



INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTOR

| | | | | | |
|--------------------------|-------------------------------------------------------------------------------------|------------------|----------------|-------------------|----------------|
| Course Title | NON DESTRUCTIVE TESTING | | | | |
| Course Code | AME526 | | | | |
| Programme | B.Tech | | | | |
| Semester | VI | ME | | | |
| Course Type | Professional Elective | | | | |
| Regulation | IARE - R16 | | | | |
| Course Structure | Theory | | | Practical | |
| | Lectures | Tutorials | Credits | Laboratory | Credits |
| | 3 | - | 3 | - | - |
| Chief Coordinator | Mr. A. Venuprasad, Assistant Professor | | | | |
| Course Faculty | Mr. A. Venuprasad, Assistant Professor Mr. A. Anudeep Kumar, Assistant Professor | | | | |

I. COURSE OVERVIEW:

Understand the basic principles of various NDT methods, fundamentals, discontinuities in different product forms, importance of NDT, applications, limitations of NDT methods and techniques and codes, standards and specifications related to non-destructive testing technology. To impart knowledge of advanced NDE Techniques-I and advanced NDE Techniques-II. Overview the concepts, principles, and methods employed for NDT of structures and materials.

II. COURSE PRE-REQUISITES:

| Level | Course Code | Semester | Prerequisites | Credits |
|-------|-------------|----------|---------------------------------|---------|
| UG | AHS007 | I | Applied Physics | 3 |
| UG | AME005 | III | Metallurgy and Material Science | 3 |

III. MARKS DISTRIBUTION:

| Subject | SEE Examination | CIA Examination | Total Marks |
|-------------------------|-----------------|-----------------|-------------|
| Non Destructive Testing | 70 Marks | 30 Marks | 100 |

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

| | | | | | | | |
|---|------------------------|---|----------|---|--------------|---|--------|
| ✓ | Chalk & Talk | ✓ | Quiz | ✓ | Assignments | ✗ | MOOCs |
| ✓ | LCD / PPT | ✗ | Seminars | ✗ | Mini Project | ✓ | Videos |
| ✗ | Open Ended Experiments | | | | | | |

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five units and each unit carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with “either” or “choice” will be drawn from each unit. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

| | |
|------|----------------------------------------------------------------------------------------------|
| 50 % | To test the objectiveness of the concept. |
| 50 % | To test the analytical skill of the concept OR to test the application skill of the concept. |

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

| Component | Theory | | Total Marks |
|-----------|----------|------------|-------------|
| | CIE Exam | Quiz / AAT | |
| CIA Marks | 25 | 05 | 30 |

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz / Alternative Assessment Tool (AAT):

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are to be answered by choosing the correct answer from a given set of choices (commonly four). Marks shall be awarded considering the average of two quizzes for every course. The AAT may include seminars, assignments, term paper, open ended experiments, five minutes video and MOOCs.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

| Program Outcomes (POs) | | Strength | Proficiency assessed by |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------------------------------------|
| PO 1 | Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems. | 2 | Presentation on real-world problems |
| PO 3 | Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations. | 3 | Seminar |
| PO 4 | Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions. | 3 | Seminar |
| PO 5 | Modern tool usage: Create, select and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitation. | 2 | Presentation on real-world problems |

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

| Program Specific Outcomes (PSOs) | | Strength | Proficiency assessed by |
|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------------------------|
| PSO 1 | Professional Skills: To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams. | 1 | Seminar |
| PSO 2 | Problem solving skills: An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability. | 2 | Seminar |
| PSO 3 | Successful career and Entrepreneurship: To build the nation, by imparting technological inputs and managerial skills to become technocrats. | 1 | Seminar |

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

| The course should enable the students to: | |
|-------------------------------------------|-------------------------------------------------------------------------------------------|
| I | Apply the techniques of surface non destructive techniques testing methods. |
| II | Apply of ultrasonic, radiographic techniques. |
| III | Understand advanced NDT technique. |
| IV | Understand the relevant non-destructive testing methods for various engineering practice. |

