



THE COUNCIL OF COMMUNITY COLLEGES OF JAMAICA
ASSOCIATE OF SCIENCE EXAMINATION

SEMESTER II – 2019 MAY

PROGRAMME: ENGINEERING
COURSE NAME: MECHANICAL ENGINEERING SCIENCE
CODE: ENGS1202
YEAR GROUP: ONE
DATE: TUESDAY, 2019 MAY 14
TIME: 9:00 A.M. – 11:00 A.M.
DURATION: 2 HOURS
EXAMINATION TYPE: FINAL

This Examination Paper has 7 Pages

INSTRUCTIONS:

- 1. THIS PAPER CONSISTS OF SIX (6) QUESTIONS. ANSWER ANY FOUR (4)**

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO

SECTION A

Instruction: In the booklet provided, answer any TWO (2) questions from this section.

Question 1

A. The rate of flow, Q , of liquid in a cylindrical tube is given by the equation

$$Q = \frac{\pi r^4 \Delta P}{8\eta L}, \text{ where}$$

Q = rate of flow of liquid (m^3/s)

r = radius of the tube, (m)

L = length of the tube (m)

ΔP = pressure difference between the ends of the tube (Pa).

i. Find the dimensions of the quantities r^4 , Q and ΔP . (3 marks)

ii. Determine the dimensions of the quantity η . (3 marks)

B. A simply supported beam ABC is shown in **Figure 1**. If the weight of the beam is negligible, determine the reactions R_A and R_B at points A and B respectively.

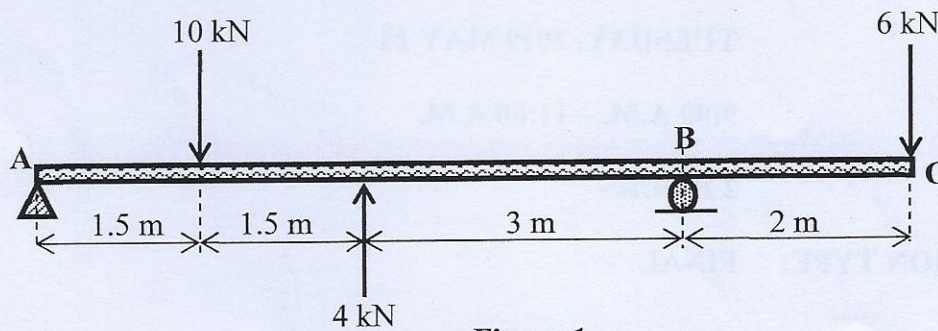


Figure 1

(6 marks)

C. A rectangular hole is cut from a square metal sheet as shown in **Figure 2**.

- i. Determine the location of the centroid of the metal sheet from the x-axis and y-axes. **(4 marks)**
- ii. Determine the mass of the metal sheet if its thickness is 2.5 mm and the density of steel is 7800 kgm^{-3} . **(4 marks)**

