

DEPARTMENT OF PHYSICS  
 NATIONAL INSTITUTE OF TECHNOLOGY, TIRUCHIRAPPALLI.  
 Course Plan for I M.Tech. Non-Destructive Testing (NDT)

| COURSE PLAN – PART I                    |  |                          |                 |
|---|--|--------------------------|-----------------|
| Course Title                            | ADVANCED NDE TECHNIQUES I  |                          |                 |
| Course Code                             | PH602  | No. of Credits           | 3               |
| Course Code of Pre-requisite subject(s) | NIL  |                          |                 |
| Session                                 | JANUARY 2019   | Section (if, applicable) | N.A.            |
| Name of Faculty                         | M.MANIMOHAN  | Department               | Physics         |
| Email                                   | manmobhel@gmail.com  | Telephone No.            | 9442503011      |
| Name of Course Coordinator(s)           | Prof. Dr. B. Karthikeyan   |                          |                 |
| E-mail                                  | bkarthik@nitt.edu  | Telephone No.            | (0431) 250-3612 |
| Course Type                             | <input checked="" type="checkbox"/> Core course <input type="checkbox"/> Elective course |                          |                 |

Syllabus (approved in BoS)

**Phased Array Techniques**

Principles of phased array inspection – phased array probes and their characteristics – Phased array wedges – Focal law - Beam shaping, steering-Scanning with phased array probes- linear, sectorial, C scan. Instrumentation – phased array instruments, calibration methods, checking probe elements – beam angles and beam shape – data collection and data analysis, principles of data analysis – data acquisition, defect detection, sizing, interpretation and characterization – procedures for verification of flaw existence and position, reporting, applications – Case studies.

**Time of Flight Diffraction**

Theory and principles of Time of Flight Diffraction (TOFD) –Data acquisition and interpretation – TOFD techniques – selection of probe angle – calibration and optimization, optimizing angles – flaw location and sizing – types of scan, equipment requirements – advantages, limitations of detection and resolution – codes and standards – interpretation, evaluation, applications, case studies. *Introduction to Synthetic Aperture Focusing Technique (SAFT).*

**Ultrasonic Guided Waves**

Basics of guided waves – Generation of guided waves – Dispersion curves –Modes in guided waves – advantages and limitations – Applications, few case studies. Introduction to EMAT

**Optical methods in Ultrasonic**

Laser Ultrasonic –bulk wave and lamb wave generation mechanisms – optical detection of ultrasound – measurement of in plane displacement and velocity – Laser shearography – Applications.

**Structural Health Monitoring (SHM)**

methods- strain gauging- genetic algorithm- AI-ANN-AE-Neural network-cluster-pattern recognition-condition monitoring- vibration methods-thermography -life and integrity assessment.

**COURSE OBJECTIVES**

To introduce students with the recent advances in the field of Advanced NDE Techniques and to equip them with the knowledge of different process for a better evaluation in complex geometries.

**COURSE OUTCOMES (CO)**

| Course Outcomes  | Aligned Programme Outcomes (PO)  |
|--|--|
| <ol style="list-style-type: none"> <li>To have a better knowledge in the field of advanced techniques in ultrasonic NDE.</li> <li>To plot dispersion curves and perform long range inspection using guided waves for plates, pipes and rods.</li> <li>To size the defects using TOFD technique.</li> <li>To carry out examination by optical techniques to measure the displacement and velocity.</li> <li>To differentiate various defect types and select the appropriate NDT method for inspecting the component</li> </ol> | <p>Knowledge on advance NDT methods used in industries, Hands on experience with advanced NDT equipment's Training on detection and analysis of the defects.</p> |

**COURSE PLAN – PART II****COURSE OVERVIEW**

Fundamental of PA ultrasonic, ToFD, Guided wave ultrasonics, Laser shearography , structural Health Monitoring and its usage in the NDT. Methods of calibration of instrument and evaluation of signals.

