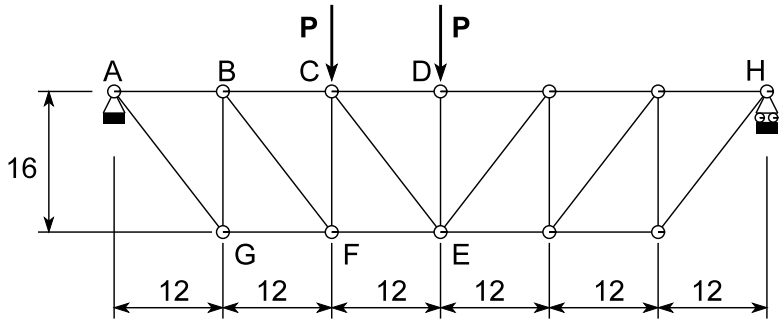
GNG 1100 - ENGINEERING MECHANICS

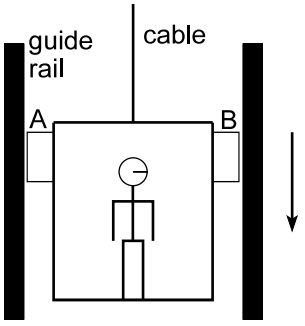
Final Examination — Time: 3 hours
11 December 2001 —
Profs. Hallett, Skaff and Tamtsia

Closed Book. All calculators allowed. Free-body diagrams must be drawn wherever appropriate.

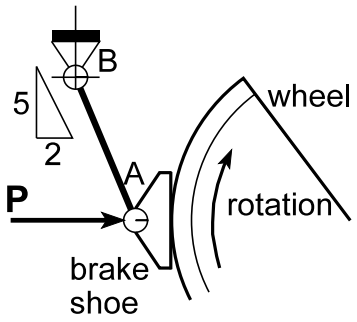


1. (12 marks) The sketch shows a pin-jointed railway truss bridge. A locomotive loads the bridge with two forces P = 60 kN. Using the method of sections, determine the forces in members CD, CE, and FE, stating in each case whether the member is in tension or compression. All dimensions are in metres.

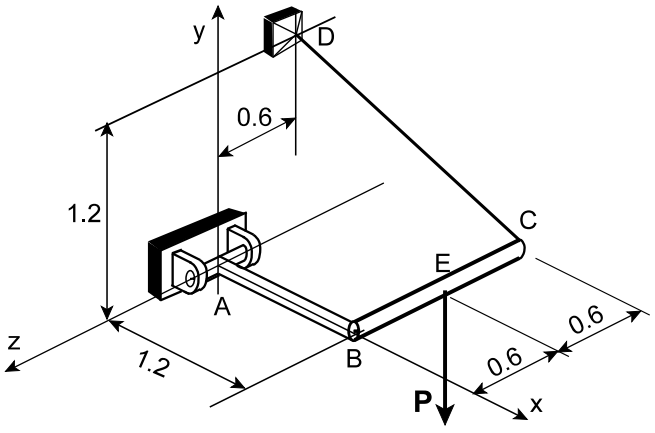
2. The car of an elevator has a mass of 1000 kg and is suspended by a single cable. A person of mass 70 kg is standing in the elevator. Two guide blocks A and B slide on vertical rails to guide the elevator as it moves, and the friction force between each block and the rail has a constant value of 50 N **for each block**. The elevator accelerates **downwards** at a rate of 2 m/s^2.
(a) (6 marks) Calculate the tension in the suspending cable.
(b) (4 marks) Calculate the force exerted on the floor of the elevator by the person inside.



3. (10 marks) The brake shoe on a railway car is suspended by a pin-jointed link AB of negligible weight. The shoe is pressed with a horizontal force P = 7 kN against a wheel rotating in the direction shown. If the coefficient of kinetic friction between the shoe and the wheel is $\mu_K = 0.2$, calculate the frictional force applied to the wheel. The brake shoe and link are in equilibrium.



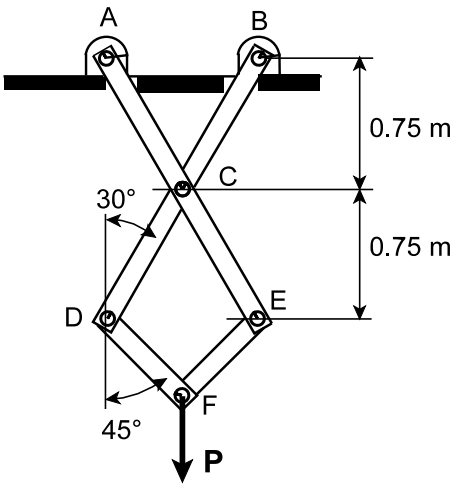
4. (14 marks) The sketch shows a bar ABC which is supported by a hinge at A and by a cable CD, and is loaded by a force P = 1.5 kN. Bar ABC lies in the x-z plane, with BC parallel to the z axis, while support points A and D lie in the y-z plane. The hinge A can resist an x- or y-component of moment, but is frictionless and offers no resistance to turning about the z axis. Determine the reactions at point A and the tension in cable CD, assuming the weight of the bar to be negligible. All dimensions are in metres.

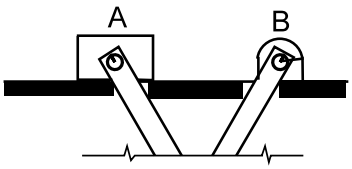


5. The sketch shows a frame supporting a weight P = 1 kN. All joints are pinned. A and B are frictionless bearings (equivalent to pin joints) which are rigidly attached to the surface. Members ACE and BCD are continuous.

(a) (10 marks) Determine all forces acting on member ACE. Assume that the weights of all parts are negligible. **Hint**: take pin F as one of your free-bodies.

(b) (4 marks) Now assume that bearing A is replaced by a block that is free to slide on the horizontal surface, as shown in the lower diagram of the top part of the frame. Determine the minimum coefficient of static friction between A and the ground required to prevent A from slipping.





Total marks for this paper: 60