UNIVERSITY COLLEGE TATI

UNIVERSITY COLLEGE TATI (UC TATI)

FINAL EXAMINATION QUESTION BOOKLET	
COURSE CODE	: DND 2054
COURSE	: ULTRASONIC TESTING I
SEMESTER/SESSION	: 2-2022/2023
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 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

QUESTION 1

a) Decibel (dB) can be measured by comparing signal heights on a calibrated screen. Calculate the new signal height (H_2), if the old signal height (H_1) is 90% and the decibel value is – 9 dB. (3 marks)

b) 50 mm Rubber Block was prepared to be tested with Ultrasonic Testing. Compression waves probes A and B will be used to inspect this material. The details of compression waves probe A and B as per table 1 below. Calculate the followings:

Table 1

Compression waves probes A	Compression waves probes B
10 mm of diameter	10 mm of diameter
4.5 MHz	1.25 MHz

i. The wavelength of sound produced by probe A and B. (3 marks)
ii. Fresnel zone of ultrasonic beam for probe A. (3 marks)
iii. Fresnel zone of ultrasonic beam for probe B. (3 marks)
iv. Fraunhoffer zone (half angle) of ultrasonic beam at 0% of sound intensity for probe A. (3 marks)
v. Fraunhoffer zone (half angle) of ultrasonic beam at 50% of sound intensity for probe B. (3 marks)

c) By referring the question 2 (b), describe the best probe to inspect the 50 mm Rubber Block test sample. (3 marks)

d) Acoustic impedance (Z) is the resistance of a material to the passage of ultrasound. Figure 1 shows the test sample. Calculate the followings percentage of sound energy reflected and transmitted at Brass (Z_1) to Tungsten (Z_2) interface. (4 marks)

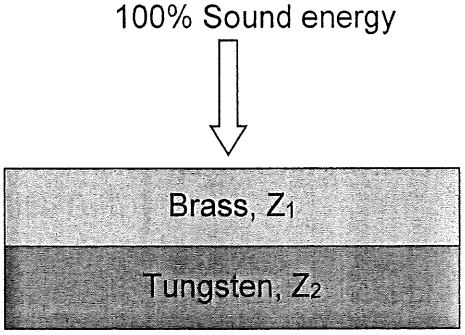

Figure 1

QUESTION 2

a) The crystals used in ultrasonic testing are X-cut in order to produce compression wave sound. Calculate the fundamental frequency of Lithium Sulphate if the crystal thickness is 1.8 mm. (2 marks)

b) Snell's law is taken from the laws of optics or light. A change of velocity from one medium to another medium is required to allow refraction to occur. Calculate the followings:

   i. The refracted angle of compression wave, β in Nickel, if the incident angle, α in Platinum is 15°. (3 marks)

   ii. The incident angle, α in Lead, if the refracted angle of shear wave , β in Aluminium is 65°. (3 marks)

c) Calculate the 1st critical angle and 2nd critical angle for Perspex as a medium 1 to Titanium as a medium 2. (5 marks)

d) Illustrate the defect signal and their location in weld area for the following defects:

   i. Toe Crack (3 marks)
   ii. Internal Porosity (3 marks)
   iii. Slag inclusion (3 marks)
   iv. Lack of root fusion (3 marks)

QUESTION 3

a) Shear waves or angle probes can only propagate in solids, rigid particle bonding being a pre-requisite.

i. State **three (3)** methods for setting test sensitivity for angle probe. (3 marks)

ii. List **three (3)** methods for sizing techniques used with shear wave probes. (3 marks)

b) Skip factor are used for projecting defect depths and positions in relation to the probe index by applying the beam path and surface distance on the test surface. 15 mm single vee butt weld plate is prepared to be tested by 60° ultrasonic probe.

i. Construct the trigonometry by using probe angle, beam path and material thickness. (3 marks)

ii. Calculate the half skip surface distance. (3 marks)

iii. Calculate the half skip beam path. (3 marks)

iv. Calculate the full skip beam path. (2 marks)

c) A 4 MHz, 8x9 mm probe size, 45° angle beam probe is used for testing a 30 mm thickness of Single Vee Carbon steel plate joint. A defect indication is obtained at a beam path of 59.4 mm, near sidewall area by using a lateral scanning. The signal for this defect is very clean signal with high amplitude response and fall quickly on swivel and orbital scanning.

i. State the name of defect found for the given details above. (1 mark)

ii. Calculate the surface distance of defect from the probe index to the center of the weld. (3 marks)

iii. Calculate the depth of defect from the top scanning surface. (4 marks)

QUESTION 4

a) State **four (4)** types of calibration blocks used in Ultrasonic testing. (4 marks)

b) Double crystal probe consists of two different crystal elements, which are Barium Titanate and Lithium Sulphate that mounted side by side.

i. List **main** advantage of Barium Titanate material. (2 marks)

ii. State **two (2)** advantages of single crystal probe. (3 marks)

iii. Explain **two (2)** advantages of double crystal probe. (4 marks)

c) Explain the properties of ultrasonic probes in terms of beam spread, attenuation and penetration for the following effects:

i. High frequency. (3 marks)

ii. Large diameter. (3 marks)

d) Describe the characteristics of particles movement, sound waves propagation and sound velocity for the following sound below:

i. Compression waves (3 marks)

ii. Shear waves (3 marks)

----------End of questions----------

ATTACHMENT 1

Table 2

Medium	Compression Velocity (m/s)	Shear Velocity (m/s)	Acoustic Impedance, Z
Air	330	-	0
Aluminium	6400	3130	17.2
Brass	4370	2100	37
Barium Titanate	5260	-	30
Cast iron	3500	2200	25
Copper	4760	2330	42.5
Gold	3240	1200	63
Molybdenum	6250	3350	63.7
Oil	1440	-	1.3
Lead	2160	700	24.6
Perspex	2740	1320	3.2
Carbon steel	5960	3240	46.5
Stainless steel	5740	3130	44.8
Silver	3700	1700	36.9
Iron	5960	3220	46.8
Tin	3380	1610	24.7
Tungsten	5170	2880	100
Lithium Sulphate	5450	-	11.2
Beryllium	1289	888	23.2
Water	1480	-	1.48
Zinc	4170	2480	29.6
Platinum	3960	1670	85
Magnesium	5790	3100	10.1
Nickel	5480	2990	48.5
Glass	5770	-	14.5
Uranium	3370	2020	63
Quartz	5730	-	15.2
Rubber	1600	-	-

Near Zone = $\frac{D^2}{\lambda}$

$\frac{\text{Sin } \alpha}{\text{Sin } \beta} = \frac{V_1}{V_2}$

$Ff = \frac{V}{2t}$

$dB = 20\log_{10} H_2/H_1$

$\left(\frac{Z_1 - Z_2}{Z_1 + Z_2}\right)^2 \times 100 = \%$ reflected energy

Sine $\frac{\theta}{2} = \frac{k\lambda}{D}$

k: 0% = 1.22 50% = 0.56

10% = 1.08

---------- **End of attachment** ----------