



DEPARTMENT OF CIVIL ENGINEERING

MAJOR :CVL864 STRUCTURAL HEALTH MONITORING (2021-22)

Time allowed: 2 hours
Venue : LH 410

Date : 06 Apr 2022
Max marks : 30

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

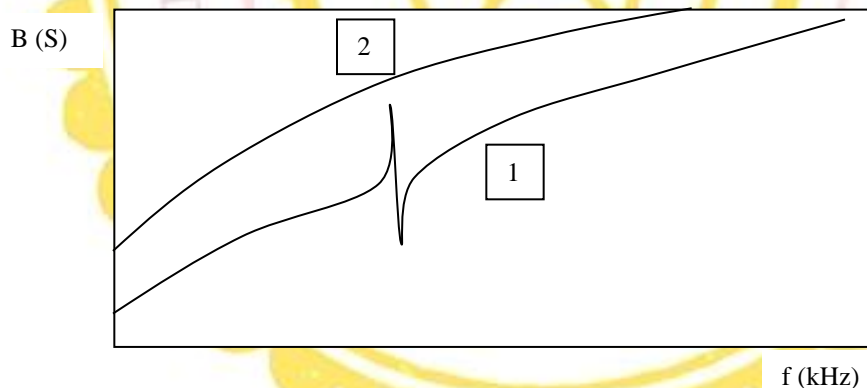
A structure is monitored using a set of ESGs with a base resistance of 120 ohms. The coefficient of thermal expansion of the structure and the ESG are 6×10^{-6} and 5×10^{-6} respectively. Both loading and temperature effects occur simultaneously, the ambient temperature increases by 25°C during the measurement. The apparent strain measured by one of the gauges is 450 microstrain (compressive). Calculate the true strain assuming gauge factor of 2.16.

(5 marks)

Question 2

What can you infer from sudden change in “B” curve of a bonded PZT patch from “1” to “2”? State clear reasons.

(3 marks)



Question 3

Explain reason that the global vibration techniques do not exhibit sufficiently high sensitivity towards incipient damage. In the context of increasing damage severity, why does the EMI technique often fail to register further change of signatures after say reaching moderate severity level of structural damage.

(5 marks)

Question 4

Derive an expression for the mechanical impedance of a PZT patch of half length l and width w . Why do we need to ensure “short circuiting” the terminals of the PZT patch for this purpose. (You need not derive expression for displacement, assume it to be known).

(5 marks)

Question 5

A PZT patch of size 10x10x0.3 mm is supposed to be employed as a sensor at the bottom mid point of a simply supported steel beam (ISMB 200) of length 3 m. If a peak potential difference of 10V is registered across the PZT patch when hit with a hammer at top the mid point, determine the following:

- (i) The strain occurring at the extreme fibres at the mid point location.
- (ii) The corresponding peak deflection at the mid point.

Assume electric permittivity = 2.12×10^{-5} F/m , piezoelectric strain coefficient = 2.10×10^{-10} m/V, Young's modulus of steel = 200 GPa, Young's modulus of PZT patch = 6.67×10^{10} N/m², I (for ISMB 200) = 2120 cm⁴.

(8 marks)

Question 6

A city flyover is instrumented with an accelerometer at the mid point. The natural frequency of the bridge is determined to be 4 Hz. The peak acceleration measured at the mid point is 6.31 ms^{-2} . Determine the peak displacement if the first mode is the dominant mode of vibration of the beam.

(4 marks)