

NATIONAL EXAMINATION - DECEMBER 2014

- STATICS AND DYNAMICS -

(04-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, the **Casio** or **Sharp** approved models.
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. Candidates are required to complete **2 questions from PART A** and **2 questions from PART B**.
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.
7. **Hand in examination question paper and self-prepared note sheet (formula sheet) with solution booklet.**

**PART A - STATICS**  
(ANSWER ANY 2 OF THE 3 QUESTIONS)

I. (20 Marks)

Determine the force in each member of the truss shown and state whether each member is in tension or compression.

NOTE: Each grid division represents a distance of one metre.

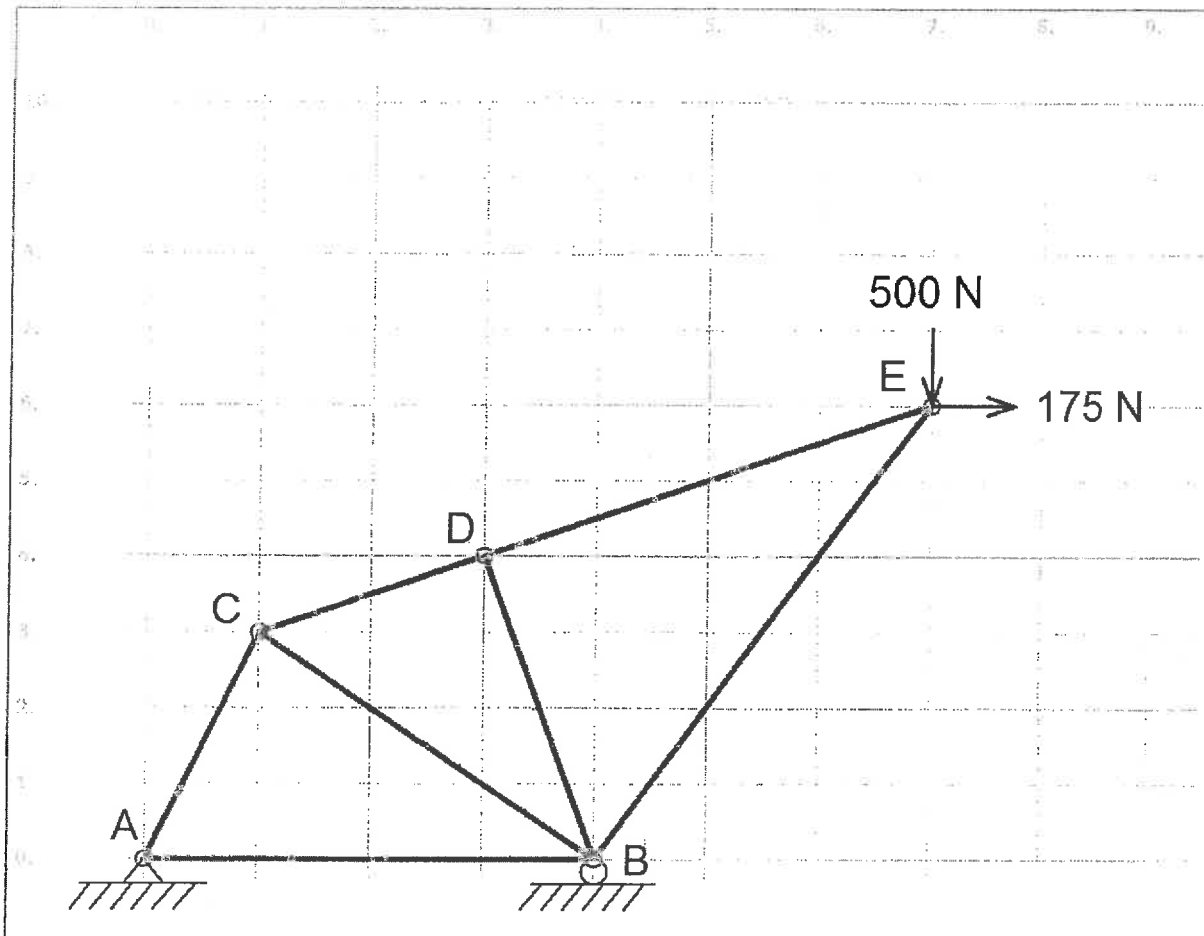


FIGURE 1.