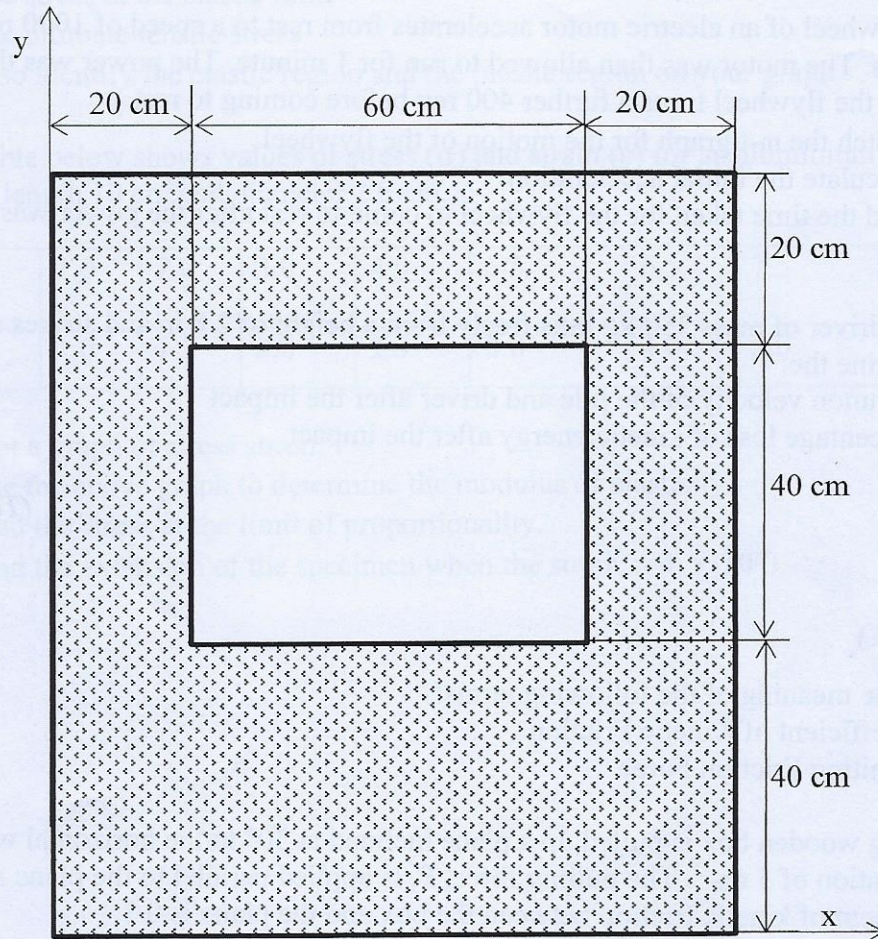


Figure 2

(Total 20 marks)

Question 2

- A. A crate is lowered at a constant velocity of 2.5 ms^{-1} by means of a cable wrapped round a pulley. The effective diameter of the pulley 0.20 m. Calculate the:
- angular velocity of the pulley (3 marks)
 - number of revolutions it makes when the crate descends 15 m (3 marks)
- B. The flywheel of an electric motor accelerates from rest to a speed of 1000 rev/min in 10 seconds. The motor was then allowed to run for 1 minute. The power was then switched off and the flywheel turns a further 400 rev before coming to rest.
- Sketch the ω - t graph for the motion of the flywheel. (3 marks)
 - Calculate the initial acceleration. (2 marks)
 - Find the time taken for the flywheel to come to rest after the power was switched off. (3 marks)
- C. A pile driver of mass 350 kg falls freely from a height of 2.8 m and strikes an 80 kg pile. Determine the:
- common velocity of the pile and driver after the impact (3 marks)
 - percentage loss of kinetic energy after the impact (3 marks)

*(Total 20 marks)***Question 3**

- A. State the meaning of the following terms:
- Coefficient of Kinetic Friction (2 marks)
 - Limiting Friction Force (2 marks)
- B. A 50 kg wooden box is pulled up a plane inclined at 30° to the horizontal with an acceleration of 5 ms^{-2} . The pulling force, P , is applied parallel to the plane and the coefficient of kinetic friction between the box and the plane is 0.3.
- Draw a diagram showing all the forces acting on the wooden box. (3 marks)
 - Find the normal reaction, N_A (4 marks)
 - Find the pulling force, P . (5 marks)
 - If the wooden box was pulled with a constant velocity, determine the pulling force that would be required to pull the box up the incline. (4 marks)

(Total 20 marks)

Question 4

A. Sketch a stress-strain graph for mild steel and identify the following points:

- i. The proportional limit stress *(2 marks)*
- ii. The yield stress *(2 marks)*
- iii. The stress at the elastic limit *(2 marks)*
- iv. The ultimate tensile stress *(2 marks)*
- v. Also identify the elastic region and the plastic region on your graph. *(2 marks)*

B. The table below shows values of stress (σ) and strain (ϵ) for an aluminium specimen of gauge length 10 cm and diameter 2.0 cm.

