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

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| Study Programme | : Bachelor of Technology Honours in Engineering |
| Name of the Examination | : Final Examination |
| **Course Code and Title** | **: DMX3302 Engineering Mechanics** |
| Academic Year | : 2019/20 |
| Date | : 08th October 2020 |
| Time | : 0930 - 1230hrs |
| Duration | : **3 hours** |

**General Instructions**

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Two (2)** parts in **Eight (8)** pages.
3. Answer **All** questions in **Part A** and **Four (4)** questions from **Part B**.
6. This is a Closed Book Test(CBT).
7. Answers should be in clear handwriting.
8. Do not use Red colour pen.

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## SECTION - A (ANSWER ALL QUESTIONS)

**(Part A 40 marks)**

*Question 01:*

A particle moves along a straight line such that its acceleration is $a = (3t^2 - 2)$ m/s$^2$, where $t$ is in seconds. When $t = 0$, the particle is located 2 m to the left of the origin, and when $t = 2$ s, it is 20 m to the left of the origin. Determine the position of the particle when $t = 4$ s.

*(05 marks)*

*Question 02:*

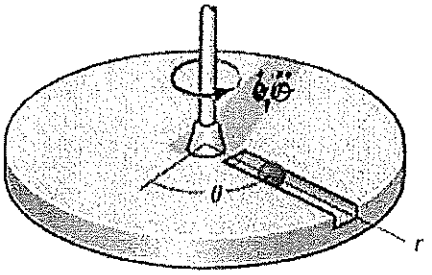


**Figure A2**

The platform is rotating about the vertical axis such that at any instant its angular position is $\theta = (4t^{3/2})$ rad, where $t$ is in seconds. A ball rolls outward along the radial groove so that its position is $r = (0.1t^3)$ m, where $t$ is in seconds (refer Figure A2). Determine the velocity and the acceleration of the ball at time $t$.

***(05 marks)***

*Question 03:*

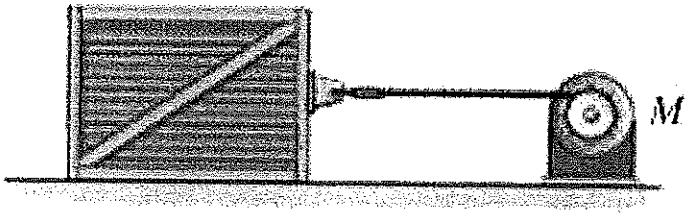


**Figure A3**

A motor **M** exerts a force of $F = (10t^2 + 100)$ N on the cable (refer Figure A3), where $t$ is in seconds. Assuming the coefficients of static and kinetic friction between the crate and the plane are $\mu_s = 0.3$ and $\mu_k = 0.25$, respectively and the crate is initially at rest, determine the velocity of the 25 kg crate when $t = 4$ s.

***(05 marks)***

*Question 04:*

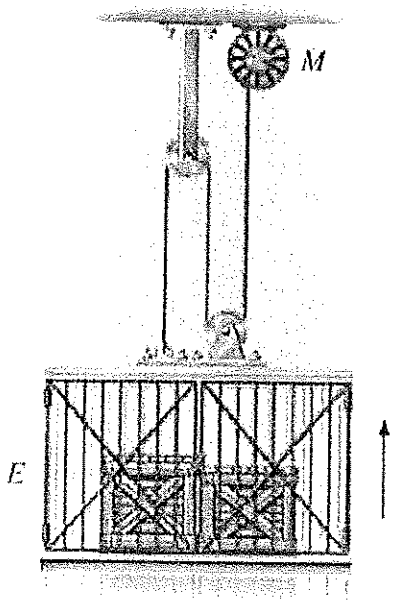


**Figure A4**

The 600 kg elevator starts from rest and travels upward with a constant acceleration $a_c = 2$ m/s$^2$ as shown in figure A4. Determine the power output of the motor **M** when t = 4 s. ***(05 marks)***