II. (20 Marks)

The solid steel post has a horizontal arm attached to its top as shown in the figure. At the end of the arm a cable with a turnbuckle is attached from point  $A$  to  $B$ . The turnbuckle is tightened to create a 1.2 kN in the direction from  $A$  to  $B$ .

- a) Using *cartesian vector methods*, determine the equivalent force moment system about the origin  $O$ .
- b) Clearly draw and label the equivalent force moment system at the origin  $O$  at the base of the vertical post showing the magnitudes and directions of the forces and moments with appropriate units.

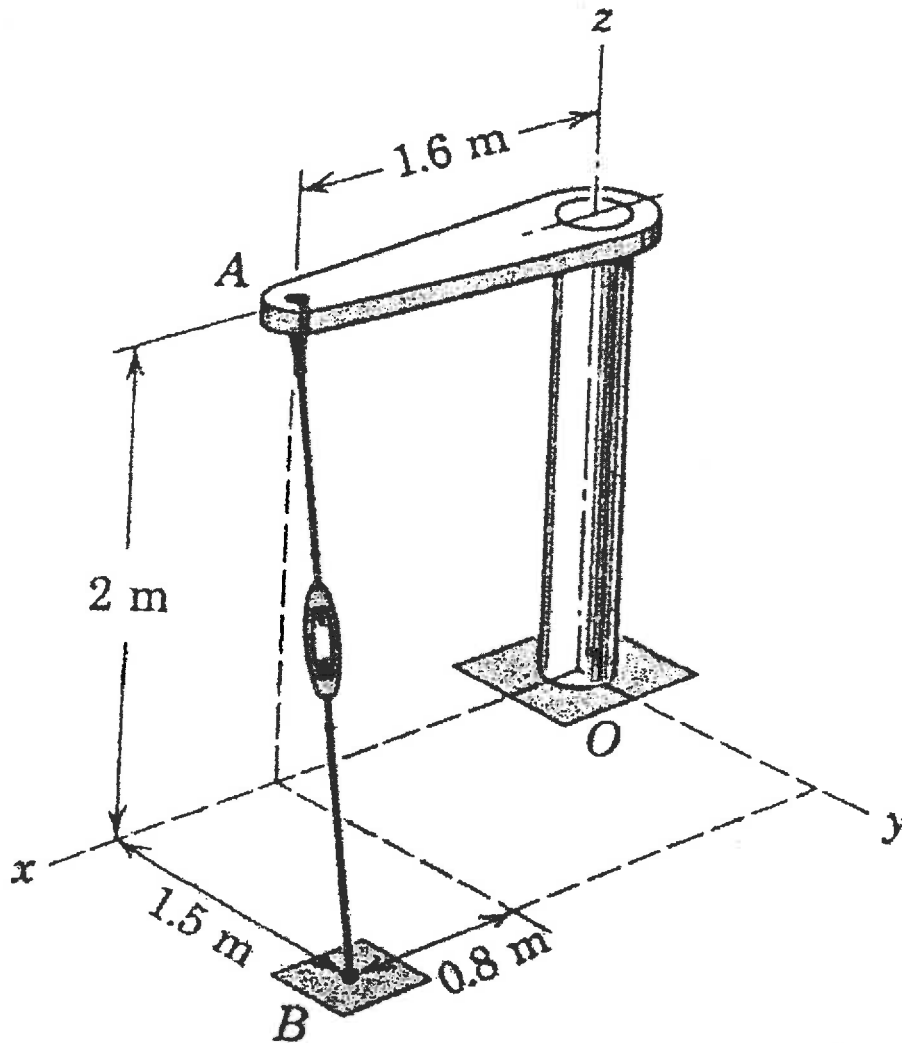


FIGURE 2

III. (THIS QUESTION CONTAINS 2 PARTS FOR A TOTAL OF 20 MARKS)

PART A. (10 Marks)

Determine the mass moment of inertia and the radius of gyration of the steel flywheel, whose cross section is shown in figure 3A, with respect to the axis of rotation. The web of the flywheel consists of a solid plate one inch thick. Neglect all rounds and fillets. (Specific weight of steel is 490 lbt/ft<sup>3</sup>).