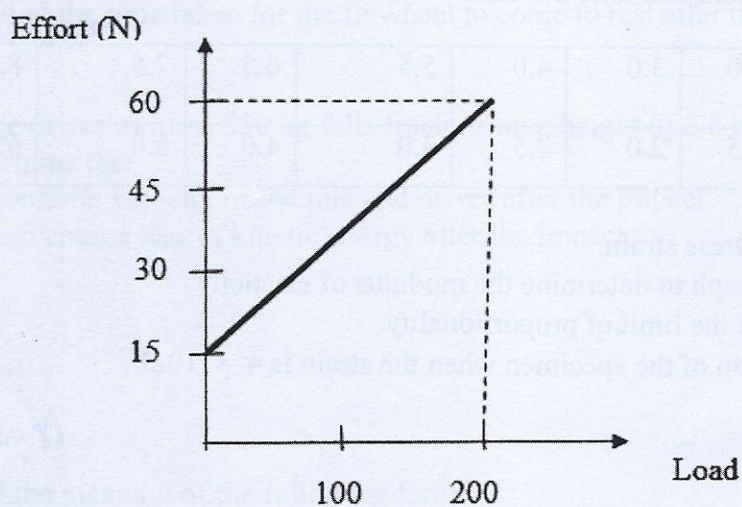
$\sigma (\times 10^8$ Pa)	1.0	2.0	3.0	4.0	5.5	6.5	7.5	8.5
$\epsilon (10^{-3})$	1.0	1.5	2.0	2.5	3.0	4.0	5.0	6.5

- i. Plot a graph of stress strain. *(3 marks)*
- ii. Use the above graph to determine the modulus of elasticity. *(2 marks)*
- iii. Find the stress at the limit of proportionality. *(2 marks)*
- iv. Find the extension of the specimen when the strain is 4×10^{-3} . *(3 marks)*

(Total 20 marks)

Question 5

- A. In a test on machine an effort of 50N was required to raise a load of 250N. If the effort moves through 150 mm to raise the load by 25 mm, find the following:
- The Mechanical Advantage (2 marks)
 - The Velocity Ratio (2 marks)
 - The efficiency (2 marks)
 - The work done by the effort. (3 marks)
 - The work done in raising the load 25 mm. (3 marks)
 - The power developed by the effort over a period of 5 seconds. (3 marks)
- B. A student investigating the law of a machine plots the graph shown below.



Use the graph to find the law of the machine.

(5 marks)

(Total 20 marks)

Question 6

- A. Air is compressed in a cylinder of a diesel engine. The initial volume of the air is 800 cm^3 and a temperature of 27°C and a pressure of 100 kPa . The air is compressed to one-fifteenth of its initial volume so that its temperature reaches 600°C . Determine the final pressure of the air. *(4 marks)*
- B. i. Distinguish between gauge pressure and absolute pressure. *(2 marks)*
 ii. A U-tube mercury manometer is used to measure the pressure of a gas in a metal container. If the gauge pressure of the gas is 13 kPa what will be the difference mercury levels in the two arms of the U-tube.
 Density of mercury = 13600 kg/m^3
 Atmospheric pressure = 101 kPa *(6 marks)*
- C. A 100 gram mass of brass was heated to 100°C and then placed in a styrofoam cup containing 150 grams of paraffin at 20°C . After stirring the final temperature reached 29°C .
 i. Determine the specific heat of paraffin. *(4 marks)*
 ii. State one assumption you made in your calculation in (i.) above. *(1 mark)*
 [Specific heat capacity of brass = $3806 \text{ Jkg}^{-1}\text{K}^{-1}$]
- D. An electric filament lamp with a clear glass bulb when switched on gives a bright white light. The bulb contains a small quantity of argon gas. Briefly describe the parts played by conduction convection and radiation in the loss of heat from the lamp filament. *(3 marks)*

*(Total 20 marks)***END OF EXAMINATION**