

S.6 TEST 1

Applied Mathematics

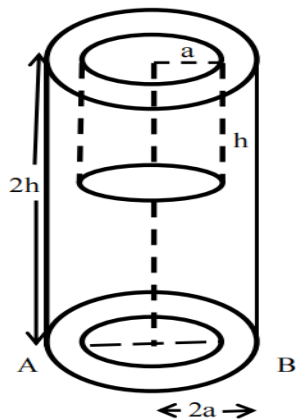
Time: $2\frac{1}{2}$ hrs

Year: 2024

Instructions: Attempt All

MECHANICS

1. A car of mass 750 kg has a maximum power of 30 kW and moves against a constant resistance to motion of 800 N.
- a) Find the maximum speed of the car;
- (i) on the level road. (3 marks)
- (ii) Up an incline of slope 1 in 10. (4 marks)
- b) the acceleration down the same incline if it moves at 40 ms^{-1} . (5 marks)
2. (a) The rectangle ABCD has $AB=4 \text{ cm}$ and $AD=2 \text{ cm}$. Particles of masses 3 Kg, 5 Kg, 1 Kg and 7 Kg are placed at the points A, B, C and D respectively. Find the distance of the centre of mass of the system from each of the sides AB and AD. (6 marks)
- (b) The figure below shows a uniform cylindrical lamina of radius $2a$ and height $2h$ with a small cylindrical hole of radius a and height h drilled centrally at one plane end.



show that the centre of gravity of the remaining solid is $\frac{13}{14}h$ from the base AB.

(6 marks)

3. A particle is projected from a point which is 2 m above the ground level with a velocity of 40 ms^{-1} at an angle of 45° to the horizontal. Find its horizontal distance from the point of projection where it hits the ground. (6 marks)

4. An over loaded taxi travelling with a constant speed of 25 ms^{-1} passes a stationary traffic police car. Two seconds later, the police car sets off in pursuit of the taxi accelerating at 6 ms^{-2} . Calculate the distance covered by the police car before catching up with the taxi. (6 marks)

NUMERICAL METHODS AND PROBABILITY

5. The probability density function of a random variable X is given by;

$$f(x) = \begin{cases} \beta(x+2) & ; -1 < x \leq 0 \\ 2\beta(1-x) & ; 0 < x \leq 1 \\ 0 & ; \text{elsewhere} \end{cases}$$

- (a) Sketch the function. (2 marks)
- (b) Find the value of constant β (3 marks)
- (c) Determine the cumulative distribution function, c.d.f (5 marks)
- (d) Find the probability $P(0 < X < \frac{1}{2} / X > 0)$ (2 marks)
6. Use trapezium rule with 5 strips to find an approximate value for $\int_1^2 xe^{-2x} dx$. Correct to four decimal places. (5 marks)
7. The numbers y and z are approximated with possible values errors of Δx and Δy respectively.
- (a) Show that the maximum relative error in the quotient $\frac{y}{z}$ is given by $\left| \frac{\Delta y}{y} \right| + \left| \frac{\Delta z}{z} \right|$ (5 marks)
- (b) Given that $x = 20.136$, $y = 15.3$ and $z = 9.5342$ are rounded to the given number of decimal places, find the limits within which the exact value of $\frac{y-x}{y+z}$ is expected to lie. (7 marks)

END

Determination always leads to Improvement

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