

**UNIVERSITY COLLEGE TATI (UC TATI)****FINAL EXAMINATION QUESTION BOOKLET**

COURSE CODE	: DND 3034
COURSE	: ULTRASONIC TESTING II
SEMESTER/SESSION	: 2-2024/2025
DURATION	: 3 HOURS

Instructions:

1. This booklet contains **4** questions. Answer **all** questions.
2. All answers should be written in answer booklet.
3. Write legibly and draw sketches wherever required.
4. If in doubt, raise up your hands and ask the invigilator.

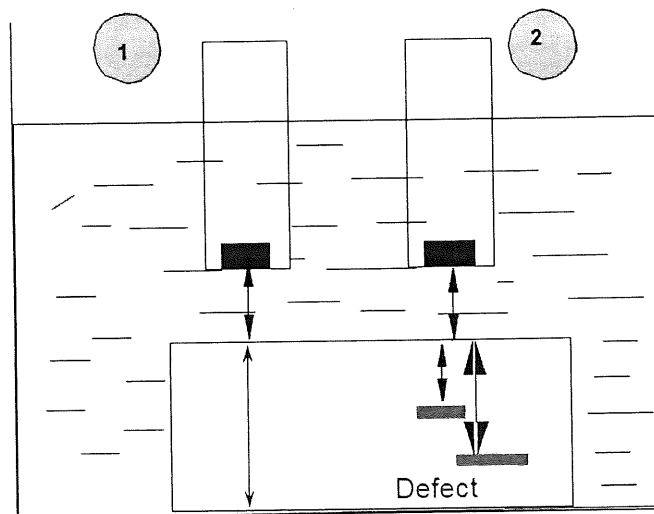
DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO

THIS BOOKLET CONTAINS 6 PRINTED PAGES INCLUDING COVER PAGE

DND 3034 ULTRASONIC TESTING II

QUESTION 1

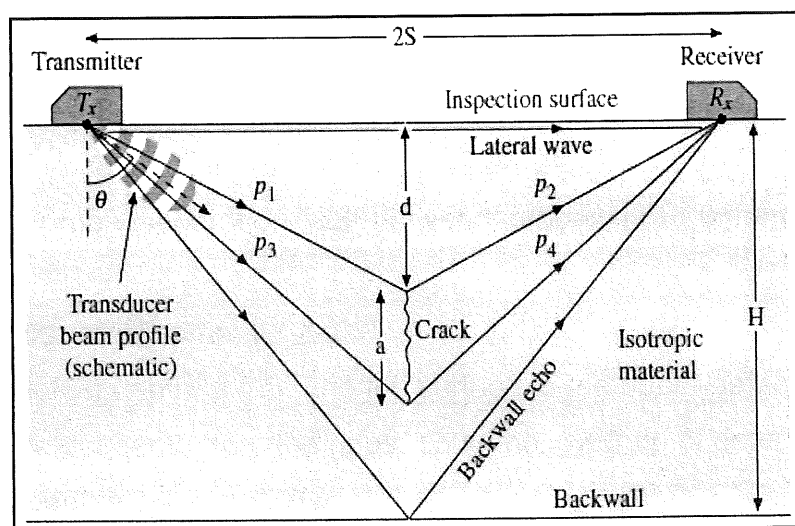
- a) In Immersion Testing, the transducer is placed in the water, above the test object, and a beam of sound is projected.
- Define the immersion testing of Ultrasonic Testing (3 marks)
 - Describe **two (2)** advantages of immersion tanks technique (4 marks)
 - Calculate the minimum water gap distance from front probe to front steel wall if the steel length, width and height are 200 mm, 100 mm and 60 mm respectively. (4 marks)
 - Illustrate and label all the signals of Immersion testing for position 2 in figure 1. (9 marks)

**Figure 1**

- b) Interpret in detail the Acceptance-Rejection Standards for the ASME BPVC VIII, Mandatory Appendix 12, Ultrasonic Examination of Welds. (20 marks)

