EX/ME/T/212/2017(S)

BME-II 1st Semester Supplementary Examination, 2017

Engineering Mechanics-III

Time: 3.0 Hrs. **Full Marks:100**

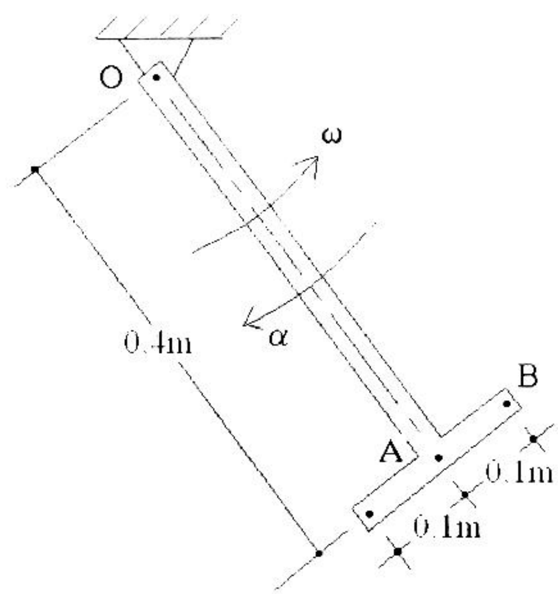
Answer any Five (5) Questions taking at least two (2) questions from *each group*. Assume missing data, if any, with proper justifications. Take g = 9.81 m/s^2 unless mentioned otherwise.

GROUP-A

Question 1 **20**

The T-shaped body shown in **FigQ1** rotates about a horizontal axis through point O. At the instant represented, its angular velocity is $\omega = 3rad/s$ and its angular acceleration is $\alpha = 14rad/s^2$ in the directions indicated. Determine the velocity and acceleration of (a) point A and (b) point B.

FigQ1



Question 2 **20**

Motion of the bar shown in **FigQ2** is controlled by the constrained paths of A and B. If the angular velocity of the bar is $2\,rad/s$ counter-clockwise as the position $\theta = 45^o$ is passed, determine the speeds of points A and P.

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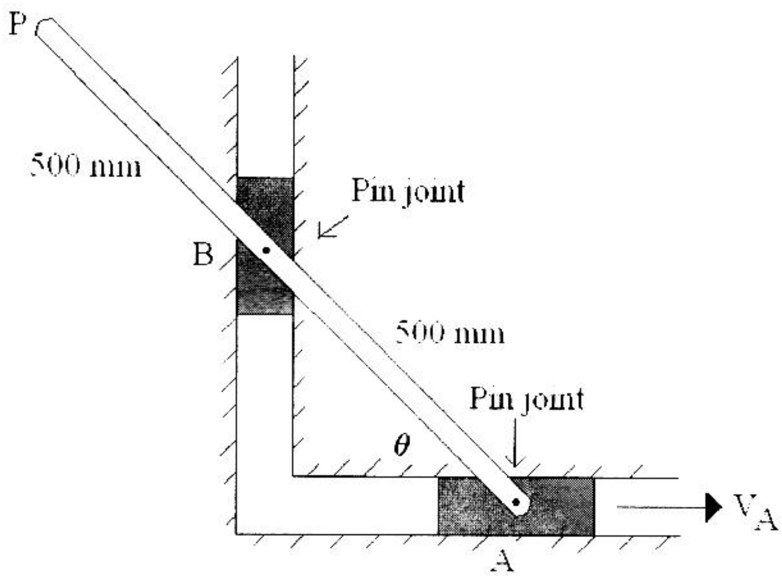
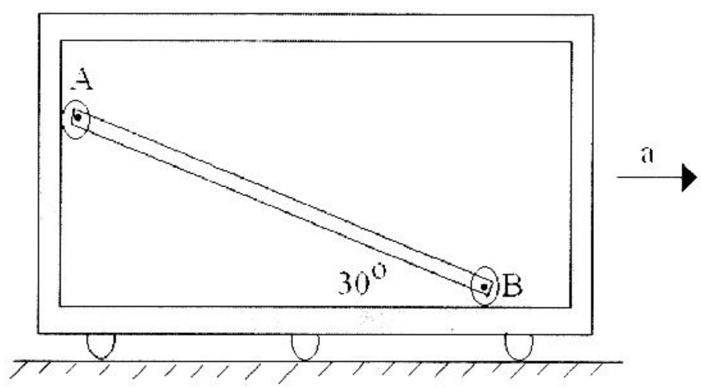


