Answer all the following questions

PART (I) STATICS

QUESTION NO. 1

(13 MARK)

A) Determine the magnitudes of the forces C and T graphically and analytically, which, along with the other three forces shown in Figure 1, act on the bridge-truss joint. **(8 Marks)**
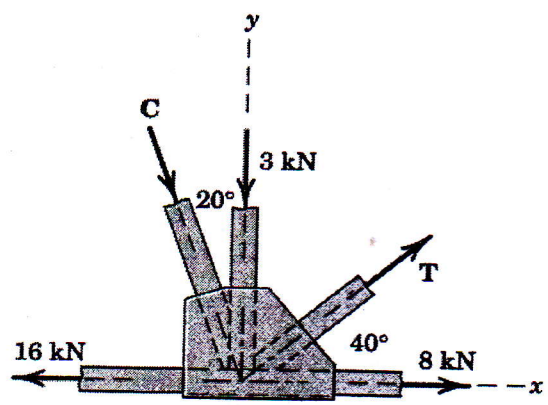

Fig.1

B) The 120-N force is applied as shown in Figure 2 to one end of the curved wrench. If $\alpha = 30°$, calculate the moment of F about the center O of the bolt. Determine the value of α which would maximize the moment about O; state the value of this maximum moment. **(5 Marks)**
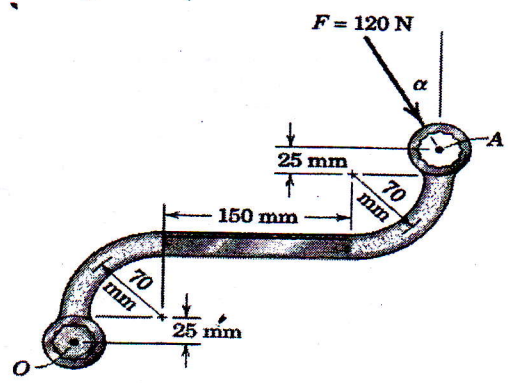

Fig.2

QUESTION NO. 2

(22 MARK)

A) Calculate the value and construct a bending moment and shear force diagram for following beam shown in Figure.3. **(9 Marks)**
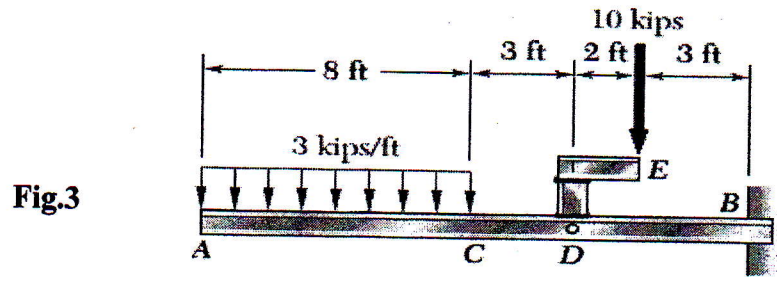

Fig.3

1

B) Determine <u>only the reaction forces</u> at point B and point C of the compound beam as shown in Figure. 4. (5 Marks)

10.6 kN/m

5.1 kN/m   5.1 kN/m

A   D
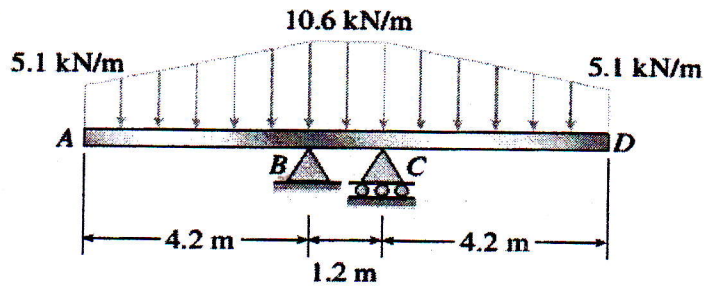
B   C

4.2 m

1.2 m

4.2 m

Fig. 4

C) Determine the moments of inertia and the radius of gyration of the shaded area as shown in Figure. 5 with respect to the x and y axes. (8 Marks)
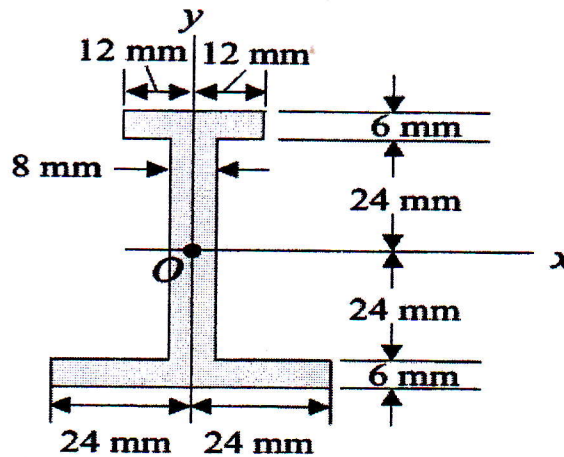
y