**COURSE TEACHING AND LEARNING ACTIVITIES**

| Sl.No | Date       | Day      | Time        | Topics  | Presentation     |
|-------|------------|----------|-------------|---|------------------|
| 1     | 24.01.2019 | Thursday | 9.20-10.10  | Ultrasonic Testing Basic  | PPT+ Black Board |
| 2     | 25.01.2019 | Friday   | 10.30-11.20 | Ultrasonic Testing Basic  | PPT              |
| 3     | 25.01.2019 | Friday   | 11.20-12.10 | Basics of PAUT, phased array probes and their characteristics       | PPT              |
| 4     | 31.01.2019 | Thursday | 9.20-10.10  | Phased array wedges, Focal law sequencing                           | PPT              |
| 5     | 01.02.2019 | Friday   | 10.30-11.20 | Beam shaping, steering  | PPT+ Black Board |
| 6     | 01.02.2019 | Friday   | 11.20-12.10 | Beam shaping, steering  | PPT              |
| 7     | 07.02.2019 | Thursday | 9.20-10.10  | Scanning with phased array probes-linear, sectorial, C scan mapping | PPT              |
| 8     | 08.02.2019 | Friday   | 10.30-11.20 | Instrumentation – phased array instrument, calibration methods      | PPT              |
| 9     | 08.02.2019 | Friday   | 11.20-12.10 | data collection and data analysis, data acquisition                 | PPT+ Black Board |
| 10    | 14.02.2019 | Thursday | 9.20-10.10  | defect detection, sizing,   | PPT+ Black       |

|    |            |          |             |   |                  |
|----|------------|----------|-------------|---|------------------|
|    |            |          |             | interpretation and characterization   | Board            |
| 11 | 15.02.2019 | Friday   | 10.30-11.20 | procedures for verification of flaw existence and position, reporting, applications | PPT+ Black Board |
| 12 | 15.02.2019 | Friday   | 11.20-12.10 | Case studies. Applications  | PPT              |
| 13 | 21.02.2019 | Thursday | 9.20-10.10  | Theory and principles of Time of Flight Diffraction (TOFD)                          | PPT              |
| 14 | 22.02.2019 | Friday   | 10.30-11.20 | Data acquisition and interpretation TOFD techniques – selection of probe angle –    | PPT              |
| 15 | 22.02.2019 | Friday   | 11.20-12.10 | calibration and optimization, optimizing angles flaw location and sizing –          | PPT+ Black Board |
| 16 | 28.02.2019 | Thursday | 9.20-10.10  | types of scan, equipment requirements   | PPT              |
| 17 | 01.03.2019 | Friday   | 10.30-11.20 | advantages, limitations of detection and resolution – codes and standards           | PPT              |
| 18 | 01.03.2019 | Friday   | 11.20-12.10 | interpretation, evaluation, applications,   | PPT+ Black Board |
| 19 | 07.03.2019 | Thursday | 9.20-10.10  | case studies.   | PPT              |
| 20 | 08.03.2019 | Friday   | 10.30-11.20 | Introduction to Synthetic Aperture Focusing Technique (SAFT).                       | PPT              |
| 21 | 08.03.2019 | Friday   | 11.20-12.10 | Basics of guided waves  | PPT+ Black Board |
| 22 | 14.03.2019 | Thursday | 9.20-10.10  | Generation of guided waves  | PPT              |
| 23 | 15.03.2019 | Friday   | 10.30-11.20 | Dispersion curves ,Modes in guided waves  | PPT              |
| 24 | 15.03.2019 | Friday   | 11.20-12.10 | advantages and limitations – Applications, case studies                             | PPT+ Black Board |
| 25 | 21.03.2019 | Thursday | 9.20-10.10  | Introduction to EMAT  | PPT              |
| 26 | 22.03.2019 | Friday   | 10.30-11.20 | Laser Ultrasonic  | PPT+ Black Board |
| 27 | 22.03.2019 | Friday   | 11.20-12.10 | bulk wave and lamb wave generation mechanisms                                       | PPT              |
| 28 | 28.03.2019 | Thursday | 9.20-10.10  | optical detection of ultrasound   | PPT              |
| 29 | 29.03.2019 | Friday   | 10.30-11.20 | measurement of in plane displacement and velocity                                   | PPT+ Black Board |
| 30 | 29.03.2019 | Friday   | 11.20-12.10 | Laser shearography  | PPT              |
| 31 | 04.04.2019 | Thursday | 9.20-10.10  | Applications.   | PPT+ Black Board |
| 32 | 05.04.2019 | Friday   | 10.30-11.20 | Structural Health Monitoring (SHM) Methods  | PPT              |
| 33 | 05.04.2019 | Friday   | 11.20-12.10 | strain gauging-   | PPT              |
| 34 | 11.04.2019 | Thursday | 9.20-10.10  | genetic algorithm, AI-ANN-AE-Neural network-  | PPT              |
| 35 | 12.04.2019 | Friday   | 10.30-11.20 | pattern recognition-condition   | PPT              |