IX. COURSE LEARNING OUTCOMES (CLOs):

| CLO Code | CLO's | At the end of the course, the student will have the ability to: | PO's Mapped | Strength of Mapping |
|-----------|-------|-----------------------------------------------------------------------------------------------------------------------------|-------------|---------------------|
| AME526.01 | CLO 1 | Understand the visual examination techniques in direct and indirect methods for NDT. | PO 1 | 3 |
| AME526.02 | CLO 2 | Remember the various equipment available for the visual inspection and the codes and standards for non-destructive testing. | PO 1, PO 3 | 3 |

| CLO Code | CLO's | At the end of the course, the student will have the ability to: | PO's Mapped | Strength of Mapping |
|-----------------|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|----------------------------|
| AME526.03 | CLO 3 | Apply the liquid penetrant test that can be used for effective identification of surface cracks in metals. . | PO 1, PO 4 | 2 |
| AME526.04 | CLO 4 | Apply the codes and standards applicable for the liquid penetrant testing in the classification of NDT | PO 1, PO 4, PO 5 | 3 |
| AME526.05 | CLO 5 | Understand the principle of magnetic particle testing and the advantages and limitations of the magnetic particle testing equipment and process. | PO 1, PO 3 | 2 |
| AME526.06 | CLO 6 | Understand the principle of ultrasonic testing and identify the suitable methods for conducting non-destructive testing using the ultrasonic testing equipment. | PO 1, PO 3, PO 4 | 3 |
| AME526.07 | CLO 7 | Evaluate the interpretation procedures for NDT by ultrasonic testing along with its applications. | PO 1 | 2 |
| AME526.08 | CLO 8 | Understand transmission and pulse-echo methods of ultrasonic testing. | PO 1 | 2 |
| AME526.09 | CLO 9 | Evaluate and apply ultrasonic testing and acoustic emission testing and for various particle applications. | PO 1, PO 3 | 3 |
| AME526.10 | CLO 10 | Understand the working principle, advantages, limitations and applications of X-ray film in radiography testing. | PO 1 | 2 |
| AME526.11 | CLO 11 | Remember X-ray films used in industrial radiography and describe the stage of development of X-ray films in radiography testing. | PO 3 | 3 |
| AME526.12 | CLO 12 | Apply the knowledge of radiographic testing method for the NDT of metals for knowing the defects internally present in the metals. | PO 1 | 3 |
| AME526.13 | CLO 13 | Remember the variables and the radiographic image quality improving techniques along with the safety norms to be considered for radiation effects | PO 1, PO 5 | 3 |
| AME526.14 | CLO 14 | Understand various process during interaction of X-ray with matter. . | PO 1 | 2 |
| AME526.15 | CLO 15 | Understand the working principle, advantages, limitations and applications of various advanced radiography techniques viz fluoroscopy testing, xerography, computed tomography. | PO 1, PO 3, | 3 |
| AME526.16 | CLO 16 | Understand the principle of phase array and its technique utilized for the NDT of materials along with the equipment for phase array. | PO 1, PO 5 | 2 |
| AME526.17 | CLO 17 | Remember the verification for flow existence and position for reporting and applications of the phase array | PO 1, PO 4, PO 5 | 2 |
| AME526.18 | CLO 18 | Understand the techniques and interpretation of radiography in the field of phase array techniques and various applications of the process. | PO 1 | 2 |
| AME526.19 | CLO 19 | Remember the special radiographic techniques and the various advantages and limitations of the processes. | PO 1 | 1 |
| AME526.20 | CLO 20 | Understand the acoustic emission inspection method principle and understand its various applications. | PO 1, PO 3, PO 4 | 3 |

