UNIVERSITY COLLEGE TATI

UNIVERSITY COLLEGE TATI (UC TATI)

FINAL EXAMINATION QUESTION BOOKLET	
COURSE CODE	: DND 3034
COURSE	: ULTRASONIC TESTING II
SEMESTER/SESSION	: 1-2024/2025
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 7 PRINTED PAGES INCLUDING COVER PAGE

QUESTION 1

a) In Immersion Testing, the transducer is placed in the water, above the test object, and a beam of sound is projected.

i. Define the immersion testing of Ultrasonic Testing (3 marks)

ii. List **four (4)** applications of immersion testing. (4 marks)

iii. Describe **two (2)** advantages of immersion tanks technique (4 marks)

iv. Illustrate and label all the signals of Immersion testing for position 2 in figure 1. (6 marks)

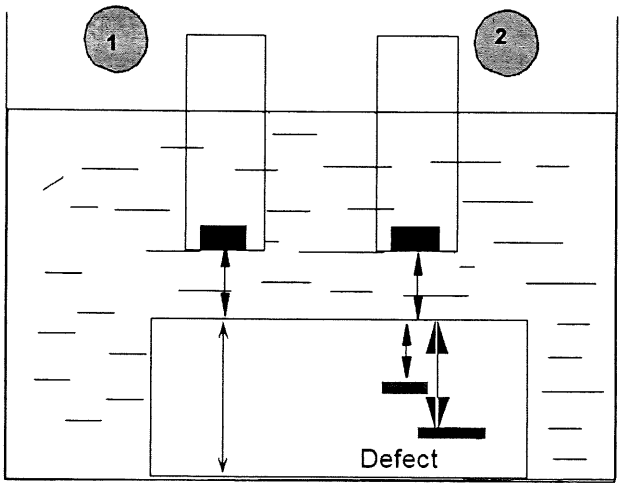

Figure 1

b) The reference level, **b** at 50 % FSH is 55 dB. The maximum signal amplitude indication is obtained at 90 % FSH by using 60° probe. The indication beam path is 54 mm, defect length is 30 mm and the plate thickness is 45 mm. By referring to Table 8.2 Ultrasonic Acceptance-Rejection Criteria for Statically Loaded Non-Tubular Connections, calculate the followings:

i. The indication level, **a**. (3 marks)

ii. The attenuation factor, **c**. (3 marks)

iii. The indication rating, **d** including discontinuity severity class. (4 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).

i. List **four (4)** different types of sound waves are generated in the construction of a TOFD image. (4 marks)

ii. Describe **two (2)** advantages of TOFD technique compared to conventional UT technique. (4 marks)

b) Figure 2 shows the sound propagation in TOFD technique. 40 mm double-vee butt weld pipe of Carbon Steel is prepared to be inspected by using TOFD technique. The second arrival time, t_1 is 17.5 μs and the third arrival time, t_2 is 19.6 μs. The probe separation, **2S** between probes is 100 mm. Calculate the followings:

i. The defect depth, **d** from the top surface to the upper defect tip. (4 marks)

ii. The defect depth from the upper tip to the lower tip of defect, **a**. (5 marks)

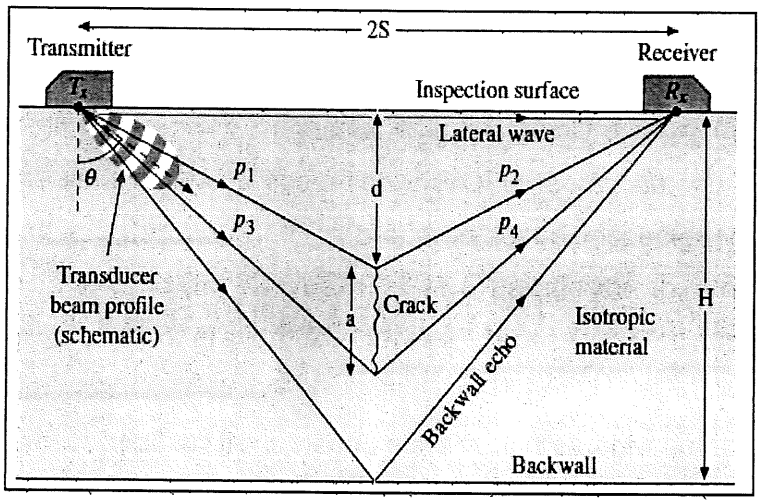

Figure 2

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.

i. State **four (4)** basic parameters of Phased Array probes. (4 marks)

ii. Explain **two (2)** advantages of PAUT. (4 marks)

iii. Describe **two (2)** main differences between Phased Array Ultrasound Testing and Conventional Method Ultrasonic Testing. (4 marks)

b) 16-inch Carbon Steel butt weld pipe test piece is prepared to be tested by using shear wave PAUT probe. The test frequency is 18 MHz and the individual element size, **e** is 0.452 mm. Calculate the maximum steering angle for Phased Array inspection. (5 marks)

c) Figure 3 shows two pieces of carbon steel plate with nominal thickness for each plate are 40 mm and 45 mm respectively was welded and inspected by using ultrasonic testing. Slag inclusion was found during the inspection by using 45°shear wave probe. The length of Slag inclusion is 25 mm. The defect depth is 30 mm and the d rating is about +12.4 dB. Interpret the result of Ultrasonic Testing by referring the Table 8.3 UT Acceptance-Rejection Criteria (Cyclically Loaded Non-Tubular Connections in Tension). (7 marks)