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

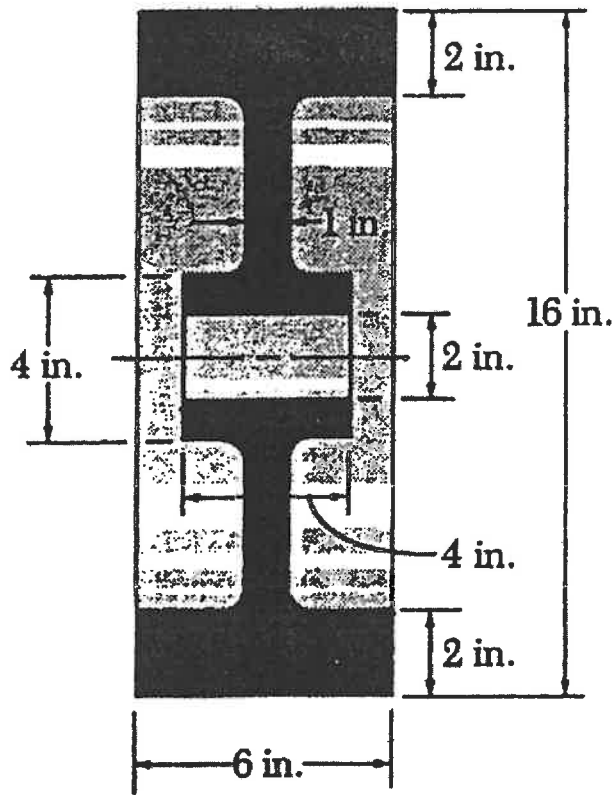


FIGURE 3A

QUESTION 3 PART B, CONTINUED ON NEXT PAGE

PART B. (10 Marks)

Determine by direct integration the centroid of the area shown in figure 3B..

