GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: Non Destructive Testing
(Code: 4352103)

Diploma Programme in which this course is offered	Semester in which offered
Metallurgy Engineering	5th Semester

1 RATIONALE

Engineering materials plays crucial role in day-to-day applications. Metallurgy engineers plays important role in suggesting and providing optimum and defect free products for the same. various manufacturing process of metallurgy may create defects in the final product and also defects may be generated in service. Hence, it is necessary to detect defect in product and resolve it for the product to be used in application. This course is offered to inculcate fundamentals, methodology, and skills to use various Non-Destructive techniques for defect detection and estimation to ensure desired properties and long product service life. The course ensures eligibility of student's basic knowledge and skills for enrolling in NDT Level II certificate.

2 COMPETENCY

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

- **To suggest and conduct relevant NDT testing method as per standards for given product and provide remedies for detected defect through report of testing.**

3 COURSE OUTCOMES (COs)

At the end of the study of this course the student will be able to:

- CO1: Select an appropriate non-destructive technique as per requirement
- CO2: Apply non-destructive testing methods for a given problem or application.
- CO3: Interpret the types of defects and suggest remedies from the testing result.

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	
2	0	2	3	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

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Perform Liquid penetrant test on welded joints and boiler plate, castings.	02	04
2	Perform the Magnetic testing for bearing case and welded joints	03	04
3	Observe Eddy Current testing during industrial visit and prepare report.	04	04
4	Perform the Ultrasonic testing of welded joints and casting	05	06
5	Observe X ray film related to welded joints and casting during industrial visit and prepare report.	06	06
6	Observe leak and pressure technique during industrial visit and prepare report	07	04
	Total Hours		**28**

Notes:

1. 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.
2. 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.

Sr. No.	Sample Performance Indicators for the PrOs.	Weightage in %
1	Identification of the component and Preparation of experimental Set-up	20
2	Operate equipment set-up	10
3	Observation and recording of the data correctly	10
4	Interpretation of the result and conclusion	20
5	Safety precaution and safety gadgets used	20
6	Submission of report within time limit and attendance in the laboratory	20

6 MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

These major equipment with broad specifications for the PrOs is a guide to procure them by the

administrators to user in uniformity of practical in all institutions across the state.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Dye Penetrant Testing Kit (Cleaner, Penetrant & Developer)	1
2	Magnetic Yoke (230 V and 50 Hz AC supply) Pole distance 300 mm	2
3	Eddy current testing machine for laboratory (portable)	3
4	Digital Ultrasonic Axle Tester (Digiscan DS – 333)	4
5	Portable X- ray systems and X-ray units with pulse technology for radiographic testing	5
6	Leak testing equipment	6

7 AFFECTIVE DOMAIN OUTCOMES

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

- Student will visit local TPI laboratories and observe the standard procedures of various testing methods and prepare reports.
- Student will prepare report of various materials and tools being used in NDT based on observations.
- Student will visit sites where advanced NDT methods are being conducted and make a report

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	Major Learning Outcomes	Topics and Sub-topics
UNIT-I Introduction to NDT	1a. Introduction to NDT 1b. Comparison between DT and NDT 1c. Merits and demerits of NDT 1d. Various types of NDT methods 1e. Visual inspection and its various aid tools	1.1. Brief introduction NDT 1.2. Compare destructive testing and nondestructive testing 1.3. Advantages and limitations in nondestructive testing 1.4. Classify types of NDT testing methods 1.5. Visual inspection: its importance in NDT and tools used for Visual Inspection
UNIT-II Dye/Liquid Penetrant test method	2a. Introduction and principle of DPT/LPT and its procedure 2b. types and characteristics of penetrants testing materials 2c. Various penetrant testing methods 2d. Application and its limitations	2.1. Introduction and principle of DPT/LPT and its procedure steps cleaning, penetrant application removal of penetrant, application of developers and inspection. 2.2. Various types of penetrants testing materials: penetrants cleaners ad emulsifiers, developers, test bocks 2.3. Penetrant testing methods: water washable, post emulsifiable, solvent removable 2.4. Application and limitation of DPT/LPT
UNIT-III Magnetic Particle Testing Method	3a. Introduction and principle of MPT 3b. Magnetizing techniques 3c. MPT procedure 3d. Equipment required for MPT 3e. Its advantages and limitation	3.1. Magnetism: concept and principle 3.2. Magnetizing techniques by: permanent magnet, Electromagnet, Constant current flow, threading bar, coil, induced current 3.3. Procedure of Operating and Producing result of MPT method 3.4. Various components used in MPT method 3.5. Advantages and limitations of MPT method
UNIT-IV Eddy Current testing	4a. Introduction and principle of ECT 4b. Equipment required for ECT 4c. ECT techniques 4d. Its advantages and limitation	4.1. Concept Principle of ECT 4.2. Various components used in MPT method 4.3. ECT techniques: high sensitivity, single frequency, multifrequency, high frequency, 3D or phase array (advance techniques: MOI, Pulse eddy, squid method for information not to be asked in examinations) 4.4. ECT advantages and limitation

