**GNG 1100 - ENGINEERING MECHANICS**

Final Examination — Time: 3 hours
17 December 2002 — 
Profs. Droste, Hallett and Skaff

Closed Book. Only non-programmable calculators may be used. Free-body diagrams must be drawn wherever appropriate.

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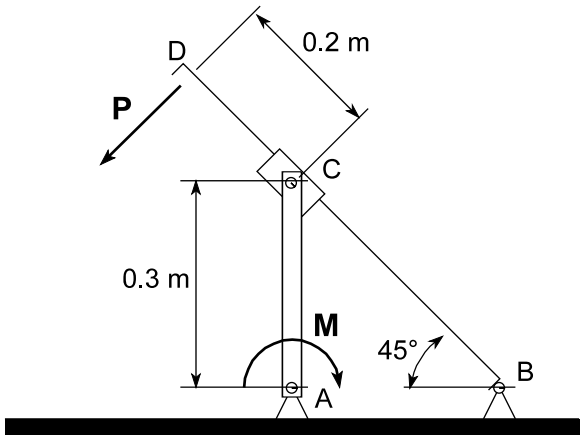
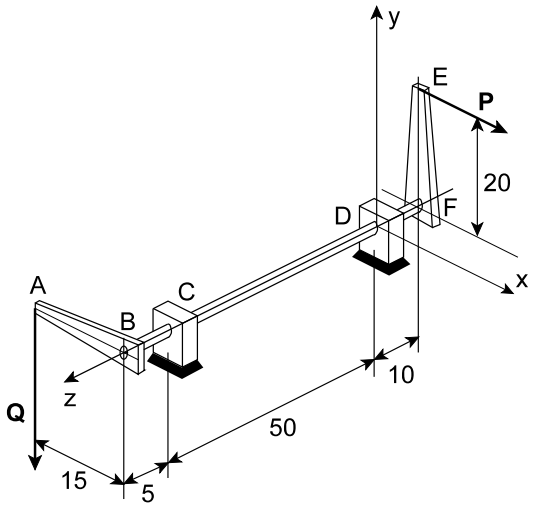
**1.** (10 marks) The mechanism shown has pin joints at A and B and is driven by a couple **M** = 100 Nm at A. At C is a frictionless slider which is attached to member AC by a frictionless pin.
(a) Calculate the force P required to maintain the system in equilibrium. **P** acts at right angles to BD, and AC is vertical.
(b) Determine the reactions at A and B.



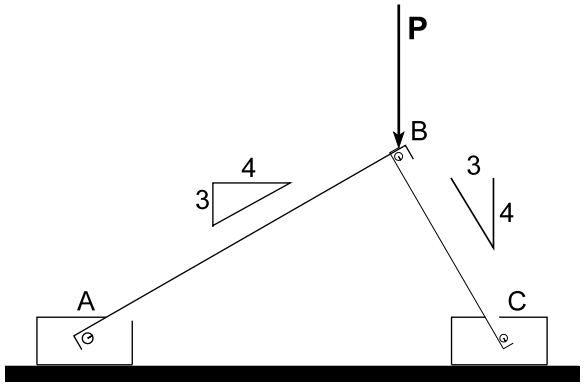

**2.** (12 marks) The sketch shows a shaft BF with levers at both ends, acted on by a force P = 500N at E and a force Q at A. The shaft is supported by frictionless bearings at C and D which are aligned with the shaft. Bearing D can exert an axial thrust, but bearing C can not. Lever AB and force **P** are parallel to the x axis, while lever FE and force **Q** is parallel to the y axis. Calculate the force Q and the components of the reactions at C and D, assuming equilibrium. All dimensions are in cm.

**3.** (12 marks) Block A weighs 195 N and block C weighs 120 N. The coefficient of friction between each block and the horizontal surface is $\mu_S$ = 0.3. All joints are pinned, and bars AB and BC are of negligible weight. The applied force **P** is vertical.

(a) Write the force in BA and the force in BC as functions of P. **Hint**: you may take point B as a free-body.

(b) Find the magnitude of the applied load **P** for which motion will impend. **Hint**: assume that slipping impends at C but not at A.

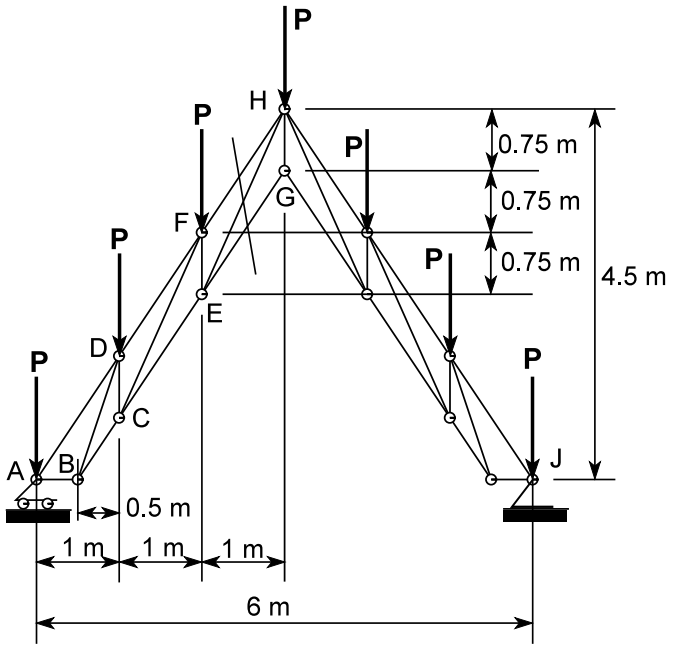
(c) Verify that slipping does not occur at A.



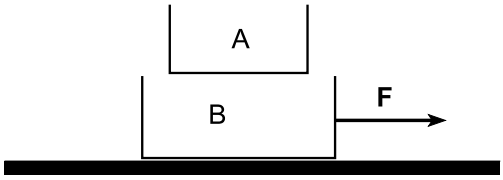

**4.** (12 marks) The sketch shows a roof truss for a group of townhouses presently being built in Sandy Hill. The truss is loaded by 7 vertical forces **P** of 1.20 kN each, representing the design snow load required by the Ottawa building code. All joints are pinned. AH is parallel to BG, and the truss and loading are symmetrical about the vertical line through G.

(a) Find the reactions at the supports (points A and J).

(b) Determine the forces in members FH and EG using the method of sections. State whether each is in tension or compression. **Do not use the method of joints. A method of joints solution will be given a mark of 0 (zero).**



**5.** (14 marks) Block A has a mass of 15 kg and block B a mass of 30 kg. A force **F** is applied to block B as shown, causing both blocks to accelerate (note that block B is already sliding on the horizontal surface). The coefficients of friction for all contact surfaces are $\mu_S = 0.35$ and $\mu_K = 0.25$.




(a) Determine the largest force F that can be applied to B without causing A to slip relative to B.

(b) If force F is now increased to 300 N, determine the acceleration of A with respect to stationary coordinates and the acceleration of A with respect to B.

**Total marks for this paper: 60**