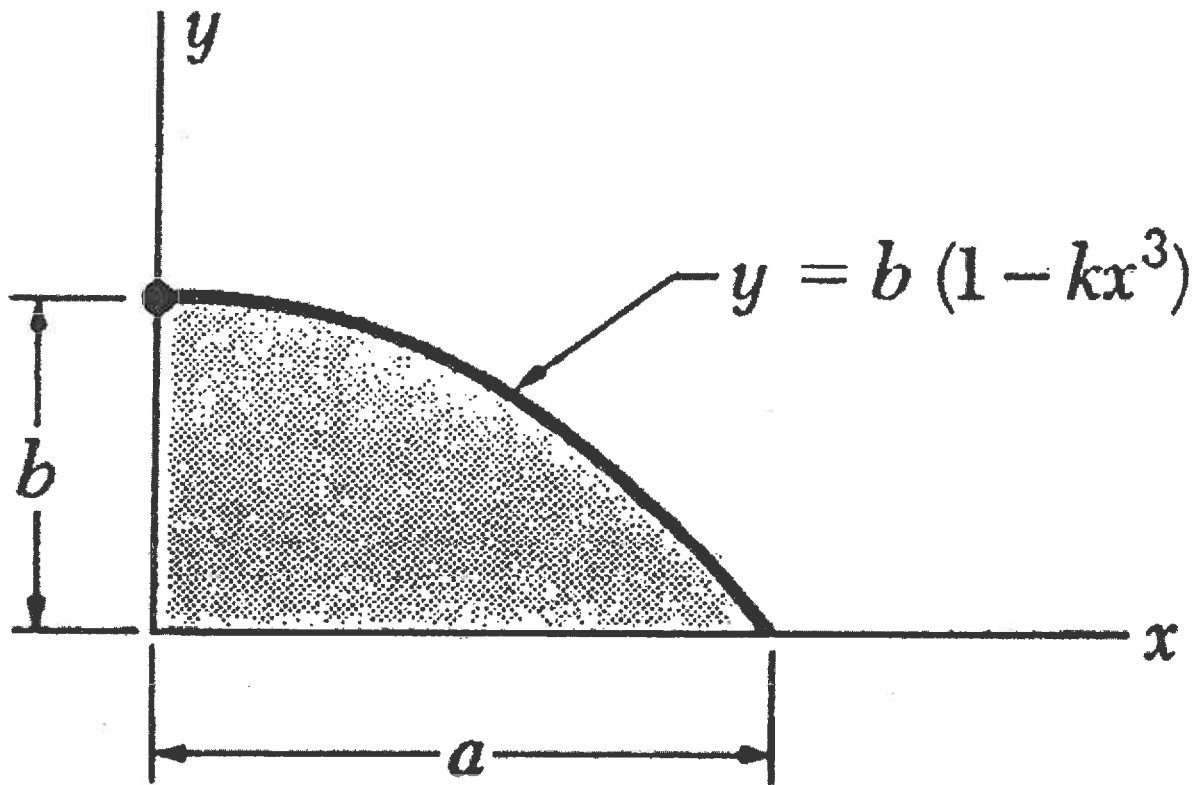


FIGURE 3B

**PART B - DYNAMICS**  
(ANSWER ANY 2 OF THE 3 QUESTIONS)

IV. (20 Marks)

Figure 4 shows a four bar linkage. For the position shown, bar AB has a constant angular velocity of 4 rad/sec counterclockwise. Determine;

- a) The angular velocities of bars BD and DE, and,
- b) The angular accelerations of bars BD and DE.

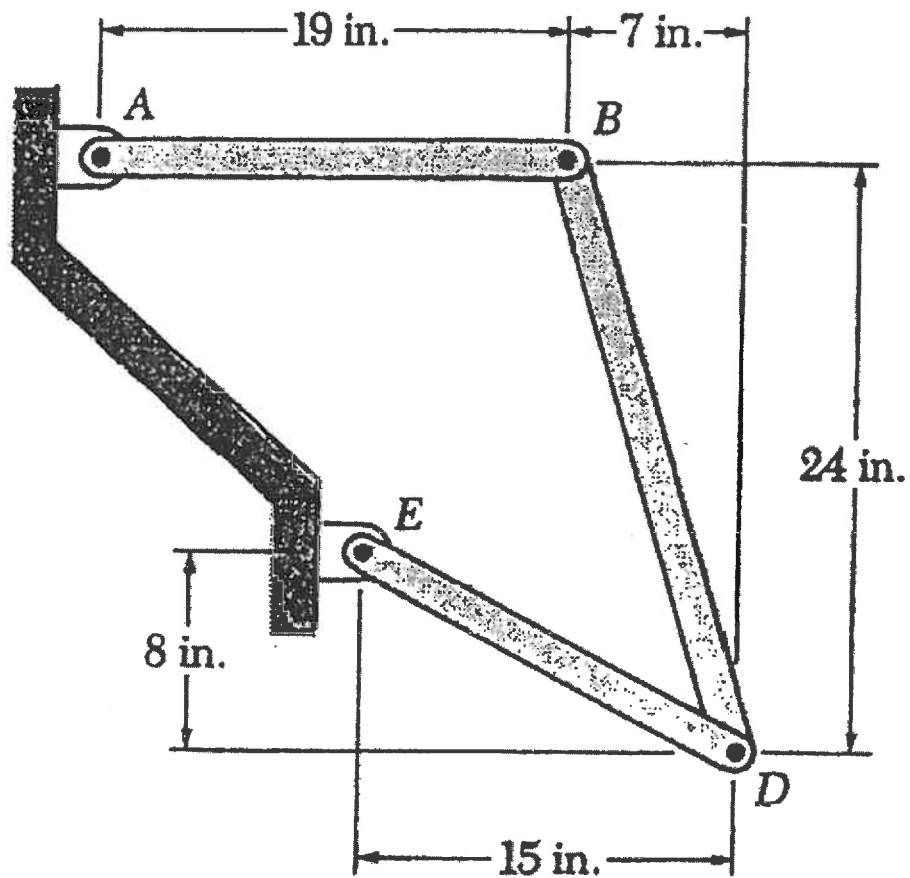


FIGURE 4.

V. ( 20 marks )

A frictionless collar which weighs  $20 \text{ lb}_f$  slides along a vertical rod as shown in figure 5. The spring attached to the collar has an undeformed length of 4 inches and a constant of  $3 \text{ lb}_f/\text{in}$ . If the collar is released from rest in position 1, determine its velocity after it has moved downward 6 inches to position 2.

