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

Study Programme	Bachelor of Science Honours in Engineering
Name of the Examination	Final Examination
Course Code and Title	**DMX3302 Engineering Mechanics**
Academic Year	2024/2025
Date	25th February 2026
Time	0930 – 1230 hrs
Duration	**03 hours**

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Six (6)** questions in **Four (4)** pages.
3. **Answer All questions.**
4. This is a Closed Book Test (CBT).
5. Answers should be in clear handwriting.

QUESTION 01 (20 marks)

Answer the following questions based on the vibrating system shown in Figure Q1. The mass m vibrates freely on the surface without friction.

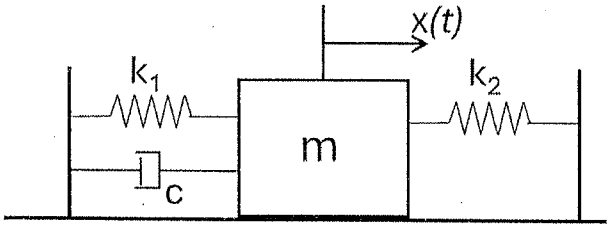

Figure Q1

a) Write the governing equation of the system in the standard form.

b) General solution for the $m\ddot{x} + 2\xi\omega_n\dot{x} + \omega_n^2 x = 0$ equation with boundry conditions $x(0) = x_0$ and $\dot{x}(0) = \dot{x}_0$ is given as $x(t) = Ae^{-\zeta\omega_n t}\sin(\omega_d t + \phi_d)$. Show that

$$A = \sqrt{x_0^2 + \left(\frac{\dot{x}_0 + \xi\omega_n x_0}{\omega_d}\right)^2}$$

And

$$\phi_d = \text{atan}\left(\frac{\omega_n x_0}{\dot{x}_0 + \xi\omega_n x_0}\right)$$

c) If spring constants $k_1 = 4 \times 10^4$ N/m , $k_2 = 3 \times 10^4$ N/m , mass $m = 12.5$ kg and damping constant $c = 750$ Ns/m ; Find the following,

i. natural frequency ω_n
ii. damping ratio ξ
iii. damped natural frequency ω_d
iv. logaritmic decriment δ

d) It is given that $\dot{x}(0) = 0$ and $x(0) = 3$ cm. Write the equation of motion for the above system.

QUESTION 02 (20 marks)

Beam AB is supported by a pin support at A and roller support at B as in the Figure Q2. A linearly varying distributed load (0 kN/m to 1.6 kN/m) is applied between C and D. A point load of 4.2 kN is applied at point F as shown in Figure Q2.

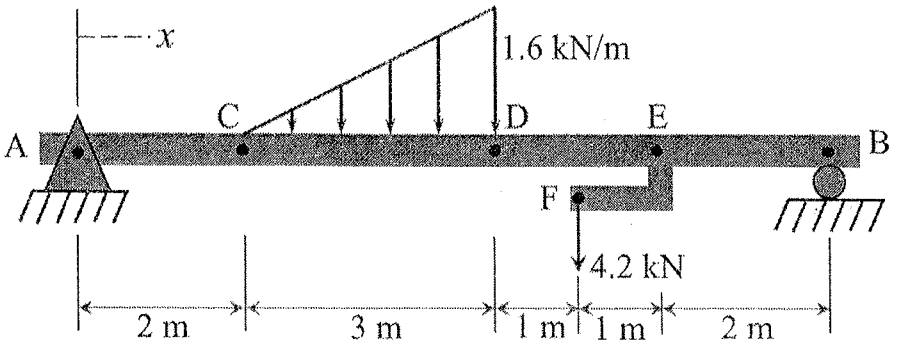

Figure Q2

a) Change the line of action of 4.2 kN froce from point F to point E.

b) Draw the free body diagram for beam AB.

c) Find the reactions at point A and at point B.

d) Find expressions of bending moment and shear force between AC, CD, DE and EB.

e) Draw the bending moment and shear force diagrams for the beam AB

QUESTION 03 (15 marks)

The pendulum consists of a 15-kg solid ball and 6-kg rod (Figure Q3). If it is released from rest when $\theta_1 = 90°$, determine the angle θ_2 after the ball strikes the wall, rebounds, and the pendulum swings up to the point of momentary rest. Take $e = 0.6$.

