NATIONAL EXAMINATION - DECEMBER 2002

- STATICS AND DYNAMICS -

(98-BS-3)

3 HOURS' DURATION

Notes:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer-paper a clear statement of any assumption made.

2. This is a **"CLOSED BOOK"** examination. However, candidates may bring **ONE 8½"×11" sheet** of self-prepared notes. Candidates may use one of two calculators, a **Casio FX-991** or a **Sharp EL-540**.

3. Squared paper will be provided, on request of the candidate, as an aid in the conducting of graphical solutions, if that is the method of solution preferred.

4. Any **FOUR** questions completed will constitute a complete paper, and only four will be marked.

5. If more than four questions are presented for assessment then only the **first four undeleted solutions encountered will be marked.**

6. All questions are of equal value. Total marks 80.

I. (20 marks)

A 9 meter length of railroad track is lifted by a crane using the rail tongs shown in figure 1. If the track has a mass of 40 kg/m, determine;

a) the forces exerted at D and F on the tong BDF, and

b) the force exerted at C on arm CDE.

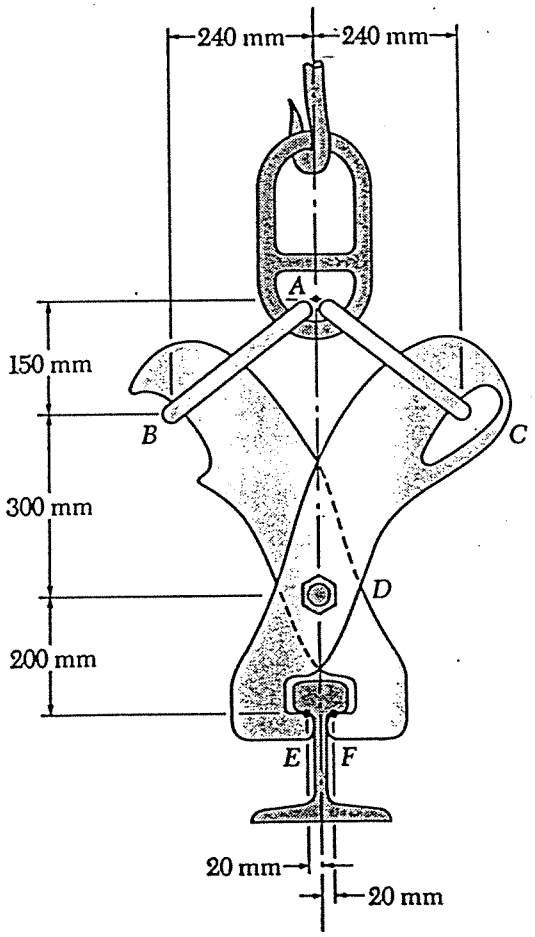

FIGURE 1.

II. (20 marks)

An antiaircraft gun fires a shell with an initial muzzle velocity of 1500 ft/sec, as a plane passes directly over the position of the gun (A) as shown in figure 2. The plane maintains an altitude of 6000 ft and a velocity of 450 mi/hr, determine;
NOTE: 1 mile = 5280 ft

a) the required firing angle (α) if the shell is to hit the plane, and

b) the velocity and acceleration of the shell relative to the plane at the time of impact.

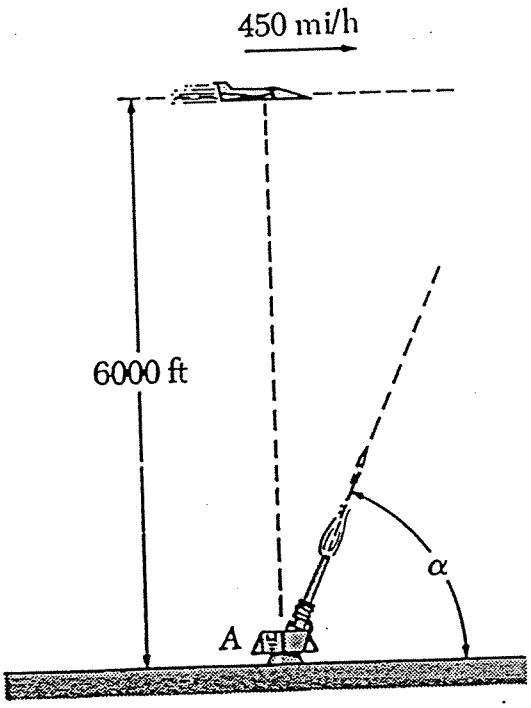

FIGURE 2.