12 mm | 12 mm

6 mm

8 mm

24 mm

O   x

24 mm

6 mm

24 mm   24 mm

Fig. 5

******** GOOD LUCK**********

This exam measures the following ILOs						
Question number	Q1(a)	Q1(b)	Q1(b)	Q2(a)	Q2(b)	Q2(c)
skills	A1	A3	B2	B4	C1	C3
	Knowledge & Understanding		Intellectual		Professional	

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Part 2: Dynamics (40 marks) 10/1/2018

Question 3 (7 + 8 marks)

a) The right-angle bar shown in Fig. (3-a) rotates clockwise with an angular velocity which is decreasing at the rate of 4 rad/s². Write the vector expressions for the velocity and acceleration of point A when ω = 2 rad/s.
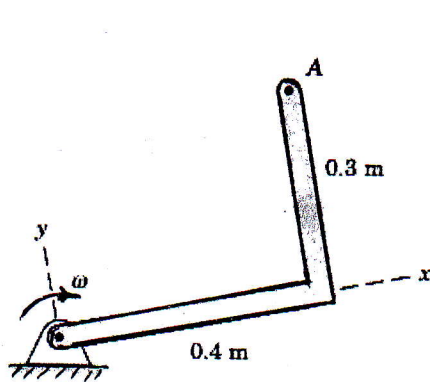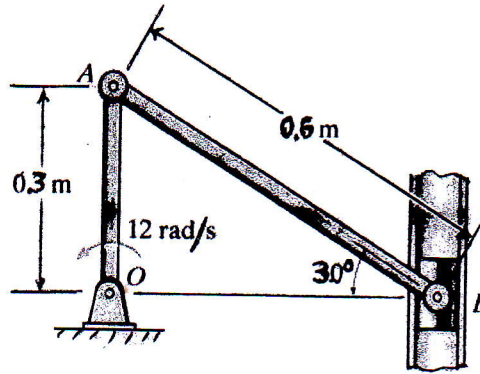

Fig. 3-a   Fig. 3-b

b) The crank and connecting rod of a steam engine are 0.3 m and 0.6 m respectively. The crank OA rotates with a constant angular velocity of 12 rad/s. Find graphically, or otherwise, the velocity of A, the angular velocity of the link AB and the piston acceleration for the position shown in Fig. 3-b.

Question 4 (7 + 8 marks)

a) The ram of a pile driver shown in Fig. (4-a) has a mass of 750 kg and is released from rest 2 m above the top of the 2000-kg pile. If the ram rebounds to a height of 0.1 m after impact with the pile, calculate (a) the velocity v_p' of the pile immediately after impact, (b) the coefficient of restitution e, and (c) the percentage loss of energy due to the impact.
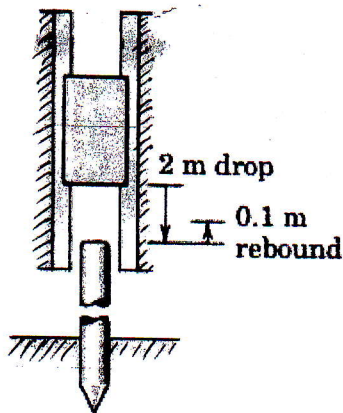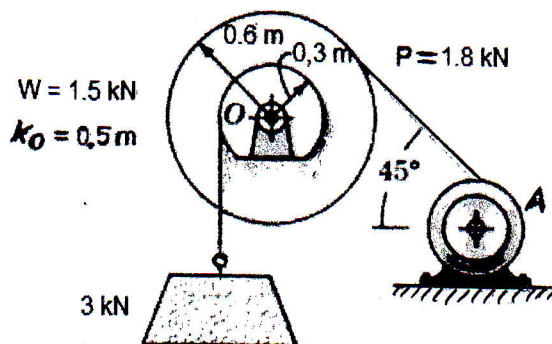

Fig. 4-a   Fig. 4-b

b) The concrete block weighing 3 kN is elevated by the hoisting mechanism shown in Fig. (4-b), where the cables are securely wrapped around the respective drums. The drums, which are fastened together and turn as a single unit about their mass center at O, have a combined weight of 1.5 kN and a radius of gyration about O of 0.5 m. If a constant tension $P = 1.8$ kN is maintained by the power unit at A, determine the vertical acceleration of the block and the resultant force on the bearing at O.

Question 5   **(2 + 2 + 6 marks)**

a) Write down the differential equation describing undamped free vibration, its general solution and the definitions of "amplitude", "period", and "frequency".

- Demonstrate the basic elements of a vibrating system and define the natural frequency.

b) The bent rod shown in Fig. 5 has a negligible mass and supports a 5-kg collar at its end. If the rod is in the equilibrium position shown, determine the natural period of vibration for the system.
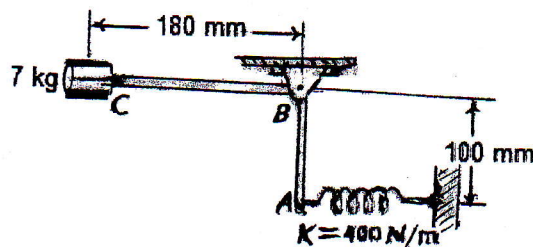

Fig. 5

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Good Luck