FigQ2

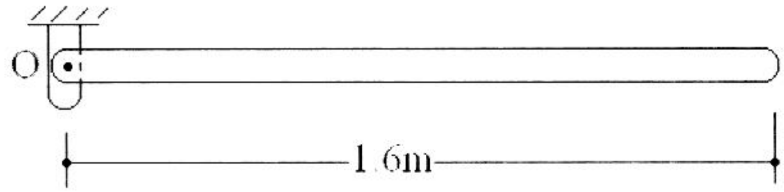
Question 3 **10×2=20**

a. For what acceleration *a* of the frame will the uniform slender rod maintain its orientation as shown in **FigQ3(a)**? Neglect friction at the small rollers A and B.



FigQ3(a)

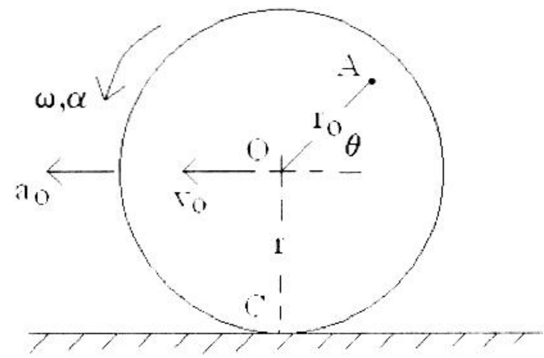
b. The uniform 20kg slender rod shown in **FigQ3(b)** is pivoted at O and swings freely in the vertical plane. If the bar is released from rest in the horizontal position, calculate the initial value of the force R exerted by the bearing on the bar an instant after release.



FigQ3(b)

Question 4 20

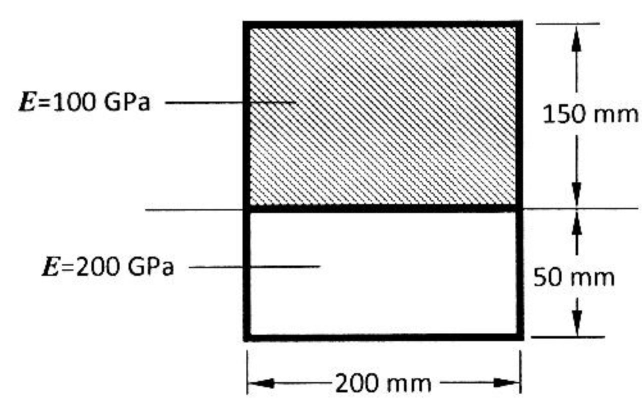
The wheel of radius r rolls to the left without slipping and, at the instant considered, the centre O has a velocity v_o and acceleration a_o to the left. Determine the acceleration of the points A and C on the wheel for the instant considered. Refer to **FigQ4**.



FigQ4

Group-B

Q5(a) A cantiliever beam of length 4.0 m is carrying a uniformly distributed load of intensity 10.0kN/m. The cross-section of the beam is rectangular and is made of two materials of coefficients of elastic modulii as 100 GPa and 200 GPa respectively as shown in **FigQ5(a)**. Calculate the maximum values of the tensile and compressive stresses developed in the beam.