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X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

| Course Learning Outcomes (CLOs) | Program Outcomes (POs) | | | | | | | | | | | | Program Specific Outcomes (PSOs) | | |
|---------------------------------|------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|----------------------------------|------|------|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CLO 1 | 3 | | | | | | | | | | | | 1 | 2 | |
| CLO 2 | 3 | | 3 | | | | | | | | | | | 2 | |
| CLO 3 | 2 | | | 2 | | | | | | | | | 1 | 2 | |
| CLO 4 | 3 | | | 3 | 3 | | | | | | | | 1 | 2 | |
| CLO 5 | 2 | | 2 | | | | | | | | | | 1 | 2 | |
| CLO 6 | 3 | | 3 | 3 | | | | | | | | | | 2 | 1 |
| CLO 7 | 2 | | | | | | | | | | | | 1 | 2 | |
| CLO 8 | 2 | | | | | | | | | | | | | 2 | |
| CLO 9 | 3 | | 3 | | | | | | | | | | | 2 | 1 |
| CLO 10 | 2 | | | | | | | | | | | | 1 | | |
| CLO 11 | | | 3 | | | | | | | | | | | 2 | |
| CLO 12 | 3 | | | | | | | | | | | | 1 | 2 | |
| CLO 13 | 3 | | | | 2 | | | | | | | | 1 | 2 | |
| CLO 14 | 2 | | | | | | | | | | | | 1 | | 1 |
| CLO 15 | 3 | | 3 | | | | | | | | | | 1 | 2 | |
| CLO 16 | 2 | | | | 2 | | | | | | | | | 2 | 1 |
| CLO 17 | 2 | | | 2 | 2 | | | | | | | | 1 | | |
| CLO 18 | 2 | | | | | | | | | | | | | 2 | |
| CLO 19 | 1 | | | | | | | | | | | | | 2 | |
| CLO 20 | 3 | | 3 | 3 | | | | | | | | | 1 | 2 | |

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XI. ASSESSMENT METHODOLOGIES – DIRECT

| | | | | | | | |
|----------------------|------------------------------|--------------|------------------------------|--------------|------|---------------|------|
| CIE Exams | PO 1 PO 3 PO 4 PO 5 | SEE Exams | PO 1 PO 3 PO 4 PO 5 | Assignments | PO 1 | Seminars | PO 2 |
| Laboratory Practices | - | Student Viva | PO 1 | Mini Project | PO 1 | Certification | - |
| Term Paper | - | | | | | | |

XII. ASSESSMENT METHODOLOGIES – INDIRECT

| | | | |
|---|----------------------------------------|---|---------------------------|
| ✓ | Early Semester Feedback | ✓ | End Semester OBE Feedback |
| ✓ | Assessment of Mini Projects by Experts | | |

XIII. SYLLABUS

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|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|
| UNIT-I | SURFACE NDE METHODS |
| Visual examination, direct and indirect methods, equipment, codes and standards, liquid penetrant testing, variables, interpretation and evaluation of test results, applicable codes and standards, magnetic particle testing, principle, equipment, advantages and limitations. | |
| UNIT-II | ULTRASONIC TESTING |
| Principle of ultrasonic testing, methods, equipment, evaluation, interpretation, applications. | |
| UNIT-III | RADIOGRAPHIC TESTING |
| Principles, films, radiography equipment, variables, radiographic image quality, techniques, safety. | |
| UNIT-IV | ADVANCED NDE TECHNIQUES-I |
| Principle of phase array, technique, equipment, verification of flow existence and position, reporting, application, special radiographic techniques and interpretation of radiography, advantages and limitations. | |
| UNIT-V | ADVANCED NDE TECHNIQUES-II |
| Acoustic, emission inspection, principles and applications, leak testing, principles and applications, industrial computed tomography principles and applications. | |
| Text Books: | |
| <ol style="list-style-type: none"> 1. J. Prasad, C.G.K Nair, —Non-destructive Test and Evaluation of materialsl, Tata McGraw-Hill, 2nd Edition, 2011. 2. J. Krautkramer, H. Krautkramer, —Ultrasonic Testing of materiall, Springer, 4th Edition, 1990 | |
| Reference Books: | |
| <ol style="list-style-type: none"> 1. B. Raj, T. Jayakumar, M. Thavasinumuthu, —Practical Non-destructive Testingl, Alpha science International Limited, 3rd Edition, 2002. 2. R. Halshaw, —Industrial Radigraphy: Theory and Practicel, Springer, 2nd Edition, 1995. 3. ASM, —Non–destructive examination and quality controll, ASM International, volume17, 9th Edition, 1989. | |

