



The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Mechanical Engineering

Study Programme	Bachelor of Technology Honours in Engineering
Name of the Examination	Final Examination
Course Code and Title	DMX5201 Advance Engineering Mechanics
Academic Year	2025
Date	17 th March 2026 (Tuesday)
Time	09.30 - 12.30 hrs
Duration	03 hours

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of in **Four (4)** Pages.
3. Answer **All Questions**.
4. This is a Closed Book Test (CBT).
5. Answers should be in clear handwriting.

QUESTION 1 (16 marks)

Determine the I_{xx} , I_{yy} , I_{zz} , I_{xy} , I_{yz} and I_{zx} of the thin plate shown in Figure Q1 above the given coordinate system. The material has a density per unit area of 50 kg/m^2 .

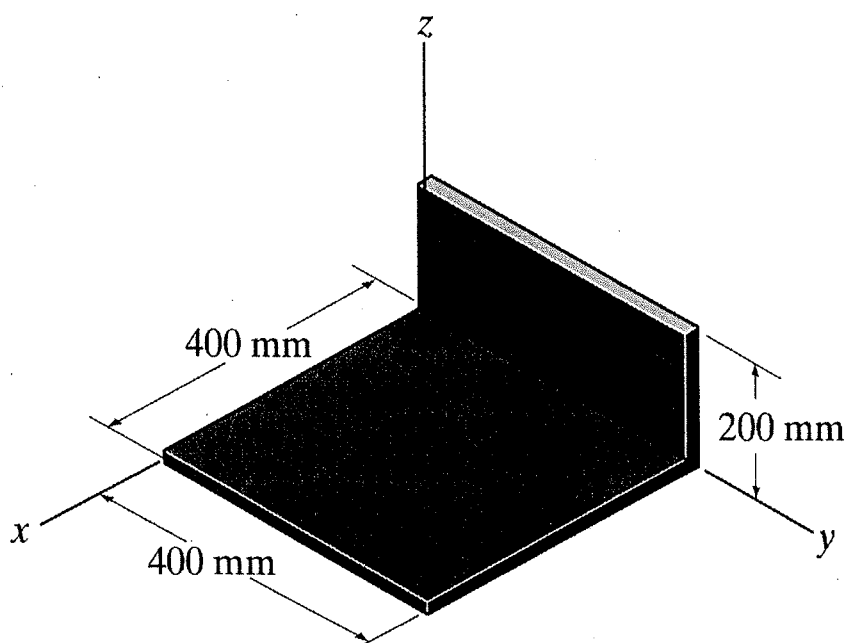


Figure Q1

QUESTION 2 (16 marks)

Answer the following questions based on the vibrating system shown in Figure Q2. The mass m vibrates freely on the surface without friction with the initial conditions $x_0 = 0.03$ m and $\dot{x}_0 = 0$ m/s.

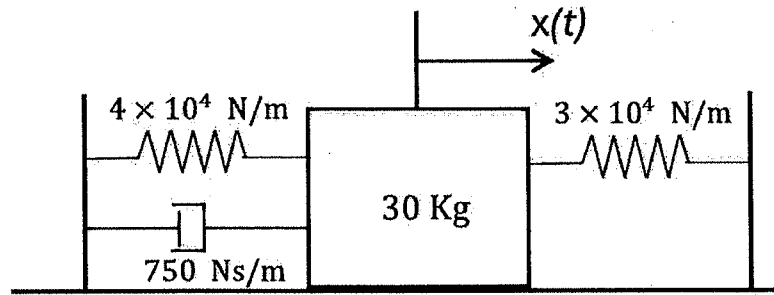


Figure Q2

- (a) The natural frequency, ω_n
- (b) The damping ratio,
- (c) Whether the system is underdamped, critically damped, or overdamped
- (d) The undamped period, T
- (e) Undamped frequency in Hz, f
- (f) The damped natural frequency (if appropriate),
- (g) The damped period (if appropriate),
- (h) The logarithmic decrement (if appropriate),
- (i) The amplitude of vibrations, A
- (j) The phase between the response and a pure sinusoid (if appropriate),
- (k) The free response of the system

QUESTION 3 (16 marks)

Figure Q3 shows a vibrating system consisting of two masses m_1 and m_2 . This represents a simple multi degree of freedom vibrating system. It can be assumed that the system is frictionless, and the boundaries are rigid.