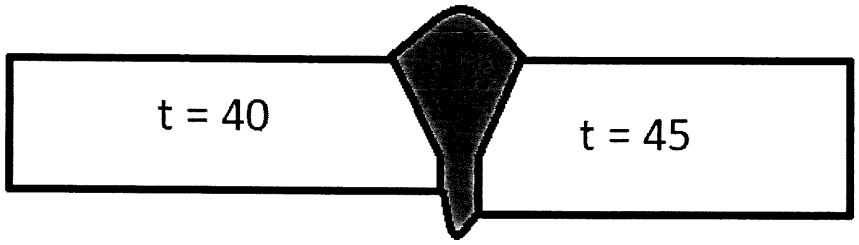

Figure 3

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.

i. List **five (5)** type of signals generated by the Internal Rotary Inspection System (IRIS) on steel tube that contain no defect. (5 marks)

ii. Explain the general concepts of ultrasound generation and propagation in IRIS. (6 marks)

b) The 6-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 34.2 μs and 37.4 μs respectively. The delay time, T_{delay} is 30.12 μs. Calculate the followings:

i. The remaining wall thickness, **WT** of Brass tube. (3 marks)

ii. The internal diameter, **ID** of Brass tube. (3 marks)

c) The ASME BPVC is the world's most comprehensive collection of codes of practice governing the design, fabrication, and inspection for steam boilers, unfired and fired pressure vessels and nuclear components.

i. Define the Abbreviations of words for ASME. (3 marks)

ii. Define the Abbreviations of words for BPVC. (3 marks)

iii. Describe in detail the Acceptance-Rejection Standards for the ASME BPVC VIII, Mandatory Appendix 12, Ultrasonic Examination of Welds. (9 marks)

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

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

Table 2: Ultrasonic Acceptance-Rejection Criteria for Statically Loaded Non-Tubular Connections

Table 8.2
UT Acceptance-Rejection Criteria (Statically Loaded Nontubular Connections and Cyclically Loaded Nontubular Connections in Compression) (see 8.13.1, 8.13.2(2), and C-8.25.6)

Discontinuity Severity Class	Weld Size[a] in inches [mm] and Search Unit Angle										
	5/16 through 3/4 [8–20]	> 3/4 through 1–1/2 [20–38]	> 1–1/2 through 2–1/2 [38–65]			> 2–1/2 through 4 [65–100]			> 4 through 8 [100–200]		
	70°	70°	70°	60°	45°	70°	60°	45°	70°	60°	45°
Class A	+5 & lower	+2 & lower	–2 & lower	+1 & lower	+3 & lower	–5 & lower	–2 & lower	0 & lower	–7 & lower	–4 & lower	–1 & lower
Class B	+6	+3	–1 0	+2 +3	+4 +5	–4 –3	–1 0	+1 +2	–6 –5	–3 –2	0 +1
Class C	+7	+4	+1 +2	+4 +5	+6 +7	–2 to +2	+1 +2	+3 +4	–4 to +2	–1 to +2	+2 +3
Class D	+8 & up	+5 & up	+3 & up	+6 & up	+8 & up	+3 & up	+3 & up	+5 & up	+3 & up	+3 & up	+4 & up

ATTACHMENT 2

Table 3: Ultrasonic Acceptance-Rejection Criteria for Cyclically Loaded Non-tubular Connections

Table 8.3
UT Acceptance-Rejection Criteria (Cyclically Loaded Nontubular Connections in Tension)
(see 8.13.2 and C–8.25.6)

Discontinuity Severity Class	Weld Size[a] in inches [mm] and Search Unit Angle										
	5/16 through 3/4 [8–20]	> 3/4 through 1–1/2 [20–38]	> 1–1/2 through 2–1/2 [38–65]			> 2–1/2 through 4 [65–100]			> 4 through 8 [100–200]		
	70°	70°	70°	60°	45°	70°	60°	45°	70°	60°	45°
Class A	+10 & lower	+8 & lower	+4 & lower	+7 & lower	+9 & lower	+1 & lower	+4 & lower	+6 & lower	–2 & lower	+1 & lower	+3 & lower
Class B	+11	+9	+5 +6	+8 +9	+10 +11	+2 +3	+5 +6	+7 +8	–1 0	+2 +3	+4 +5
Class C	+12	+10	+7 +8	+10 +11	+12 +13	+4 +5	+7 +8	+9 +10	+1 +2	+4 +5	+6 +7
Class D	+13 & up	+11 & up	+9 & up	+12 & up	+14 & up	+6 & up	+9 & up	+11 & up	+3 & up	+6 & up	+8 & up

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

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

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

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

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

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

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

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

$$\sin\theta_{st} = 0.514\frac{\lambda}{e}$$

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