THE PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY

MECHANICAL ENGINEERING

SECOND SEMESTER EXAMINATION - 2024

Vibration Analysis ME 321
MONDAY 21st Oct 2024

MAXIMUM MARK: 55 (%wt. 40)

TIME ALLOWED: 2 HOURS

INSTRUCTIONS FOR CANDIDATES:

1. You have 10 minutes to read the paper. You must not begin writing during this time.
2. Answer question **One (1)** and any other two **(2)** Marks or each part of the questions are indicated in the bracket.
3. Use only ink. Do not use pencil or writing except or drawing and sketches.
4. All answers must be written in the answer book provided. No other written material will be accepted.
5. Write your **name** and **ID number** clearly on the front page of the answer booklet provided. **Do it now!**
6. Use of Calculator in the exam room is permitted. Notes and textbooks are not allowed. Required property values are provided in the question paper.

Question 1 (25 marks)

A counterrotating eccentric mass exciter shown in Figure 1 below, is used to determine the vibration characteristics of a structure of mass 181.4 kg. At a speed of 900 rpm, a stroboscope shows the eccentric masses to be at the top at the instant the structure is moving upward through its static equilibrium position, and corresponding amplitude is 21.6mm. If the unbalance of each wheel of the exciter is 0.0921 kg.m, determine

(i) The natural frequency of the structure

(ii) The damping factor of the structure

(iii) The amplitude at 1200 rpm

(iv) The angular position of the eccentrics at the instant the structure is moving upward through its equilibrium position

(v) Is the system **underdamped**, **Overdamped** or **Critically damped**

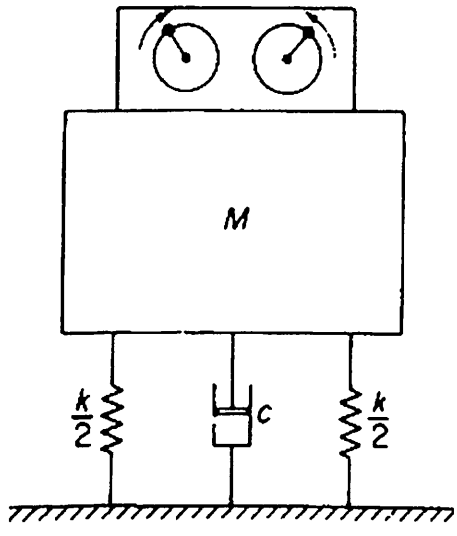

Figure 1

Question 2 (10 marks)

Model the response of rotational unbalanced systems under harmonic force using the provided hints:

- Equation of motion: $m\ddot{x} + c\dot{x} + kx = mew^2 \sin wt$

Question 3

(10 marks)

An unknown mass **M** kg attached to the end of unknown spring ***K*** has a natural frequency of **94 cpm**. When a **0.453 kg** mass is added to **M**, the natural frequency lowered to **76.7 cpm**. Determine the unknown mass **M** and the spring constant ***K***, N/m.

Question 4

(i) Discuss two (2) major objectives why study of vibration analysis is important. (use valid examples to support your answers). (5 marks)

(ii) Explain what a stroboscope is used for. (5 marks)

- $\omega_n = \sqrt{\frac{k}{m}}$ - Undamped Natural Frequency
- $\zeta = \frac{c}{c_c} = \frac{c}{2m\omega_n}$ - Damping Ratio
- $\delta_{st} = \frac{F_0}{k}$ - Deflection under the Static Force F_0
- $r = \frac{\omega}{\omega_n}$ - Frequency Ratio
- Variation of M and ϕ with frequency ratio r: