) and non-destructive test (NDT). 1.4 Importance of IS and ASTM standards. 1.5 IS and ASTM standards for various DT and NDT .
<b>Unit – II Destructive Testing</b>	2a. Describe various destructive testing methods 2b. Explain the process of tensile and compressive testing. 2c. Explain hardness, impact and fatigue test 2d. Describe importance of endurance limit in fatigue. 2e. Explain creep and cupping testing.	2.1 List the destructive test. 2.2 Explain stress-strain diagram. 2.3 Tensile testing: Importance, procedure, calculation, operation and co-relation with other test. 2.4 Compression testing: Importance, procedure. 2.5 Hardness testing: Importance, types of testing, procedure, applications. 2.6 Impact testing: Importance, procedure, types of test. 2.7 Fatigue testing: Explain endurance limit, procedure. 2.8 Creep testing: Importance, procedure. 2.9 Cupping test: Importance, procedure.
<b>Unit – III Non-Destructive Testing</b>	3a. Classify various non-destructive testing. 3b. Check different metals and alloys by visual inspection method. 3c. Explain non destructive tests like: Liquid penetrant test, Magnetic particle test, Ultrasonic test, X-ray and Gamma ray radiography, Eddy current test 3d. Identify defects by using relevant NDT methods.	3.1 Types of non-destructive test. 3.2 Visual inspection: Application, Merits and demerits. 3.3 Procedure, merits, demerits and application of Liquid penetrant test, Magnetic particle test, Ultrasonic test, X-ray and Gamma ray radiography, Eddy current test.
<b>Unit – IV Characterization of metals and alloys</b>	4a. Classify various material characterisation techniques. 4b. Describe briefly TGA, DSC, SEM, TEM, XRF, XRD, AAS and AES	4.1 Importance of materials characterisation 4.2 Classification of material characterisation techniques. 4.3 Introduction, principle and application of TGA, DSC, SEM, TEM, XRF, XRD, AAS and AES

## 6 SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
1	Importance of Testing	06	04	02	00	06
2	Destructive Testing	20	06	08	10	24
3	Non-Destructive Testing	20	06	08	10	24
4	Characterization of metals and alloys	10	08	08	00	16
<b>Total</b>		<b>56</b>	<b>24</b>	<b>26</b>	<b>20</b>	<b>70</b>

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

**Note:** 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.

## 7 SUGGESTED LIST OF EXERCISES/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 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.	Practical/Exercise (Outcomes' in Psychomotor Domain)	Apprx. Hrs. Required
1	II	Determine the tensile strength of M.S. and Al alloys on universal testing machine as per I. S. Code.	04
2	II	Determine the compressive strength of C.I., Brass and Copper as per IS code.	04
3	II	Determine the Impact strength of Cu, Brass, Al, M.S. on Izod impact testing machine as per IS code.	04
4	II	Determine the Hardness by Rockwell hardness tester of Cu, Al and M.S.	04
5	II	Determine the Hardness by Brinell hardness tester of Cu, Al and M.S.	04
6	II	Determine the Hardness by Vicker's hardness test of Cu, Al and M.S.	04
7	II	Determine Fatigue strength of given sample for given sample	02
8	II	Draw and interpret Creep curve based on given data.	02
9	II	Compare Cupping value of low Carbon steel as per IS, BIS, DIN code on Cupping testing machine.	02
10	III	Observe X ray film related to welded joints and casting during	04

S. No.	Unit No.	Practical/Exercise (Outcomes' in Psychomotor Domain)	Apprx. Hrs. Required
		industrial visit and prepare report.	
11	III	Perform the Ultrasonic testing of welded joints and casting	06
12	III	Perform the Magnetic testing for bearing case and welded joints	06
13	III	Perform Liquid penetrant test on welded joints and boiler plate, castings.	06
14	III	Identify Ferrous and Non ferrous material according to their physical properties.	04
<b>Total Hrs</b>			<b>56</b>

## 8 SUGGESTED LIST OF STUDENT ACTIVITIES

- i. Students perform practical and write observations and submit term work in the form of journal.
- ii. Students will visit industries and write report.
- iii. Students in group prepare power point presentation and give seminar on selected topic.

## 9. SPECIAL INSTRUCTIONAL STRATEGIES (If Any)

- i. Arrange Industrial visit
- ii. Show video/animation films photographs depicting different testing methods and equipment used.
- iii. Collect failed samples and discuss the cause of failure and remedial measures.

## 10. SUGGESTED LEARNING RESOURCES

### A. List of Books:

S. No.	Title of Books	Author	Publication
1	Practicals non destructive testing	Baldev Raj	Narosa publications, third edition. 2012
2	Engineering Metallurgy : Applied Physical Metallurgy	R. A. Higgins	Viva Books
3	Testing of metallic materials	Suryanarayan, A.V.K	BS Publication, 2007
3	Elements of metallurgy	Dr. D. Swarup	Rastogi Publication
4	An Introduction to Materials Characterization	P. R. Khangaonkar	Penram International Publishing (India) Pvt. Ltd.

### B. List of Major Equipment/Materials

Universal testing machine, Rockwell hardness testing machine, brinell hardness testing machine, Vickers hardness testing machine, cupping testing machine, liquid penetration test kit, Ultrasonic flow detector, Magnetic particle testing machine, Plates and bars of Aluminium, Mild steel, Stainless steel, Cast iron, Copper, Brass

**C. List of Software/Learning Websites**

- i [http://www.calce.umd.edu/TSFA/Hardness\\_ad\\_.htm](http://www.calce.umd.edu/TSFA/Hardness_ad_.htm)
- ii [http://en.wikipedia.org/wiki/Tensile\\_testing](http://en.wikipedia.org/wiki/Tensile_testing)
- iii [www.nptel.com](http://www.nptel.com)

**11. COURSE CURRICULUM DEVELOPMENT COMMITTEE****Faculty Members from Polytechnics**

- **Dr. I. B. Dave**, HOD (Met. Dept.), Dr S & S. S. Ghandhy College of Engineering and Technology, Surat.
- **Dr. G. H. Upadhyay**, Prof. (Met. Dept.), L. D. College of Engineering, Ahmedabad.
- **Prof.V. N. Kaila**, I/C HOD (Met. Dept.), Government Polytechnic, Rajkot.

**Coordinator and Faculty Members from NITTTR Bhopal**

- **Dr. C.K Chugh**, Professor, Department of Mechanical Engineering
- **Dr. K.K. Jain**, Professor, Department of Mechanical Engineering