UNIT-V Ultrasonic Testing	5a. Introduction of waves and its forms 5b. Principle of UT ,its Technique and Advantages and limitations 5c. Equipment required for UT 5d. Calibration methods 5e. Normal beam inspection 5f. Flaw characterization and types of scan	5.1. Types of sound waves and its propagation 5.2. Principle and working of UT and its advantages and limitations. Inspection methods: normal incident pulse echo and through transmission, angle beam pulse echo, probe selection criteria, penetration and resolution 5.3. Types of transducers and probes for UT 5.4. Calibration method and standard blocks for calibrations 5.5. Normal beam inspection and angle beam inspection methods 5.6. Flaw characterization and A,B,C scan, thickness and defect detection methods
UNIT-VI Radiography Testing method	6a. Principle, source and generation of radiations and its Characteristics 6b. Techniques of RT 6c. Components of RT method 6d. Interpretation of radiography	6.1. Principle of RT, source and Radiation generations X ray and Gamma ray and its properties 6.2. Single wall single image, double wall penetration, latitude, and special techniques of RT 6.3. Types of films, geometric factors, screens, penetrometer and radiographic exposure 6.4. Interpretation of radiography results
UNIT- VII Miscellaneous NDT methods and safety measures	7.a. Leak and pressure techniques 7.b. Thermal techniques 7.c. Safety and precautions in NDT operations	7.1. Leak testing principle, procedure, advantages and limitations 7.2. Thermal testing principle, procedure, advantages and limitations 7.3. Safety and precautions in to be followed as per environment: industrial safety, laboratory safety, disposal of radioactive samples

9 SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to NDT	2	2	2	2	6
II	Dye/Liquid Penetrant test method	4	2	4	3	9
III	Magnetic Particle Testing Method	4	2	4	3	9
IV	Eddy Current testing	5	3	5	4	12
V	Ultrasonic Testing	5	3	6	4	13
VI	Radiography Testing method	6	3	7	4	14
VII	Miscellaneous NDT methods and safety measures	2	2	2	3	7
	Total	28	17	30	23	70

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

1. This specification table shall be treated as a general guideline for students and Teachers. The actual distribution of marks in the question paper may slightly vary from above Table.
2. 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.

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 conduct following activities in group

- Student will visit local TPI laboratories and observe the standard procedures of various testing methods and prepare reports.
- Student will prepare report of various materials and tools being used in NDT based on observations.
- Student will visit sites where advanced NDT methods are being conducted and make a report

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 are 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 need to ensure to create opportunities and provisions for co-curricular activities.
f) Guide students on how to address issues on environment and sustainability.
g) Encourage students to read codes and standards.

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. However, in the fifth and sixth semesters, it should be preferably be individually undertaken to build up the skill and confidence in every student to become problem solver so that he/she contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, 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 total duration of the micro-project should not be less than 16 (sixteen) student engagement hours during the course. The student 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:

1. Collect various material /metal samples and generate NDT reports such as PMI, Spectroscopy etc
2. Prepare reports of weld root testing.
3. Collect samples for Visual inspections.
4. Collect data and interpret and conclude report.
5. Seminar/presentation for relevant development in NDT

13 SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Non-Destructive Testing	Sadashiva M	Publisher: Notion Press ISBN: 9781639977918
2	Non-Destructive Testing - Ndt	Sureshkumar P	Publisher: Notion Press ISBN: 9798889758501
3	Non-Destructive Testing	Dr. S. Roseline	Publisher: Notion Press ISBN: 9798887171319
4	Practical Non-Destructive Testing 3rd Edition	Baldev Raj	Publisher: Narosa ISBN: 978-8173197970,
5	Non-Destructive Test And Evaluation Of Materials, 2 Edition	J Prasad	Publisher: McGraw-Hill Education India ISBN: 978-0070707030

14 SOFTWARE/LEARNING WEBSITES

- https://onlinecourses.nptel.ac.in/noc20_mm07/preview

15 PO-COMPETENCY-CO MAPPING

Semester II	Foundry Technology (Course Code: 4342101)						
	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, Experimentation & Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Manage-ment	PO 7 Life-long learning
Competency	To supervise production of metal casting in foundry with quality using knowledge and skills of various foundry operations.						
CO1: Select an appropriate non-destructive technique as per requirement	3	2	1	1	1	1	2
CO2: Apply non-destructive testing methods for a given problem or application.	3	2	2	2	1	1	2
CO3: Interpret the types of defects and suggest remedies	3	2	2	3	1	1	3

from the testing result.							

16 COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

S. No.	Name and Designation	Institute	Contact details
1.	**Shri Mandar J Joshi** Lecturer Metallurgy Engineering	Dr. S. & S. S. Ghandhy College of Engineering & Technology, Surat	mandarjoshi999@gmail.com
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