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FigQ(5a)

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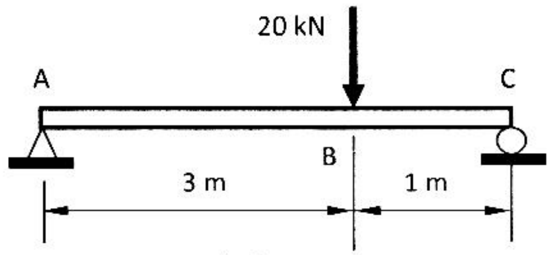
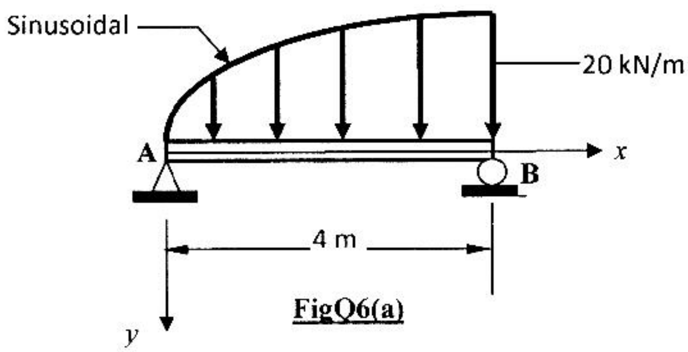
(b) A simply-supported beam **ABC** is shown in **FigQ5(b)**. Using ***moment-area theorems***, calculate the slope of the elastic line at point A and the deflection of the beam at point B of the beam. Assume flexure rigidity of the beam is 20×10^6 N·m^2. **08**



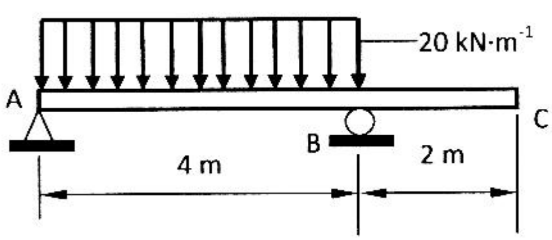
FigQ5(b)

Q6(a) A simply-supported beam AB is loaded with distributed loading as shown in **FigQ6(a)**. Write the loading intensity function if it is given that the ***distributed load is parabolic.*** Hence establish the equation of the elastic curve of the beam. Use the x-y co-ordinate system given in your figure to formulate the equation. **10**



FigQ6(a)

Q6(b) A beam **ABC** is shown in **FigQ6(b)**. Using the concept of ***singularity function***, calculate the deflection of the beam at point C. Assume $EI = 20\times10^6$ N·m^2 **10**



FigQ6(b)

Q7(a) A long, slender and prismatic column of length L and flexural rigidity EI is fixed at one end and pinned or hinged at the other end. The column carries an axial compressive load. Using the flexure equation find the expression of the critical load for the column. **14**

(b) Refer to **FigQ7(b)** where a flexible structure is shown. Using the **Castigliano's appropriate theorem**, calculate the horizontall deflection at point A of the structure. Assume the constancy of the flexural rigidity EI of the structure and ignore any corner discontinuities. Take into account only the bending deformation of the structure in your calculations. Assume that end C of the structure is fixed.

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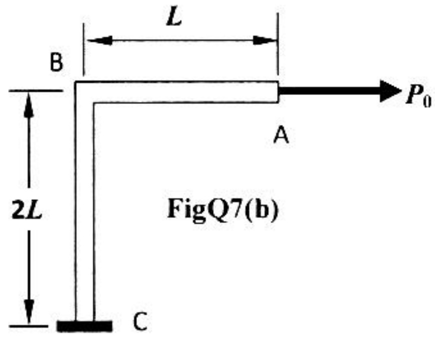

FigQ7(b)

Q8(a) Deduce the flexure formula (symbols carry their usual meanings):- **5**

$$\frac{d^2y}{dx^2} = -\frac{M_x}{EI}$$

(b) Why reinforced concrete beams are used? What do you understand by balanced reinforced concrete beams? **3+4=7**

(c) Define slenderness ratio for a column. Explain with a suitable graph the nature of failure of various types of column. **1+3=4**

(d) Write Castigliano's second theorem and explain clearly your answer with neatly drawn figures. **4**