III. (20 marks)

Figure 3 shows the cross section of a proposed light weight flywheel design. The density of the steel is 7830 kg/m^3, and the density of the aluminium is 2770 kg/m^3. Determine'

a) the weight of the flywheel and the mass moment of inertia about the centre axis, and

b) repeat part (a) if the flywheel was made entirely of steel.

NOTE: For a hollow cylinder: $$I_m = \frac{1}{2} m (R^2+r^2)$$

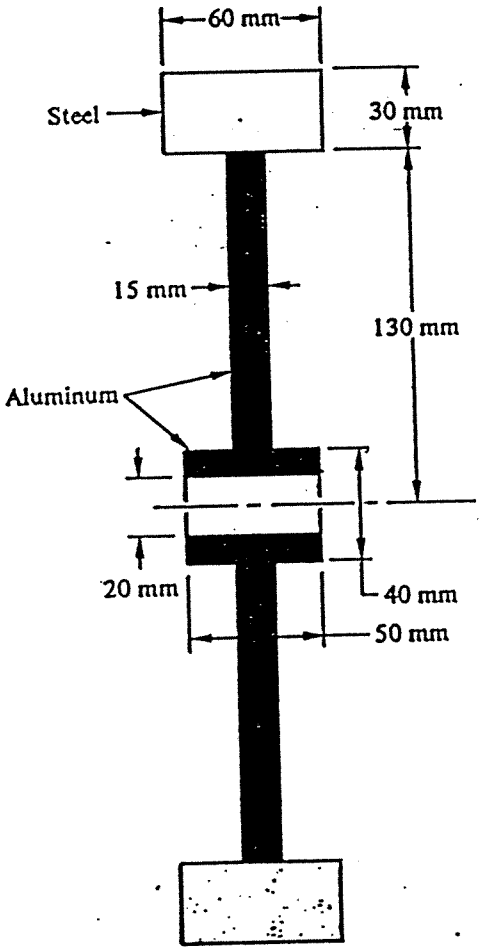

FIGURE 3.

IV. (20 Marks)

The double pulley shown in figure 4 has a total mass of 6 kg and a centroidal radius of gyration of 135 mm. Five disks, each of mass 1.2 kg, are attached to cables A and B as shown (three disks on A and two on B).The system is balanced and at rest in the state shown. One of the disks is then removed from cable A. If the bearing friction at the hub of the pulley is equivalent to a couple of moment 0.5 Nm, determine the velocity of cord A after it has moved 600 mm.

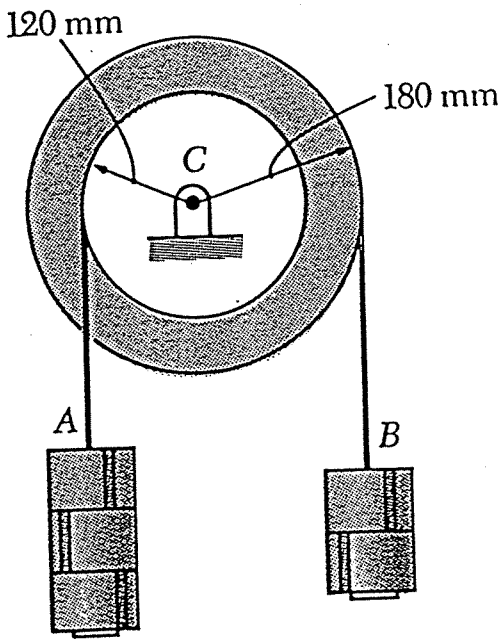

FIGURE 4.

V. (20 Marks)

A belt is placed over the rim of a 12 kg disk as shown in figure 5 and is then attached to a 4 kg cylinder and to a spring with a constant of $k = 500$ N/m. If the cylinder is moved 75 mm down from its equilibrium position and released, determine,

a) the period of vibration, and

b) the maximum velocity of the cylinder.

NOTES: Assume that friction is sufficient to prevent the belt from slipping on the rim.

