

GNG 1105E - ENGINEERING MECHANICS

Final Examination
April 2011
Professor Y. M. Haddad

Time: 3 hours
Page 1 of 3

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.

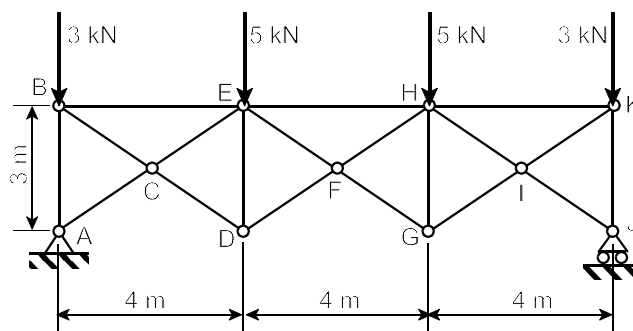
1. (13 marks total) A truss carries four loads as shown. All joints in the truss are pinned.

(a) (2 marks) Calculate the reactions at the supports A and J.

(b) (2 marks) Identify all zero force members in the truss.

(c) (4 marks) Using the method of joints, determine the forces in members AB and BC. State whether each member is in compression or tension.

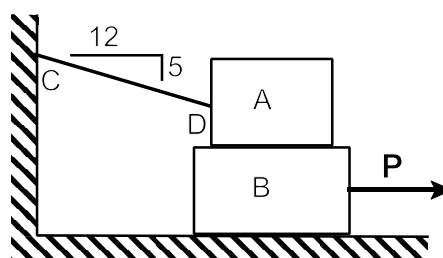
(d) (5 marks) Using the method of sections, determine the forces in members EF and DF. State whether each member is in compression or tension. If you use the method of joints, you will get a mark of zero (0) for this part of the problem.



2. (10 marks total) Block A weighs 200 N and is secured to the vertical wall by a cord CD set at an angle as shown. Block B weighs 300 N and is acted on by horizontal force P . The coefficient of static friction between all surfaces is $\mu_s = 0.25$.

(a) (7 marks) Determine the smallest value of P required to start block B moving.

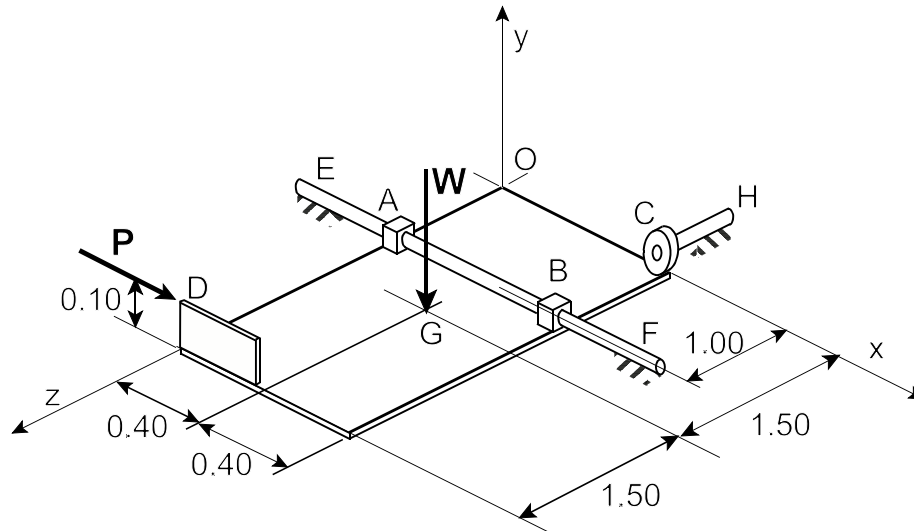
(b) (3 marks) Cord CD is removed. Calculate the new value of the smallest value of P required to start block B moving.



