Faculté de génie
Génie mécanique

uOttawa
L'Université canadienne
Canada's university

Faculty of Engineering
Mechanical Engineering

GNG 1105 - ENGINEERING MECHANICS

Supplemental Examination
22 February 2008
Profs. Hallett and Skaff

Time: 3 hours

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.

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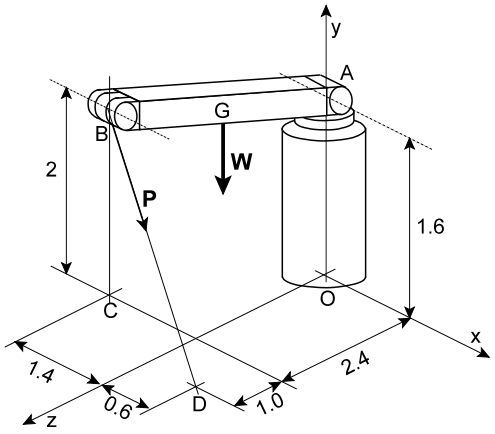
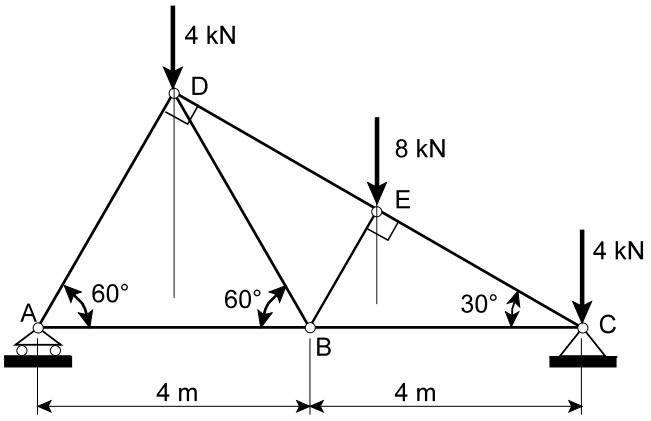
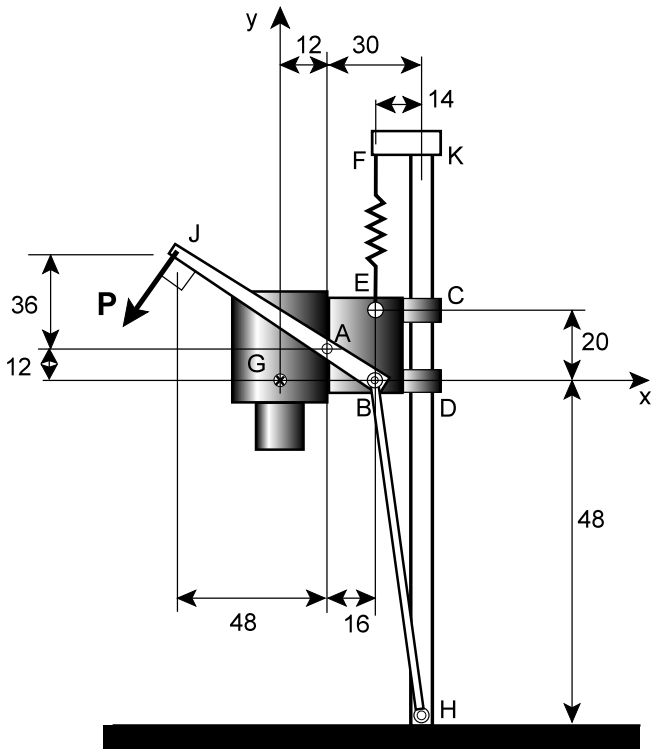
1. (12 marks total) The industrial robot shown in the sketch has a load **P** = 300 N applied at the end of its arm at point B; this force lies on line of action BD. The weight of the arm **W** = 500N acts at the centre of gravity G, located halfway between points A and B. All dimensions are in meters.
(a) (4 marks) Write the force **P** as vector components.
(b) (8 marks) Reduce **P** and **W** to an equivalent force-couple system at point O.



2. (12 marks total) The roof truss shown is supported by a pin joint at C and a roller at A. Snow loads the truss as shown. All joints are frictionless pins, and angles ADE and BEC are 90°.
(a) (4 marks) Determine the reactions at the supports.
(b) (8 marks) Find the forces in members DE, BE and BC. Specify in each case whether the member is in compression or tension. You may use either the method of sections or the method of joints.



3. (12 marks total)



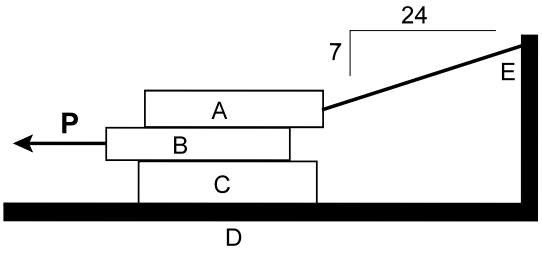
The sketch shows a drilling machine. The drill head (shaded part in diagram) is supported by two frictionless slides C and D on the vertical column HK and by a vertical spring EF. A lever JB is used to move the drill up and down; it is attached to the drill by a frictionless pin at A, and its end B is held by the pin-jointed link BH. (Note that pin B is **not** fastened to the drill.) A force P = 20 N acts at right angles to the lever. The drill weighs 500 N, and its weight may be assumed to act at point G. Points B,D and G all lie on the x axis. All dimensions are in cm.

(a) (2 marks) Draw free-body diagrams of the drill head (shaded) and of the lever BJ.

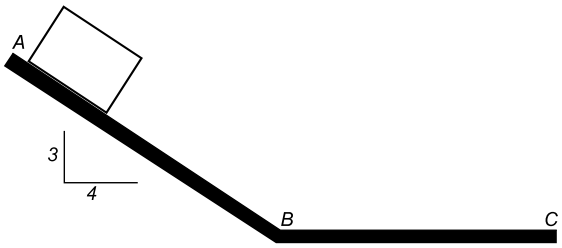
(b) (5 marks) Determine the force in the link BH.

(c) (5 marks) Determine the tension in the spring EF and the reactions at the slides C and D.

4. (12 marks total) Three blocks rest on a horizontal plane. Block A is secured to point E by a cord with the angle shown. A horizontal force **P** acts on block B. Each block weighs 25 N. The coefficient of static friction is $\mu_S = 0.20$ between all surfaces of contact.
(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 plane D.



5. (12 marks) A box of mass 10.2 kg slides down an incline AB of slope 3:4 until it reaches a horizontal surface BC, where it continues to slide. The initial velocity of the box at A is 1 m/s, the coefficient of kinetic friction is $\mu_K = 0.2$, and the distance AB is 6 m. The gravitational acceleration is 9.8 m/s^2.
(a) (6 marks) Calculate the velocity of the box at point B.
(b) (6 marks) If the velocity of the box at point C is to be 0.5 m/s, calculate the distance BC.



The solution of the quadratic equation $ax^2 + bx + c = 0$ is

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Total marks for this paper: 60