For a circular disk: $I = \frac{1}{2} m r^2$

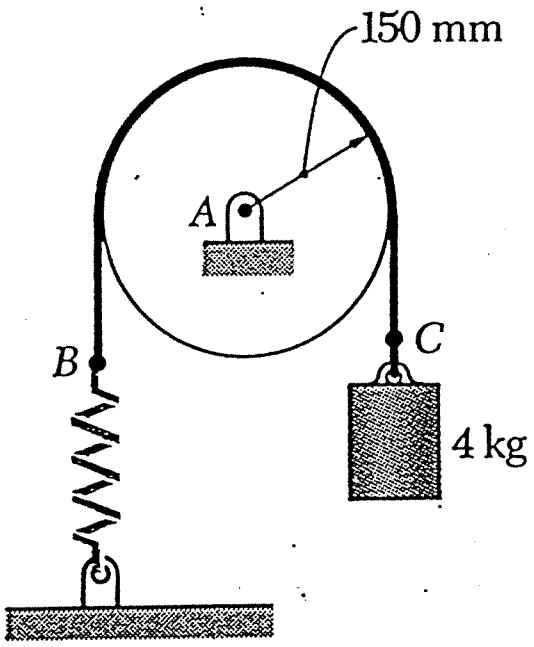

FIGURE 5.

VI. (TOTAL 20 MARKS CONTAINS 2 PARTS)

PART A. (10 Marks)

For the system shown in figure 6A below, the coefficients of friction are μ_s=0.25 and μ_k=0.20 between all surfaces of contact. Determine the smallest force **P** required to start block ***D*** moving if,

a) block ***C*** is restrained by cable ***AB*** as shown and,

b) cable ***AB*** is removed.

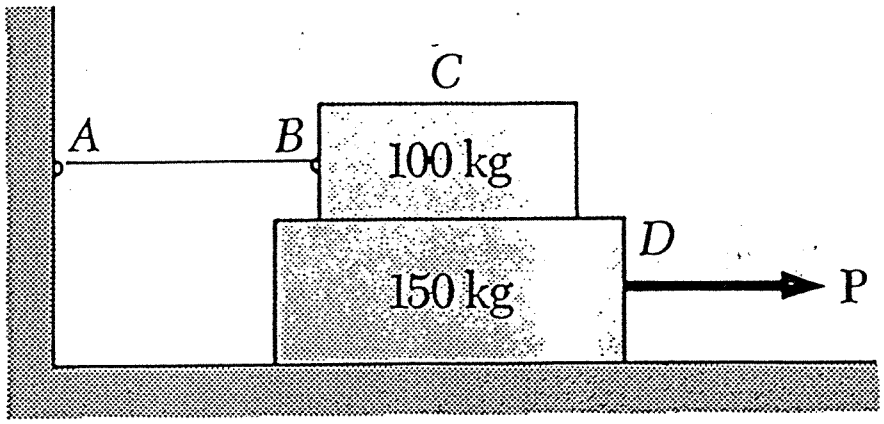

FIGURE 6A.

VI. PART B. (10 Marks)

If a clockwise couple of moment 60 lb-ft is applied to the drum shown in figure 6B, determine the smallest force which must be exerted by the hydraulic cylinder to keep the drum from rotating.

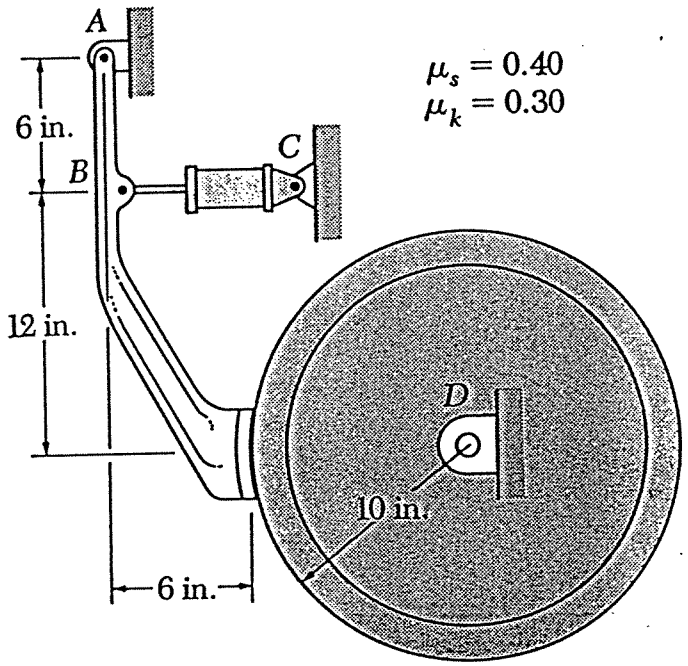

FIGURE 6B.