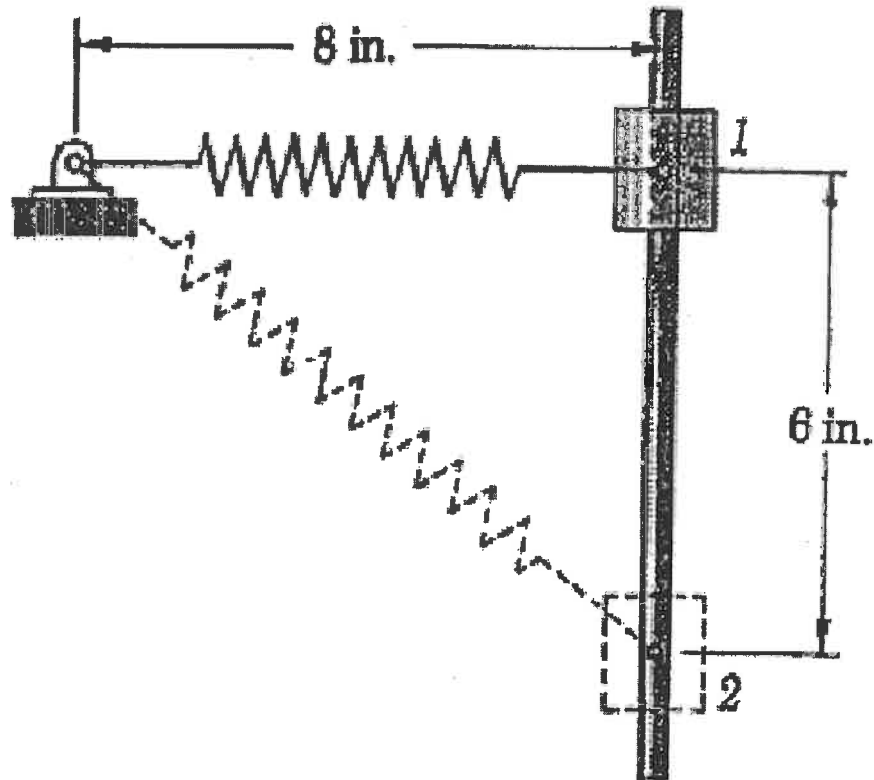


FIGURE 5.

VI. ( 20 marks )

As shown in figure 6, a 25-kg block is supported by the spring arrangement shown. If the block is moved downward from its equilibrium position and released, determine,

- a) The period and frequency of the resulting motion, and,
- b) The maximum velocity and acceleration of the block if the amplitude of the motion is 25 mm.

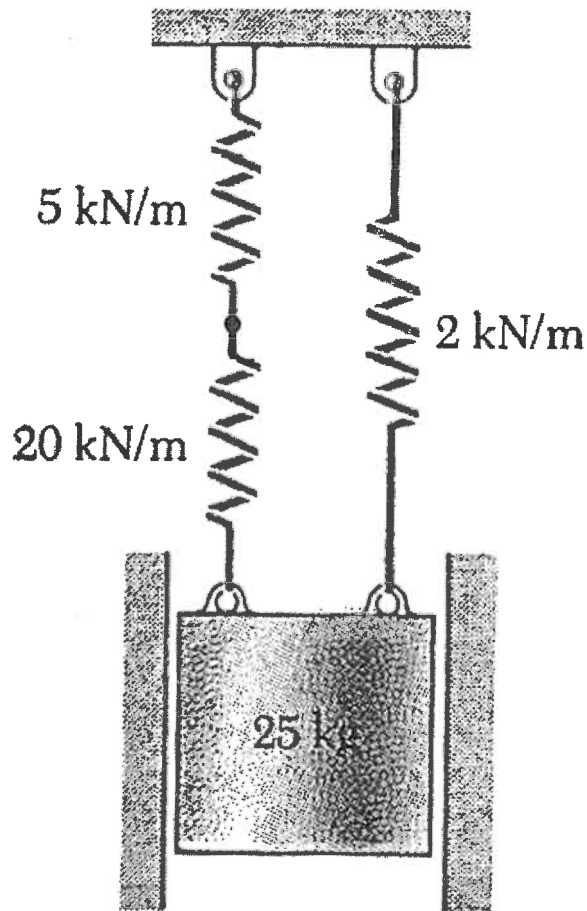


FIGURE 6.