QUESTION 2

- a) Time of Flight Diffraction (TOFD) technique is based on diffraction of ultrasonic energy from tips of discontinuities, instead of geometrical reflection on the interface of the discontinuities (conventional UT).
- List **four (4)** different types of sound waves are generated in the construction of a TOFD image. (4 marks)
 - Describe **two (2)** advantages of TOFD technique compared to conventional UT technique. (4 marks)
- b) Figure 2 shows the sound propagation in TOFD technique. 32 mm double-vee butt weld pipe of Stainless Steel is prepared to be inspected by using TOFD technique. The second arrival time, t_1 is $17.86 \mu\text{s}$ and the third arrival time, t_2 is $20 \mu\text{s}$. The probe separation, **2S** between probes is 100 mm. Calculate the followings:
- The first arrival time, t_L . (2 marks)
 - The defect depth, **d** from the top surface to the upper defect tip. (4 marks)
 - The defect depth from the upper tip to the lower tip of defect, **a**. (4 marks)
 - The fourth arrival time, t_{BW} . (2 marks)

**Figure 2**

DND 3034 ULTRASONIC TESTING II

QUESTION 3

- a) Phased Array Ultrasound Testing (PAUT) is an advanced method of ultrasound testing. Phased Array differs from conventional Ultrasound testing in many ways.
- State **four (4)** basic parameters of Phased Array probes. (4 marks)
 - Explain **three (3)** advantages of PAUT. (6 marks)
 - Describe **two (2)** main differences between Phased Array Ultrasound Testing and Conventional Method Ultrasonic Testing. (4 marks)
- b) 12-inch Carbon Steel butt weld pipe test piece is prepared to be tested by using shear wave PAUT probe. The test frequency is 15 MHz and the individual element size, e is 0.452 mm. calculate the followings:
- The ultrasonic wavelength. (2 marks)
 - The maximum steering angle for Phased Array inspection. (4 marks)

DND 3034 ULTRASONIC TESTING II

QUESTION 4

- a) Internal Rotary Inspection System (IRIS) is an ultrasonic method for the nondestructive testing of pipes and tubes. The IRIS probe is inserted into a tube that is flooded with water, and the probe is pulled out slowly as the data is displayed and recorded.
- List **five (5)** type of signals generated by the Internal Rotary Inspection System (IRIS) on steel tube that contain no defect. (5 marks)
 - Explain the general concepts of ultrasound generation and propagation in IRIS. (7 marks)
- b) 8 meter length of Brass tube was inspected by using IRIS. The results show that, the time taken for the first echo, T_0 and second echo, T_1 are $34.1 \mu\text{s}$ and $38.8 \mu\text{s}$ respectively. The delay time, T_{delay} is $30.4 \mu\text{s}$. Calculate the followings:
- The remaining wall thickness, **WT** of Brass tube. (4 marks)
 - The internal diameter, **ID** of Brass tube. (4 marks)

-----End of Question-----

DND 3034 ULTRASONIC TESTING II

ATTACHMENT 1

Table 1: Material Velocity

Medium	Compression Velocity (m/s)	Shear Velocity (m/s)	Acoustic Impedance, Z
Air	330	-	0
Aluminium	6400	3130	17.2
Brass	4370	2100	37
Cast iron	3500	2200	25
Copper	4760	2330	42.5
Gold	3240	1200	63
Oil	1440	-	1.3
Perspex	2740	1320	3.2
Carbon steel	5960	3240	46.5
Stainless steel	5740	3130	44.8
Silver	3700	1700	36.9
Tin	3380	1610	24.7
Tungsten	5170	2880	100
Water	1480	-	1.48

$$WT = v_{tube} \cdot \frac{(T1 - T0)}{2}$$

$$t_L = \frac{2S}{C}$$

$$ID = v_{water} \cdot (T0 - Delay)$$

$$t_1 = \frac{2\sqrt{S^2 + d^2}}{C}$$

$$d = \frac{1}{2} \sqrt{C^2 t_1^2 - 4S^2}$$

$$t_2 = \frac{2\sqrt{S^2 + (d + a)^2}}{C}$$

$$a = \frac{1}{2} \sqrt{C^2 t_2^2 - 4S^2} - d$$

$$t_{bw} = \frac{2\sqrt{S^2 + H^2}}{C}$$

-----End of Attachment-----