GNG 1100 - ENGINEERING MECHANICS

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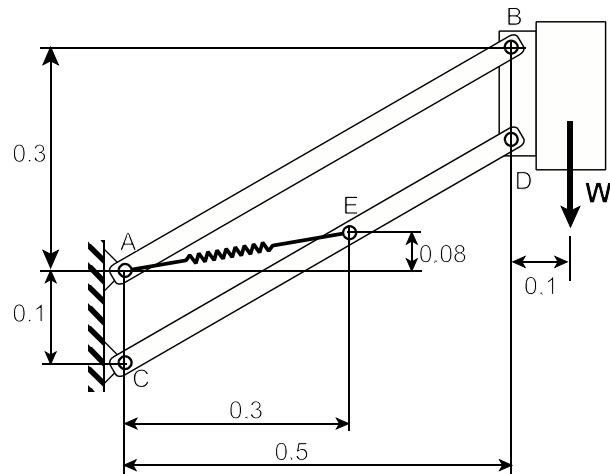
Time: 3 hours
Page 2 of 3



3. (12 marks) The sketch shows a table for medical imaging equipment which is supported by two bearings A and B and a frictionless roller C. These bearings are supported by a shaft EF parallel to the x axis which is held rigidly by fixed supports at E and F. Bearings A and B are aligned with each other, and B can support a thrust (axial) load while A cannot. The roller C rotates on shaft CH, which is parallel to the z axis and is rigidly held by a fixed support at H. Force $\mathbf{P} = 0.5 \text{ N}$ is parallel to the x-axis, and the table weight is $W = 2.5 \text{ kN}$. Determine the reactions at bearings A and B and at roller C. All dimensions are in metres. **Hint:** begin by taking moments about B.

4. (12 marks total) The sketch shows a frame supporting a lamp of weight $W = 50 \text{ N}$. Members AB and CD are parallel to each other, and all joints are pinned. The weights of the parts of the frame are negligible. All dimensions are in metres.

- (a) (2 marks) Draw free-body diagrams of
 - (i) the entire frame including the lamp, and
 - (ii) each part of the frame and the lamp.
- (b) (10 marks) Calculate the tension in the spring AE required to hold the lamp in equilibrium.

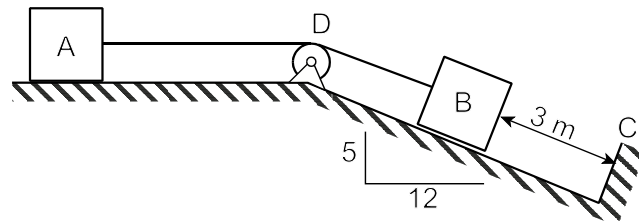


GNG 1100 - ENGINEERING MECHANICS

Final Examination
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Time: 3 hours
Page 3 of 3

5. (13 marks total) Two blocks are connected by a cord which passes over a frictionless pulley at D. Block A has a mass of 40 kg and block B a mass of 120 kg. A rests on a horizontal surface, while B rests on a ramp with the slope shown. B is initially in a position 3 m from the stop C as shown. The coefficient of kinetic friction between the blocks and the surface beneath is $\mu_k = 0.20$ for both A and B.



(a) (7 marks) Find the acceleration of the two blocks and the tension T in the cord, assuming that the blocks just begin to move at time $t = 0$.

(b) (3 marks) Determine the velocity with which B hits the stop C. If you have not solved (a) part, you may assume an acceleration of 1 m/s^2 for this part and (c) part.

(c) (3 marks) Determine how far A moves after B hits the stop C.

Total marks for this paper: 60

Answers

Problem #1:

(a) $R_A = R_J = 8 \text{ kN}$

(b) AC, CE, JI et IH

(c) $F_{AB} = 8 \text{ kN}$ (C) et $F_{BC} = 8.33 \text{ kN}$ (T)

(d) $F_{DF} = 8.33 \text{ kN}$ (T) et $F_{EF} = 8.33 \text{ kN}$ (T)

Problem #2:

(a) $P = 166 \text{ N}$

(a) $P = 125 \text{ N}$

Problem #3:

$$\mathbf{C} = (-1250 \text{ N}) \mathbf{j}$$

$$\mathbf{A} = (1249.98 \text{ N}) \mathbf{j} - (1.25 \text{ N}) \mathbf{k}$$

$$\mathbf{B} = (-0.5 \text{ N}) \mathbf{i} + (2500 \text{ N}) \mathbf{j} + (1.25 \text{ N}) \mathbf{k}$$

Problem #4:

$$(b) F (\text{in the spring}) = 271 \text{ N}$$

Problem #5:

$$(a) a = 0.1 \text{ g} = 0.98 \text{ m/s}^2$$

$$\text{and } T = 118 \text{ N}$$

$$(b) v = 2.43 \text{ m/s at } t = 2.47 \text{ s}$$

$$(c) S = 1.5 \text{ m at } t = 1.24 \text{ s}$$