***Question 05:***

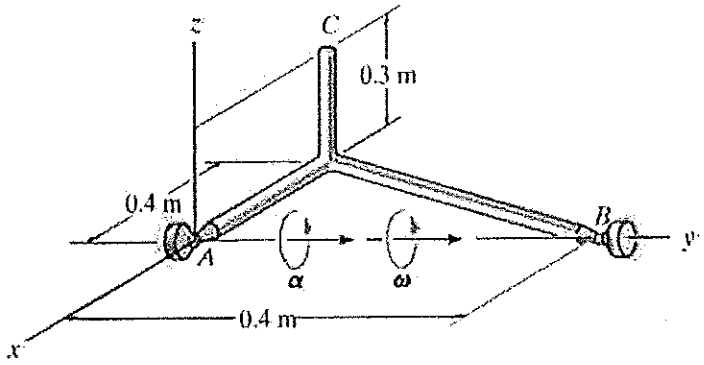


**Figure A5**

The rod assembly is supported by ball and socket joints at A and B (refer Figure A5). At the instance shown, it is rotating about the y axis with an angular velocity $\omega = 5$ rad/s and has an angular acceleration $\alpha = 5$ rad/s$^2$ in the anticlockwise direction as shown in figure A5. Determine the velocity and acceleration of point C ofthis instance with the direction.

***(05 marks)***

***Question 06:***

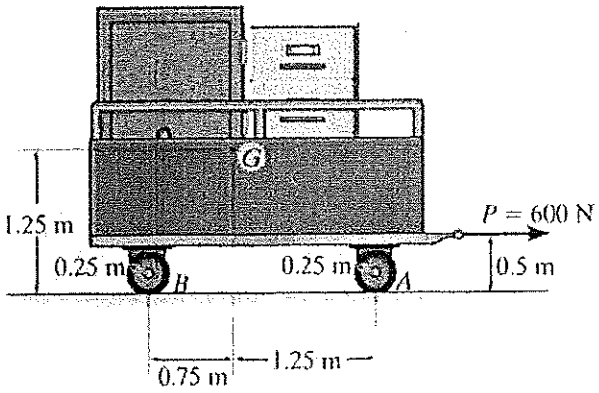


**Figure A6**

The trailer with its load has a mass of 200 kg and a center of mass at **G**. If it is subjected to a horizontal force of 600 N as shown in Figure A6, determine the trailer's acceleration and the normal force on wheel **B**.

***(05 marks)***

*Question 07:*

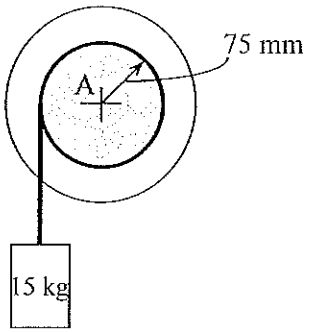


**Figure A7**

The reel of a mass of 25 kg and a radius of gyration about its center of mass **A** of $k_A = 125$ mm, has been connected to a cylinder as shown in Figure A7. Determine the velocity of the cylinder after it has descended a distance of 2 m. Assume the mass of the cylinder is 50 kg and that initially, the system is at rest.

***(05 marks)***

*Question 08:*

Determine the magnitude of the resultant force acting on a 5 kg particle at the instant $t = 2$ s, if the particle is moving along a horizontal path defined by equations $r = (2t + 10)$ m and $\theta = (1.5t^2 - 6t)$ rad, where $\boldsymbol{t}$ is in seconds.

***(05marks)***

## SECTION -B (ANSWER FOUR QUESTIONS)

**(Part B 60 marks)**

*Question 01B:*

(a) When a tensile force of 300 N is applied to an elastic element, it has an elongation of 1 mm. What is the stiffness of the element?

***(03marks)***

(b)


**Figure 1B**

The block shown in Figure 1B, has a mass of 20 kg, and it is connected to a spring having a stiffness of $k$ = 600 N/m. When the block is displaced and released, two successive amplitudes are measured as 150 mm and 87 mm. Determine the coefficient of viscous damping '$c$' and derive the equation of motion. ***(12 marks)***

***Question 02B:***

(a) A rigid body is in equilibrium under several two dimensional (co-planer) forces. State the equations of equilibrium.

