

**GNG 1105 - ENGINEERING MECHANICS**

Final Examination  
7 December 2007  
Profs. Hallett and Skaff

Time: 3 hours  
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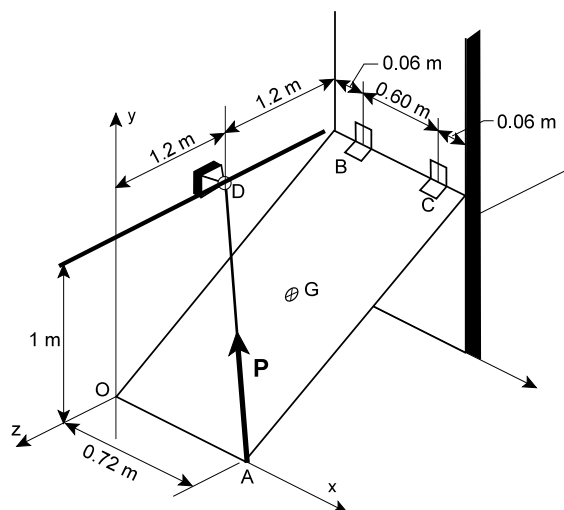
**Closed Book.** Non-programmable calculators only allowed. Free-body diagrams must be drawn wherever appropriate. Marks will be deducted for missing or incorrect free-body diagrams.

At the end of the exam, when time is up, **stop working and close your exam booklet**. Do not move or speak until all exams have been picked up and the proctor tells you that you may leave.

1. (12 marks total) The inclined plate shown in the sketch is supported by two hinges, B and C, attached to a vertical wall, and by a cable AD which exerts a force  $\mathbf{P} = 1.72 \text{ kN}$  at point A. The cable anchor, point D, lies in the  $y$ - $z$  plane. Hinge B can act as a thrust bearing, but C cannot. The weight of the plate acts at its centre G.

(a) (4 marks) Write the force  $\mathbf{P}$  as vector components.

(b) (8 marks) Determine the weight of the plate and the reactions at hinge C.

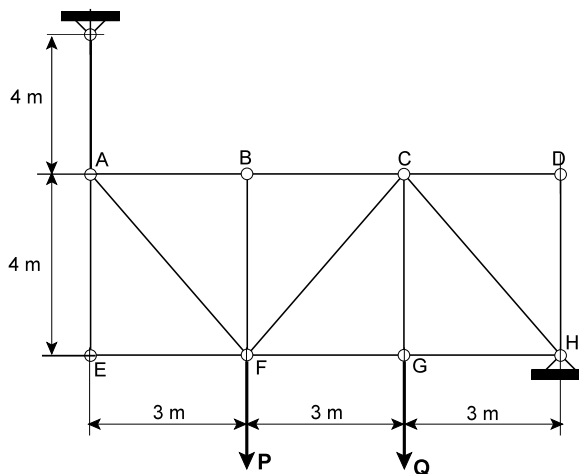


2. (12 marks total) The truss shown is supported by a pin joint at H and a vertical link at A. It is loaded by forces  $P = 20 \text{ kN}$  and  $Q = 8 \text{ kN}$ . All joints are frictionless pins.

(a) (2 marks) Determine the reactions at the supports.

(b) (8 marks) Find the forces in members BC, FC, and FG using the method of sections. Specify in each case whether the member is in compression or tension. **Note:** a solution by the method of joints will get a mark of zero (0).

(c) (2 marks) Identify all zero force members in this truss under the loading shown.