|    |            |          |             |                                |                  |
|----|------------|----------|-------------|--------------------------------|------------------|
|    |            |          |             | monitoring-                    |                  |
| 36 | 12.04.2019 | Friday   | 11.20-12.10 | vibration methods              | PPT+ Black Board |
| 37 | 18.04.2019 | Thursday | 9.20-10.10  | thermography                   | PPT+ Black Board |
| 38 | 19.04.2019 | Friday   | 10.30-11.20 | life and integrity assessment. | PPT+ Black Board |
| 39 | 19.04.2019 | Friday   | 11.20-12.10 | Case studies                   | PPT+ Black Board |

#### COURSE ASSESSMENT METHODS

| S.No. | Mode of Assessment | Week/Date                          | Duration | % Weightage  |
|-------|--------------------|------------------------------------|----------|--------------|
| 1     | CT -1              | 1 <sup>st</sup> week of March 2019 | 1 hour   | 20%          |
| 2     | CT -2              | Last week of March 2019            | 1 hour   | 20%          |
| 3     | Assignment         | 3 <sup>rd</sup> Week of April      | 1 hour   | 10%          |
| 4     | Final Exam         | End of Semester                    | 3 Hours  | 50%          |
|       |                    | <b>Total</b>                       |          | <b>100 %</b> |

**ESSENTIAL READINGS :** Textbooks, reference books Website addresses, journals, etc

#### Text Books& Reference Books::

1. J. L. Rose, Ultrasonic waves in solid media, Cambridge University Press, (2004).
2. T. Kundu, Ultrasonic Non-Destructive Evaluation: Engineering and Biological Material Characterization, CRC Press, 1 st edition, (2003).
3. L. W. Schmerr, Fundamentals of Ultrasonic Phased Arrays, Springer, (2014)
4. Phased Array Testing: Basic Theory for Industrial Applications, Olympus NDT, (2004).
5. Introduction to Phased Array Ultrasonic Technology Applications, R/D Tech, (2004).

Website addresses :ndt.net

- Journal:Journal of Non- Destructive Testing & evaluation.

#### COURSE EXIT SURVEY

- Feedback from the student after 18<sup>th</sup> week: on knowledge gained, subjects relevant to the course, methodology adopted, aspect of improvement. Whether the topics fulfill the course outcome and program outcome.

#### COURSE POLICY (including plagiarism, academic honesty, attendance, etc.)

- Absenteeism in Assessment: Extra chances will be given to the students (on medical or official purpose) not appeared in any assessments 1 - 3 with full syllabus.

#### ADDITIONAL COURSE INFORMATION

The Course Coordinator is available for consultation at times that are displayed on the coordinator's

office notice board. Queries may also be emailed to the Course Coordinator directly at [bkarthik@nitt.edu](mailto:bkarthik@nitt.edu)

**MODE OF CORRESPONDENCE (email/ phone etc.)**

- Class representatives can contact the Faculty using Email [manmobhel@gmail.com](mailto:manmobhel@gmail.com) or Phone **9442503011**.
- Students other than class representatives shall contact only for any necessary requirements.

**ATTENDANCE**

- It is mandatory to have a min. of 75% attendance to appear in the semester examination.
- Already, 25% of attendance has been relaxed for any sickness, family ceremony / festivals and academic / sport activities or any industrial visits etc.
- Student(s) having less than 75% attendance may not be allowed in the Final Assessment.
- NITT approved on-duty (OD) and genuine medical certificates will be considered.

**COMPENSATION ASSESSMENT**

- There will be one compensation assessment for all those who miss writing Test I or Test II or both for genuine permissible reasons (sickness and institute approved ODs).
- No compensation assessment will be available for improving the score in any assessments.

**ACADEMIC HONESTY & PLAGIARISM**

- Those who indulge in malpractice such as copying, plagiarism will get punishment which may lead to REDO the course (depending on the actual intensity of the activity).

**ADDITIONAL INFORMATION**

- Those who fail in the course can appear for the supplementary exam.
- Any misbehavior, indiscipline in the classroom / examination hall will be dealt with seriously. In the worst case, the institute's disciplinary committee is empowered to debar the student from the course.

**FOR SENATE'S CONSIDERATION**

(Sd)

M.Manimohan  
Course Faculty

(Sd)

CC-Chairperson

(Sd)

HOD