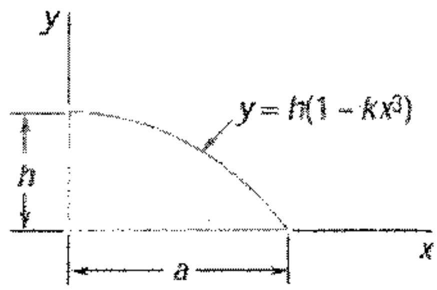
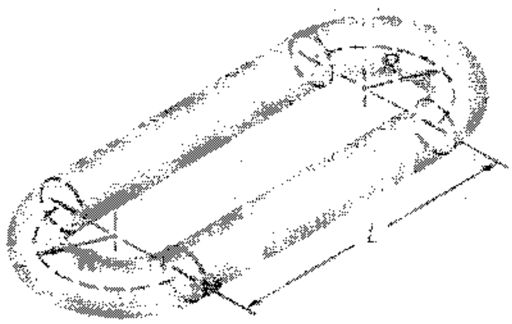
Kafrelsheikh University
Faculty of Engineering
Dept. of Mech. Engineering
Year: First Year
Subject: Mechanics II

2nd Semester
Final Examination
Date: July 5, 2021
Time allowed: 3 hours
Full Mark: 70

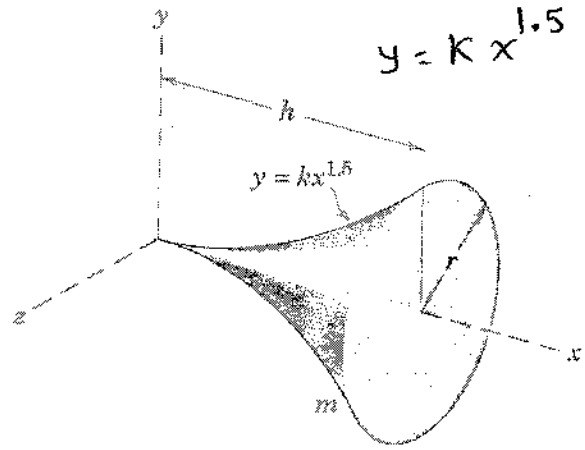
1. **(a) (10 Marks)** Determine by direct integration the centroid of the area shown. Express your answer in terms of $a$ and $h$.



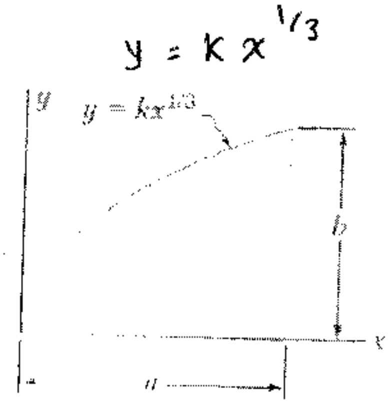
1. **(b) (10 Marks)** Determine the volume and the surface area of the chain link shown, which is made from a 6-mm-diameter bar, if $R = 5$ mm and $L = 30$ mm. If the density $\rho = 2690$ kg/m$^3$, determine the mass of the chain link.



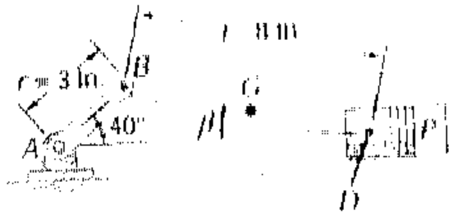
**2. (a) (10 Marks) <u>(10 Marks)</u>** Determine the mass moment of inertia of the homogeneous solid of revolution of mass $m$ about the $x$-axis.



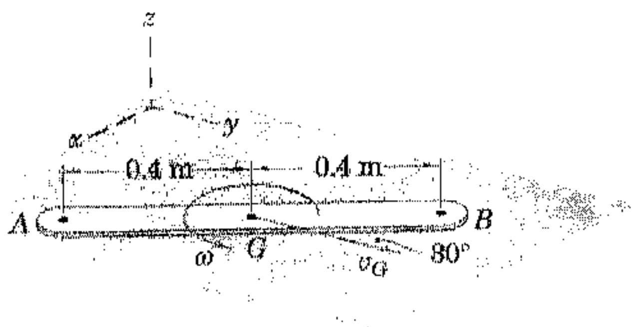
2. **(b) (10 Marks)** Calculate the moment of inertia of the shaded area about $x$-axis and $y$-axis.



