FINAL EXAM Open Book, Closed Notes, Do not write on this sheet, Show all work

1. (25 points) Determine the location \bar{x} of the center of gravity of the solid made from a hemisphere, cylinder, and cone.



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2. (25 points) Determine the moment of inertia for the beam's cross-sectional area with respect to the x' centroidal axis. Neglect the size of all the rivet heads, R, for the calculation. Handbook values for the area, moment of inertia, and location of the centroid C of one of the angles are listed in the figure.



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3. (30 points) Determine the mass moment of inertia of the assembly about an axis which is perpendicular to the page and passes through point *O*. The material has a specific weight of $\gamma = 90 \text{ lb/ft}^3$.



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4. (20 points) Draw the free-body diagrams for the four following situations.



The link is used to hold the rod in place. Determine the required axial force on the screw at *E* if the largest force to be exerted on the rod at *B*, *C*, or *D* is to be 100 N. Also, find the magnitude of the reaction force at pin *A*. Assume all surfaces of contact are smooth.



Operation of exhaust and intake valves in an automobile engine consists of the cam C, push rod DE, rocker arm EFG which rides on a smooth bearing at F, and a spring and valve, V. If the compression in the spring is 20 mm when the valve is open as shown, determine the normal force acting on the cam lobe at C. Assume the contact between the cam and the push rod at D is normal and smooth. The spring has a stiffness of 300 N/m.





The skid steer loader has a mass of 1180 kg, and in the position shown the center of mass is at G_1 . If there is a 300-kg stone in the bucket, with center of mass at G_2 , determine the reactions of each pair of wheels A and B on the ground and the force in the hydraulic cylinder CD and at the pin E. There is a similar linkage on each side of the loader.



If a force of P = 6 lb is applied perpendicular to the handle of the mechanism, determine the magnitude of force *F* for equilibrium. The members are pinconnected at *A*, *B*, *C*, and *D*.

ME 212 Statics, Fall 2006

FINAL EXAM Open Book, Closed Notes, Do not write on this sheet, Show all work

5. Bonus Question: (20 points, **No partial credit will be awarded**) Determine the internal shear force and moment acting at point *D* of the beam.

