UNIVERSITY COLLEGE TATI

UNIVERSITY COLLEGE TATI (UC TATI)

FINAL EXAMINATION QUESTION BOOKLET	
COURSE CODE	: DND 3063
COURSE	: EDDY CURRENT 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 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) Figure 1 illustrates a parallel tuned resonant circuit with V_s = 135 V, R = 75 Ω, L = 0.55 H and C = 175 μf and F = 300 Hz. Calculate the followings:

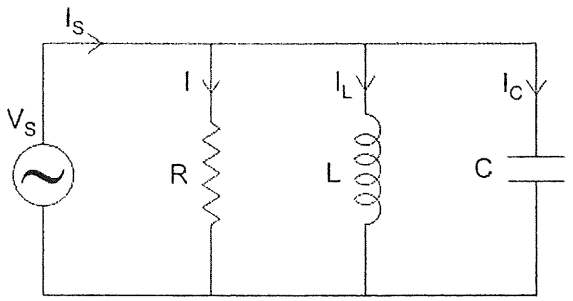

Figure 1

i. Calculate the current through resistor, I_R. (2 marks)

ii. Calculate the current through inductor, I_L. (2 marks)

iii. Calculate the current through capacitor, I_C. (2 marks)

iv. Calculate the total current through the circuit, I_T. (2 marks)

v. Calculate the phase angle of the circuit, θ. (2 marks)

vi. Draw the phase angle diagram. (2 marks)

vii. Prove that the resonant frequency, $F_r = \frac{1}{2\pi\,(LC)^{0.5}}$ (2 marks)

b) Figure 2 illustrates a series circuit of resonance with V_s = 150 V, R = 20 Ω, L = 0.26 H and C = 200 μf.

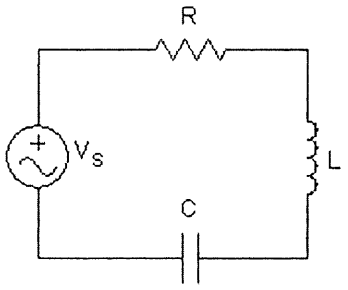

Figure 2

i. Calculate the resonant frequency, F_r. (2 marks)

ii. Calculate the current through the circuit, I. (2 marks)

iii. Calculate the voltage across the capacitor, V_C. (2 marks)

iv. Calculate the voltage across the inductor, V_L. (2 marks)

v. Calculate the voltage magnification at resonance (Q factor). (2 marks)

vi. Draw the voltage magnification diagram. (3 marks)

QUESTION 2

a) Impedance testing systems are the simplest to operate. The impedance of a coil may be represented by a vector whose length represents the impedance value and direction represents a phase angle. These vectors may be measured and plotted on a chart known as the impedance–plane diagram.

i. List **four (4)** inspection variables can be displayed on the impedance plane diagram. (4 marks)

ii. Sketch impedance plane diagram for thickness measurement of Aluminum. (2 Marks)

iii. Draw **two (2)** impedance plane diagrams of high frequency and low frequency for air (0% IACS), Stainless Steel 304 (2.5% IACS), bronze (14% IACS), aluminum (60.9% IACS) and copper (100% IACS) that showing the effect of frequency on impedance plane diagram. (4 marks)

b) During experiments with circular metal bars, certain parameters of this experiment are under control, and then a similarity could be predicted between the test results from one particular bar and those results expected from bars of other materials.

i. Calculate the limit frequency, F_g for Magnesium bar (σ = 38.6 %IACS) bar of 2.3 inches diameter. Found that the optimum frequency for finding defects in this bar was 22.5 kHz. Assumed μ_{rel} = 1. (2 marks)

ii. Calculate the test frequency ratios f/f_g. (2 marks)

iii. The same diameter size of Aluminum (σ = 64.8 %IACS) with Magnesium bar above is wished to be tested with Eddy Current. Calculate the optimum frequency for finding the similar defects in this Magnesium bar. (4 marks)

QUESTION 3

a) An essential requirement for Eddy Current inspection is a reliable means for setting the sensitivity of equipment. A reference sample must be provided for this purpose.

i. State the best reference block for Eddy Current inspection. (2 marks)

ii. List **three (3)** types of non-conductive materials often used for lift-off standards. (3 marks)

iii. List **four (4)** considerations for development and use of reference standard. (4 marks)

iv. Describe how lift-off calibration standard are constructed. (3 marks)

b) The impedance plane diagram is a very useful way of displaying eddy current data. A thorough knowledge of the complex impedance-plane diagram aids the operator in selecting the test parameters.

i. Define the meaning of lift-off. (2 marks)

ii. Define the meaning of probe-to-edge spacing. (2 marks)

iii. State the possibility occurs to the impedance-plane diagram if coil (probe) is moved across a crack. (2 marks)

iv. List **two (2)** factors affecting the probe to edge spacing. (2 marks)

v. Describe steps to measure hardness of Titanium alloy using a comparison with a known hardness. (2 marks)

vi. Demonstrate steps to find the proper frequency when performing conductivity measurements. (5 marks)

QUESTION 4

a) Location and orientation of cracks will determine whether there will be large changes or small changes in eddy current flow. This change in eddy current flow causes a change in impedance of the test circuit that is detected by a change in the meter reading.

i. Define signal-to-noise ratio. (2 marks)

ii. State the possibility of crack detection when defects lying parallel to the eddy current flow. (2 marks)

iii. Explain **three (3)** types of service cracks and location of crack that commonly occurred in our industries. (6 marks)

b) Multi-frequency eddy current techniques simply involve collecting data at several different frequencies and then comparing the data or mixing the data in some way.

i. Define Multi-frequency instruments. (2 marks)

ii. List **three (3)** advantages of using multi-frequency inspections. (3 marks)

iii. Explain the idea of testing more than one frequency (multi-frequency). (3 marks)

iv. Sketch the differences of signal displayed in tubing inspection when using absolute and differential probe. (4 marks)

c) An approximation of small, multilayer, air coil inductance has 0.2 inch means radius of coil, 0.2 inch length of coil and 0.1 inch thickness of coil.

i. Calculate the inductance of a coil, L that has the total number of turns is 70. (4 marks)

ii. If the number of turns, N is increased to 140 turns, calculate the new value of inductance, L. (2 marks)

----------**End of question**----------

List of Formula

1. $$Q\ factor = \frac{2\pi fL}{R}$$
2. $$Self\ Inductance, L = \frac{0.8\ (rN)^2}{6r + 9c + 10b}$$
3. $$(American\ Standard\ Units)\ Limit\ Frequency, F_g = \frac{1353.8}{\mu_{rel}\sigma d^2}$$
4. $$(SI\ Units)\ Limit\ Frequency, F_g = \frac{5066}{\mu_{rel}\sigma d^2}$$
5. $$Inductive\ Reactance, X_L = 2\pi fL$$
6. $$Capacitive\ Reactance, X_C = \frac{1}{2\pi fL}$$