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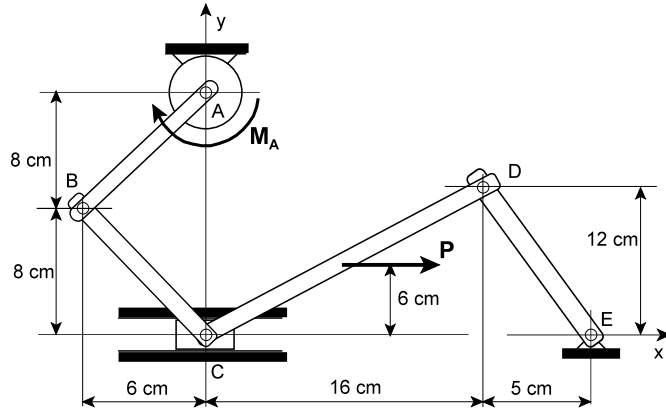
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**3.** (12 marks total) The mechanism shown is driven by an electric motor at A, which can be considered as a pin joint with a couple  $\mathbf{M}_A$  applied to member AB. Members BC and CD are joined to a frictionless slide at C, and member CD is loaded by a horizontal force  $\mathbf{P} = 84 \text{ N}$ . All joints are frictionless pins. The weights of all parts may be neglected.

**(a)** (2 marks) Draw free-body diagrams of all parts of the mechanism.

**(b)** (10 marks) Determine the magnitude and direction of the couple  $\mathbf{M}_A$ .



**4.** (12 marks total) Three blocks rest on an incline. Block A is secured to point E by a cord which is parallel to the incline. A force  $\mathbf{P}$  parallel to the incline acts on block B. Each block weighs 25 N. The coefficients of static friction are as follows:

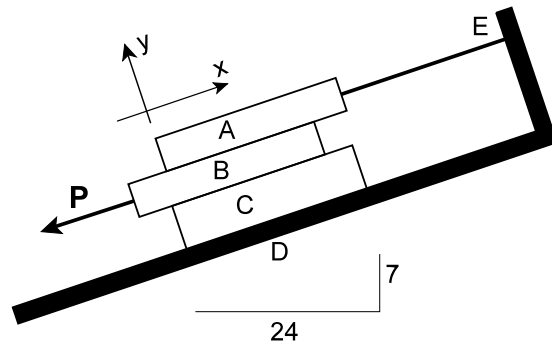
$$\mu_{S AB} = \mu_{S BC} = 0.25 ; \mu_{S CD} = 0.4 ,$$

where  $\mu_{S AB}$  means the coefficient of friction between blocks A and B, etc.

**(a)** (2 marks) Draw a free-body diagram of each block.

**(b)** (8 marks) Calculate the force  $P$  required to cause block B to start to move. Assume that block C does not move.

**(c)** (2 marks) Prove that slipping does not impend at the contact between block C and the incline D.



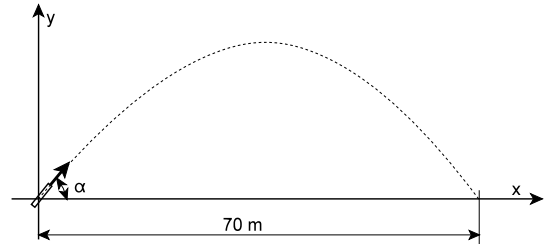
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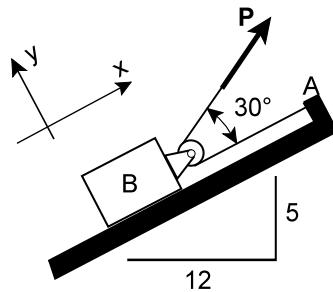
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5. (5 marks) A nozzle shoots out a jet of water with an initial velocity  $v_0 = 35$  m/s at an angle  $\alpha$  to the horizontal. Determine the value of this angle if the jet is to strike a position on the ground 70 m away from the nozzle. The acceleration due to gravity is  $9.8$  m/s<sup>2</sup>. You may find the following trigonometric relation useful:

$$\sin \alpha \cos \alpha = \frac{1}{2} \sin 2\alpha$$



6. (7 marks) A block B is accelerated up a ramp by a force  $P$  acting on a cord through a frictionless pulley. The other end of the cord is secured to point A, and the cord between the pulley and A is parallel to the ramp. The coefficient of kinetic friction between the block and the ramp is  $\mu_k = 0.15$  and the mass of the block is 13 kg. If  $P = 60$  N, find the acceleration of the block. The acceleration due to gravity is  $9.8$  m/s<sup>2</sup>.



**Total marks for this paper: 60**