***(03 marks)***

(b)

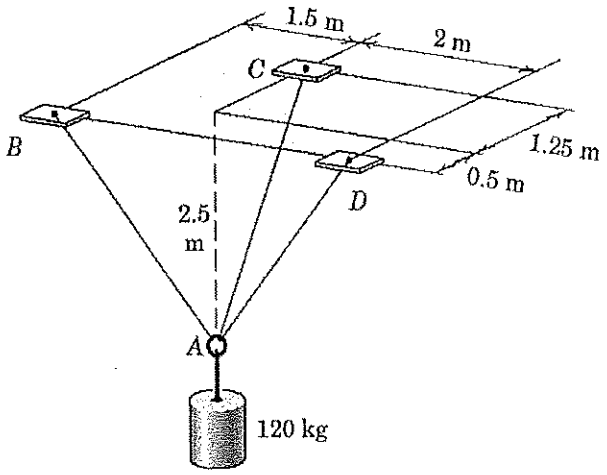


**Figure 2B**

Determine the tensions in cables AB, AC, and AD. ***(12 marks)***

***Question 03B:***

(a)

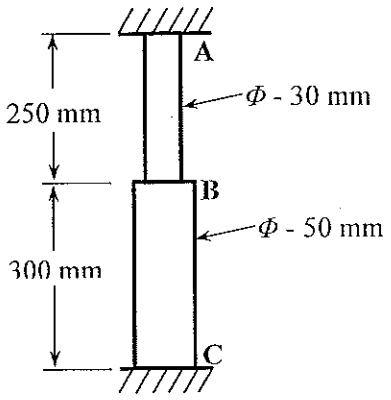


**Figure 3B-a**

A rod consisting of two cylindrical portions AB and BC is restrained at both ends as shown in Figure 3B-a. Portion AB is made of steel ($E = 210$ GPa and $\alpha = 10.5 \times 10^{-6}$ /°C) and portion BC is made of brass ($E = 95$ GPa and $\alpha = 22 \times 10^{-6}$ /°C. Knowing that the rod is initially unstressed, determine the compressive force induced in ABC when there is a temperature rise of 60°C.

***(07 marks)***

(b)

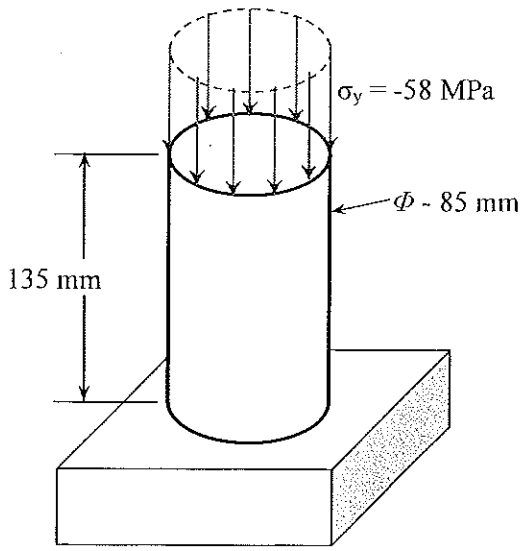


**Figure B3-b**

Figure 3B-b, shows a solid shaft made of brass, axially loaded by a compressive stress of 58 MPa. If the initial height of the shaft is 135 mm, determine the change in height and the change in volume of the cylinder due to the applied load. Modulus of elasticity (E) and Poisson's ratio of the material are 105 GPa and 0.33 respectively.

***(08 marks)***

***Question 04B:***

(a) Explain how the friction forces develop when one surface is moving relatively to the other. Give examples for friction between two solid surfaces, solid surface and a liquid and liquid and a gas.