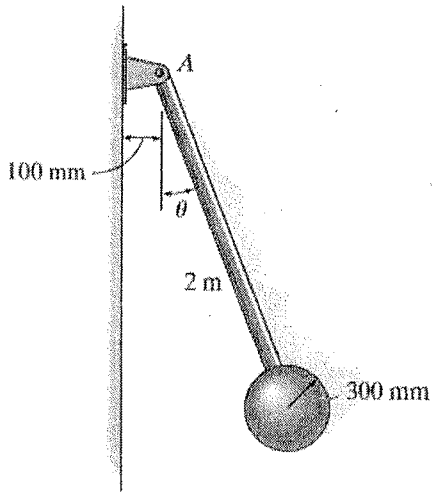

Figure Q3

QUESTION 04 (15 marks)

The welded tubular frame (Figure Q4) is secured to the horizontal x-y plane by a ball-and-socket joint at A and receives support from the loose-fitting ring at point B. An external load of 2-kN load is applied at point E parallel to y direction. The frame is kept under equilibrium by the tension cable CD. Weight of the frame can be neglected when compared with the applied load.

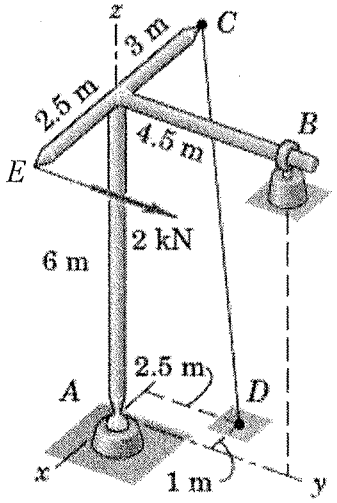

Figure Q4

a) Draw the free body diagram for the frame and clearly mark all the forces acting on it.
b) Express the external 2 kN load and the tension T in cable CD as vector forces.
c) Compute the vector moment $\mathbf{M}_A$ of tension **T** about point A.
d) Find the moment of tension **T** about line AB. (component of the moment along AB)
e) If the tension $\mathbf{T} = (0.833\,\mathbf{i} + 1.042\,\mathbf{j} - 2.50\,\mathbf{k})$ kN write the moment balance $\Sigma\mathbf{M}_A = 0$ about point A for the frame.

QUESTION 05 (15 marks)

Three 4-kg packages A, B, and C are placed on a conveyor belt that is at rest (Figure Q5). Between the belt and both packages A and C, the coefficients of friction are $\mu_s = 0.30$ and $\mu_k = 0.20$; between package B and the belt, the coefficients are $\mu_s = 0.10$ and $\mu_k = 0.08$. The packages are placed on the belt so that they are in contact with each other and at rest. Determine which, if any, of the packages will move and the friction force acting on each package.

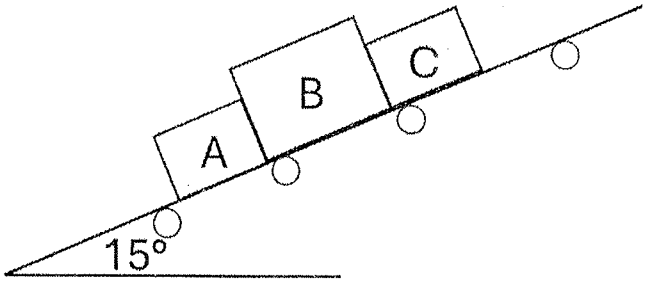

Figure Q5

QUESTION 06 (15 marks)

The uniform 24-kg plate is released from rest at the position shown (figure Q6). Determine its initial angular acceleration and the horizontal and vertical reactions at the pin *A*.

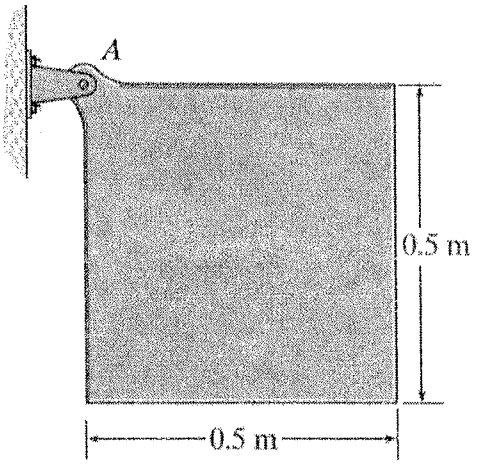

Figure Q6

End of Question Paper