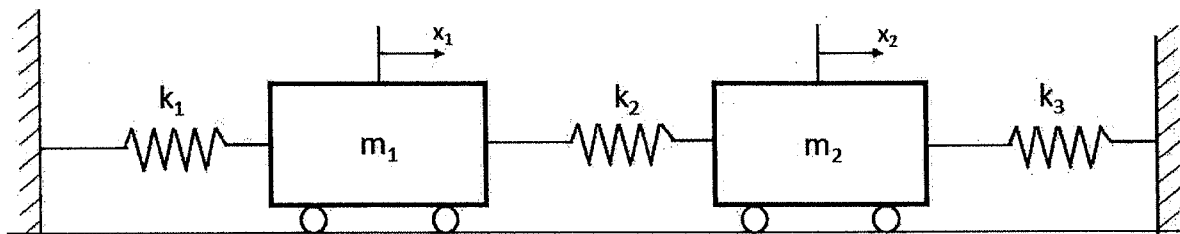


Figure Q3

- (a) Write the governing equations for the motion of mass m_1 and m_2 of the system.
- (b) Write the governing equation of motion for the system in matrix form.
- (c) If $m_1 = 8$ kg, $m_2 = 16$ kg, $k_1 = k_2 = 2 \times 10^5$ N/m and $k_3 = 3 \times 10^5$ N/m find the natural frequencies ω_n and mode shapes of the system.

- (d) When the motion starts (at $t = 0$) $x_1 = 0.001$ m, $x_2 = 0$, $\dot{x}_1 = 0$ and $\dot{x}_2 = 0$. Find the complete solution of this vibrating system. The general solution of such system with usual notations can be written as

$$x(t) = A_1 x_1 \sin(\omega_1 t + \varphi_1) + A_2 x_2 \sin(\omega_2 t + \varphi_2)$$

QUESTION 4 (16 marks)

A lifting system is composed of a motor coupled to a flywheel through a rigid mechanical coupling, as shown in Figure Q4. To find the natural frequencies of the torsional vibrations the actual system is simplified by an equivalent system constituted of inertia masses and shaft sections with geometric properties as given in Tables Q4(a) and Q4(b).

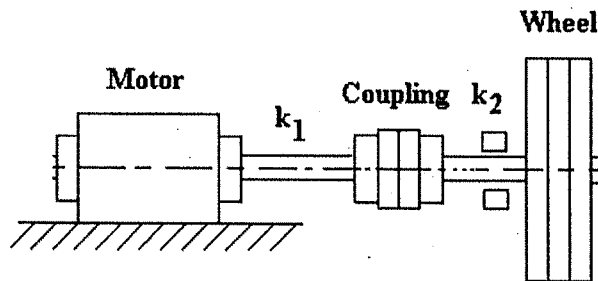


Figure Q4

Rotor	Diameter (mm)	Thickness (mm)
Motor	424	60
Coupling	337	60
Wheel	470	60

Table Q4(a)

Shaft	Diameter (mm)	Length (mm)
Shaft k_1	50	610
Shaft k_2	50	814

Table Q4(b)

It is assumed that all the rotors and shafts are made out of steel with the density 7800 kg/m^3 and the modulus of rigidity 80 GN/m^2 . Start from initial frequency value of 20 Hz .

- Draw the simplified rotor system
- Prepare the Holzer table for above rotor system.
- Find the natural frequencies and mode shapes of the system

QUESTION 5 (16 marks)

- Explain, what a Vibration Exciter is? Name three different types of vibration exciters.
- With the aid of sketches, briefly describe one of the vibration exciters you mentioned above.
- Briefly explain the procedure to find the response of a system subjected to random vibrations
- Explain Dunkerly's Method.

QUESTION 6 (20 marks)

The wheel is spinning about shaft AB (Figure Q6) with an angular velocity of $\omega_s = 10 \text{ rad/s}$, which is increasing at a constant rate of $\dot{\omega}_s = 6 \text{ rad/s}^2$, while the frame precesses about the z axis with an angular velocity of $\omega_p = 12 \text{ rad/s}$, which is increasing at a constant rate of $\dot{\omega}_p = 3 \text{ rad/s}^2$. Determine the velocity and acceleration of point C located on the rim of the wheel (along x axis) at this instant.

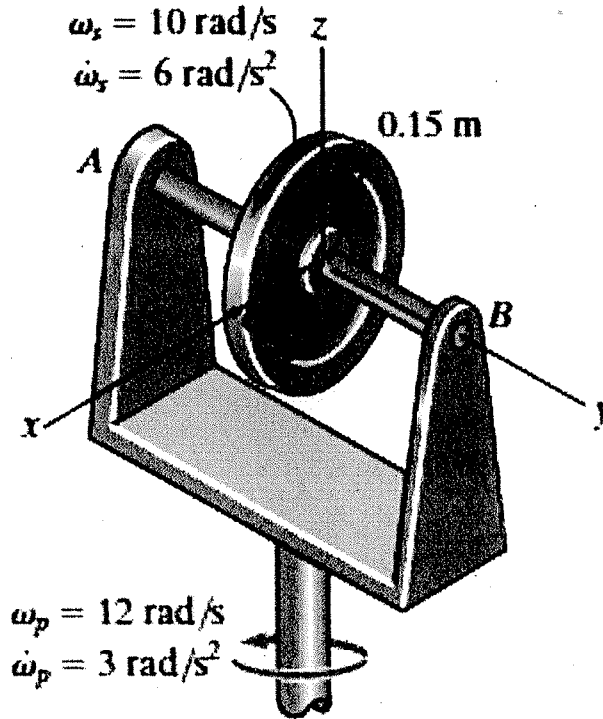


Figure Q6

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