***(05 marks)***

(b)

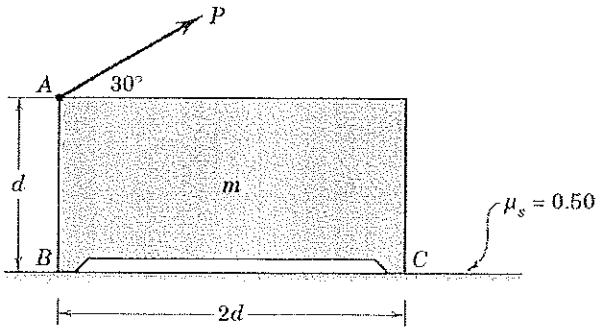


**Figure 4B**

The magnitude of force **P** is slowly increased (Figure 4B). Does the homogeneous box of mass **m** slip or tip first? State the value of **P** which would cause each occurrence. Neglect any effect from the size of the small legs of the box.

***(10 marks)***

***Question 05B:***

(a) Briefly explain about the (i)Centroid, (ii) First Moment and (iii) Second Moment ofarea. ***(03 marks)***

(b)

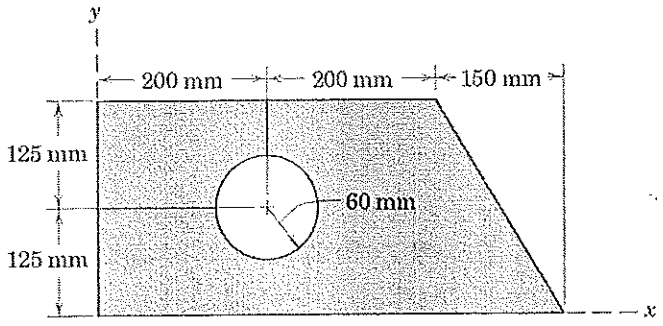


**Figure 5B**

Determine the coordinates of the centroid of the shaded area and the second momentof area aboutthe **x** axis as shown in Figure 5B.

***(12 marks)***

***Question 06B:***

(a) Mark the reaction forces at the supports if a beam is supported by (i) a roller support (ii) a pin joint and (iii) a fixed support.(consider the supports are for two dimensional systems).

***(03 marks)***

(b)

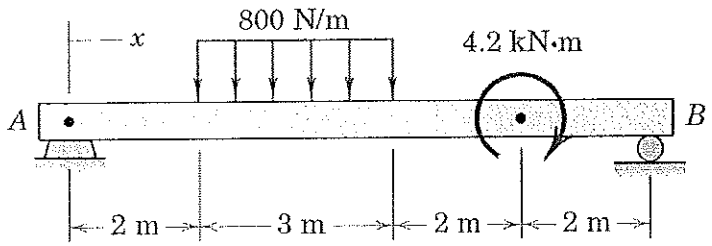


**Figure 6B**

Draw the shear force and bending moment diagrams for the beam loaded as shown in Figure 6B.

(i) Find the values of shear force and bending moment at x = 6 m.

(ii) Determine the maximum bending moment acting on the beam.

***(12 marks)***

*Question 07B:*

(a) Explain the coefficient of restitution. What is the difference between an elastic impact and a plastic impact?

*(03marks)*

(b)

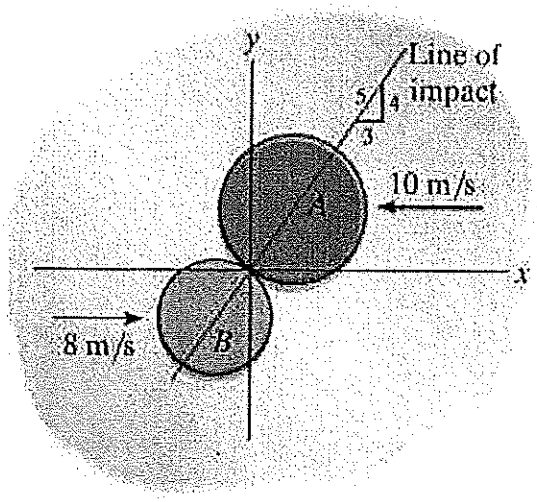


**Figure 7B**

Disks A and B have a mass of 15 kg and 10 kg respectively. If they are sliding on a smooth horizontal plane with the velocities as shown in Figure 7B, determine their speeds just after the impact. The coefficient of restitution (e) between them is e = 0.8.

*(12 marks)*