



DEPARTMENT OF CIVIL ENGINEERING

MAJOR :CVL864 STRUCTURAL HEALTH MONITORING (2023-24)

Time allowed: 2 hours
Venue : LH 114

Date : 02 May 2024
Max marks : 40

NOTE: (a) This question paper contains two pages only. (b) All questions are compulsory. (c) Assume any data which you deem is necessary but not supplied. (d) Draw neat and clear sketches wherever required. (e) Provide full explanations for securing full marks

Question 1

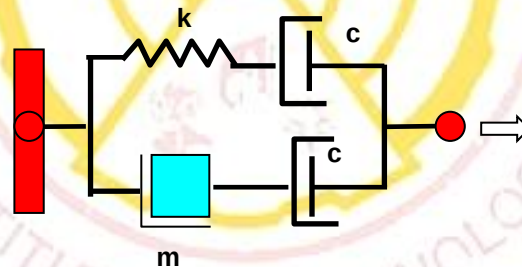
Calculate the first three theoretical resonant frequencies of an MFC patch (only d_{31} effect is present) of size $56 \times 28 \times 0.32$ mm, given that the Young's modulus is 14.7×10^{10} N/m² and the density is 5440 kg/m³. How would you experimentally determine these frequencies?

(4 marks)

Question 2

Derive an expression for the mechanical impedance of the system shown below.

(8 marks)



Question 3

Explain why the EMI technique is not able to discern further growth of damage after it reaches a moderate to high severity range?

(3 marks)

Question 4

How does temperature variation affect the signatures of the PZT patch in the EMI technique. Suggest a suitable remedial measure to aid thermal compensation

(3 marks)

Question 5

A vibrating wire strain gauge having a gauge length of 7.5 cm and a diameter of 1 mm is instrumented on the surface of a concrete beam. If during loading, the change in frequency is registered as 25 Hz (increase), accompanied by a decrease of temperature by 15 C°, compute the actual strain induced in the structure, and whether it is tensile or compressive. The prestrain induced in the wire by the manufacturer was 2000 microstrain (tension). Density of steel = 7800 kg/m³, Young's modulus of steel = 200 GPa, coefficient of thermal expansion of steel = 10×10^{-6} C° and that of concrete = 2×10^{-6} C°.

(6 marks)

Question 6

How can a piezo patch aid in monitoring fatigue induced damage of a structural component without actually measuring the true stiffness of the component. Explain your answer using equations wherever necessary.

(5 marks)

Question 7

Distinguish between structural audit and structural health monitoring. How SHM could aid the audit process?

(4 marks)

Question 8

What analogy exists between LCR circuit and a SDOF dynamic system being analyzed using the concept of mechanical impedance? How does the concept of mechanical impedance aid in simplifying a differential equation into a simple algebraic equation?

(5 marks)

Question 9

How close to reality is the assumption of pin-pin connection of PZT patch in Liang's EMI model?

(2 marks)