XIV. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

| Lecture No | Topics to be covered | Course Learning Outcomes (CLOs) | Reference |
|------------|-----------------------------------------------------------------------|---------------------------------|----------------|
| 1 | Outline of various units | CLO 1 | T1:1.4, R1:1.2 |
| 2-5 | Explain the Visual examination, direct and indirect methods | CLO 1 | T1:1.5, R1:2.4 |
| 6-7 | Explain equipment, codes and standards | CLO 1 | T1:2.5, R1:2.5 |
| 8-10 | Explain liquid penetrant testing, variables, interpretation. | CLO 1 | T1:2.5, R1:2.6 |
| 11-12 | Discuss evaluation of LT test results, applicable codes and standards | CLO 4 | T1:2.7 |

| Lecture No | Topics to be covered | Course Learning Outcomes (CLOs) | Reference |
|------------|----------------------------------------------------------------------------|---------------------------------|------------------|
| 13-14 | Explain magnetic particle testing principle. | CLO 6 | T1:3.1, R1:5.3 |
| 15-17 | Discuss magnetic particle equipment, advantages and limitations | CLO 7 | T1:3.2, R1:5.3.6 |
| 18-21 | Explain principle of ultrasonic testing and methods | CLO 7 | T1:7.1, R1:6.3 |
| 22-24 | Discuss Equipment, evaluation, interpretation and applications. | CLO 7 | T1:7.3, R1:6.3 |
| 25-27 | Explain principles, films, radiography equipment. | CLO 7 | T1:8.1, R1:6.8 |
| 28 | Discuss radiographic image quality. | CLO 7 | T1:8.2, R1:13.1 |
| 29-30 | Discuss techniques and safety of radiographic testing. | CLO 9 | T1:8.3, R1:13.2 |
| 31-32 | Explain Principle of phase array. | CLO 10 | T1:9.1, R1:13.7 |
| 33-36 | Discuss technique, equipment, verification of flow existence and position. | CLO 11 | T1:9.2, R1:10.2 |
| 37-39 | Discuss the reporting, application and special radiographic techniques. | CLO 12 | T1:9.3, R1:10.3 |
| 40-42 | Discuss the interpretation of radiography, advantages and limitations. | CLO 12 | T1:9.4, R1:11.9 |
| 43-45 | Discuss the Advanced NDE techniques. | CLO 12 | T1:11.1, R1:11.5 |
| 46-48 | Explain the acoustic emission inspection principles and applications | CLO 12 | T1:11.2 |
| 49-52 | Discuss the leak testing, principles and applications | CLO 18 | T1:11.3, R1:17.2 |
| 53-56 | Explain the Industrial computed tomography principles | CLO 19 | T1:11.4, R1:17.4 |
| 56-58 | Discuss the industrial computed tomography applications. | CLO 20 | T1:11.6 R1:18.5 |
| 59-60 | Compare the advanced NDE techniques I and advanced NDE techniques II. | CLO 21 | T1:8.1, T1:8.2 |

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

| S NO | Description | Proposed actions | Relevance with POs | Relevance with PSOs |
|------|--------------------------------------------------------------------------------------------------|----------------------------|--------------------|---------------------|
| 1 | To improve standards and analyze the concepts. | Seminars/ Guest Lecture | PO 1, PO 4 | PSO 1 |
| 2 | Encourage students to learn advanced NDE techniques. | Seminars / NPTEL | PO 4, PO3 | PSO 2 |
| 3 | Encourage students to solve real time applications and prepare towards competitive examinations. | NPTEL | PO 5 | PSO 3 |

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