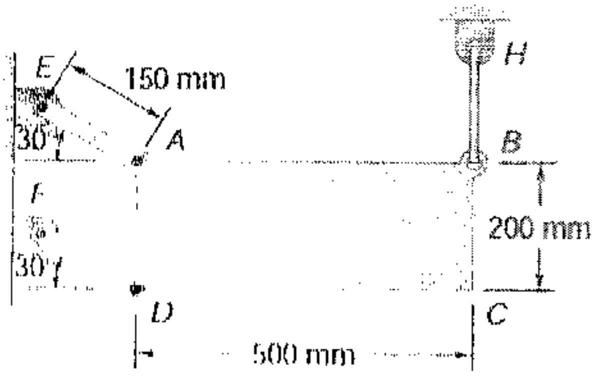
**(2 Marks)** In the engine system shown, the crank $AB$ has a constant clockwise angular velocity of **25 rad/s**. For the crank position indicated, determine (a) the angular velocity of the connecting rod $BD$, (b) the velocity of the piston $P$.



4. **(12 Marks)** Bar *AB* moves on the horizontal surface. Its mass center has a velocity $\boldsymbol{v}_G = 3$ **m/s** and an acceleration $\boldsymbol{a}_G = 4\ \mathbf{m/s^2}$ both are directed parallel to the y-axis and the bar has a counterclockwise (as seen from above) angular velocity $\boldsymbol{\omega} = 6$ rad/s and a clockwise angular acceleration $\boldsymbol{\alpha} = 3\ \mathbf{rad/s^2}$. Determine the velocity and the acceleration of point B.



**(12 Marks)** The thin plate *ABCD* of mass 8 kg is held in the position shown by the wire *BH* and two links *AE* and *DF*. Neglecting the mass of the links, determine immediately after wire *BH* has been cut (a) the acceleration of the plate, (b) the force in each link.



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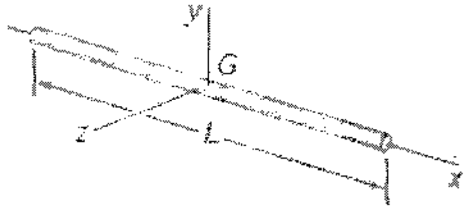
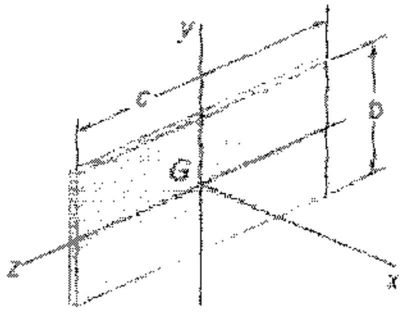
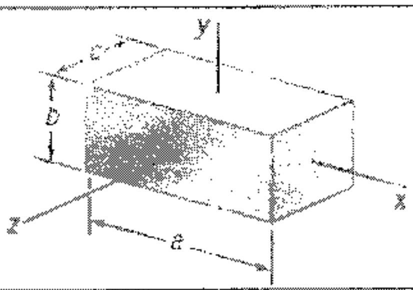
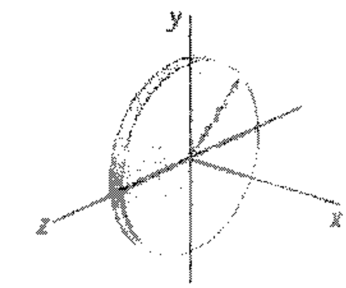
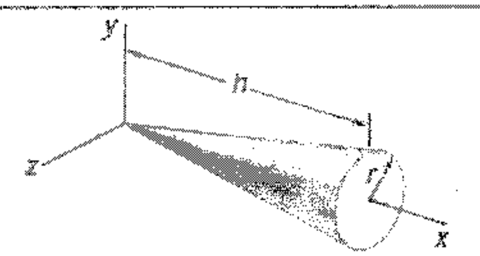
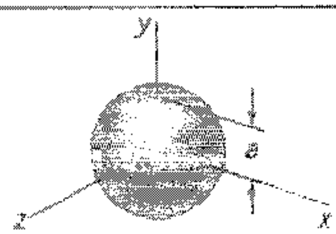
|---|---|---|
| Slender rod |  | $I_y = I_z = \frac{1}{12} mL^2$ |
| Thin rectangular plate |  | $I_x = \frac{1}{12} m(b^2 + c^2)$<br>$I_y = \frac{1}{12} mc^2$<br>$I_z = \frac{1}{12} mb^2$ |
| Rectangular prism |  | $I_x = \frac{1}{12} m(b^2 + c^2)$<br>$I_y = \frac{1}{12} m(c^2 + a^2)$<br>$I_z = \frac{1}{12} m(a^2 + b^2)$ |
| Thin disk |  | $I_x = \frac{1}{2} mr^2$<br>$I_y = I_z = \frac{1}{4} mr^2$ |
| Circular cylinder |  | $I_x = \frac{1}{2} ma^2$<br>$I_y = I_z = \frac{1}{12} m(3a^2 + L^2)$ |
| Circular cone |  | $I_x = \frac{3}{10} ma^2$<br>$I_y = I_z = \frac{3}{5} m(\frac{1}{4} a^2 + h^2)$ |
| Sphere |  | $I_x = I_y = I_z = \frac{2}{5} ma^2$ |