VII. (20 Marks)

A ballistic pendulum consisting of a 30 kg block suspended by two 1.8 m long wires as shown in figure 7 is used to measure the muzzle velocity of rifles. During a test if the pendulum swings through a horizontal distance d=250 mm when a 40 gram bullet is fired into it, determine the muzzle velocity v_0 of the rifle.
NOTE: Assume that the bullet remains imbedded in the block.

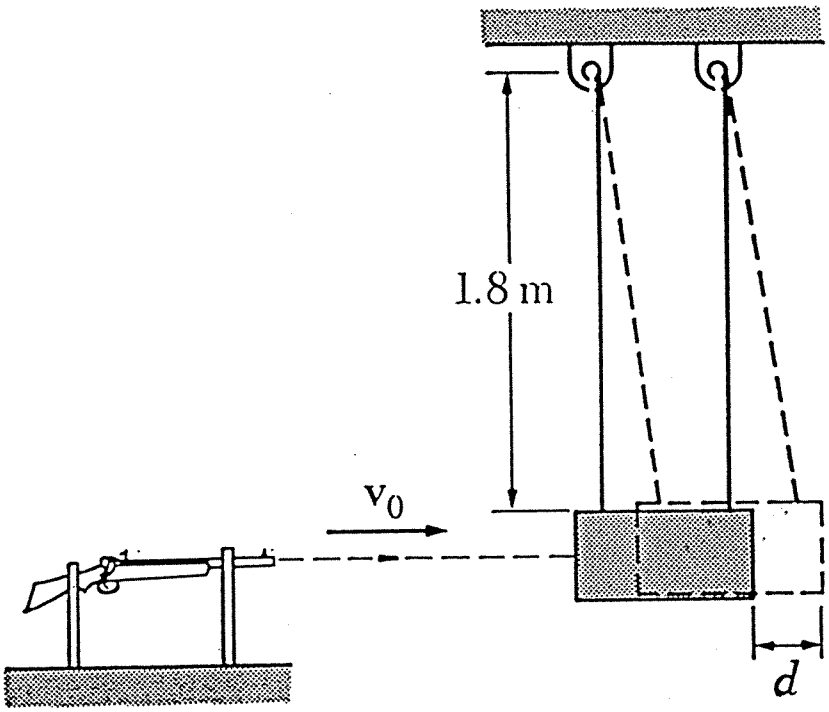

FIGURE 7.

VIII.(20 Marks)

A 5 ft. by 8 ft. sign of uniform density weighs 270 pounds and is supported by a ball and socket joint at A and the two cables, BD and EC, as shown below in figure 8. Determine the tension in each of the cables and the x, y and z components of the reaction at A.

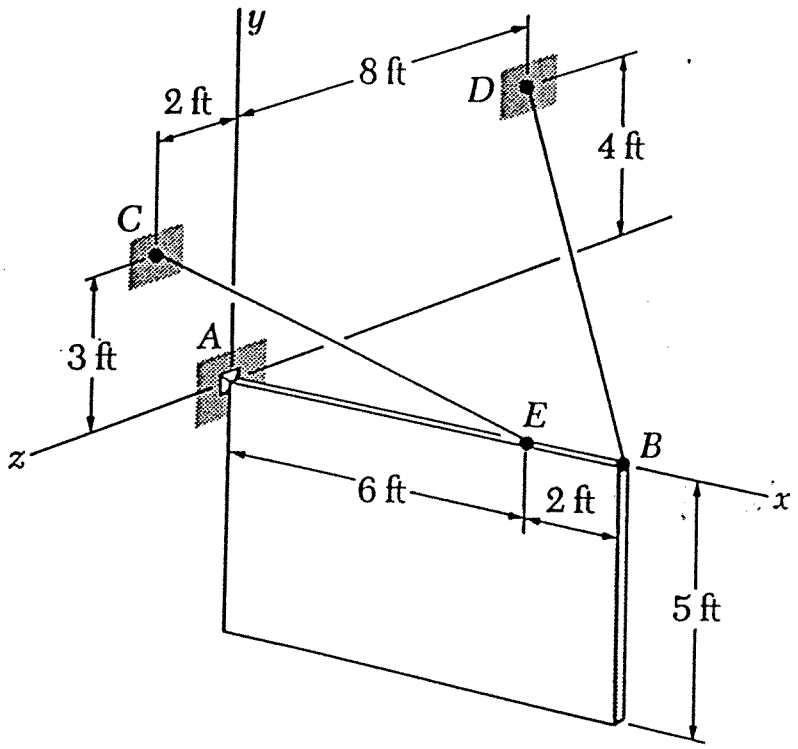

FIGURE 8.