Ex / ME / T / 213 / 2017(Old)(S)

B.MECH. ENGG. 2nd YEAR 1st SEMESTER SUPPLEMENTARY EXAMINATION, 2017

(Old)

SUBJECT: ENGINEERING MECHANICS-II

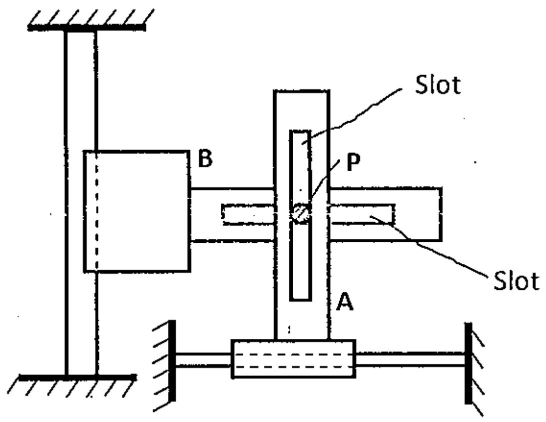
Time: Three Hours **Full Marks: 100**

This questions paper has two groups. Answer any Five (5) Questions taking at least two (2) questions from each group.

Assume missing data, if any, suitably justifying your assumptions. Take g= 9.81 m/s^2 unless mentioned otherwise.

GROUP-A

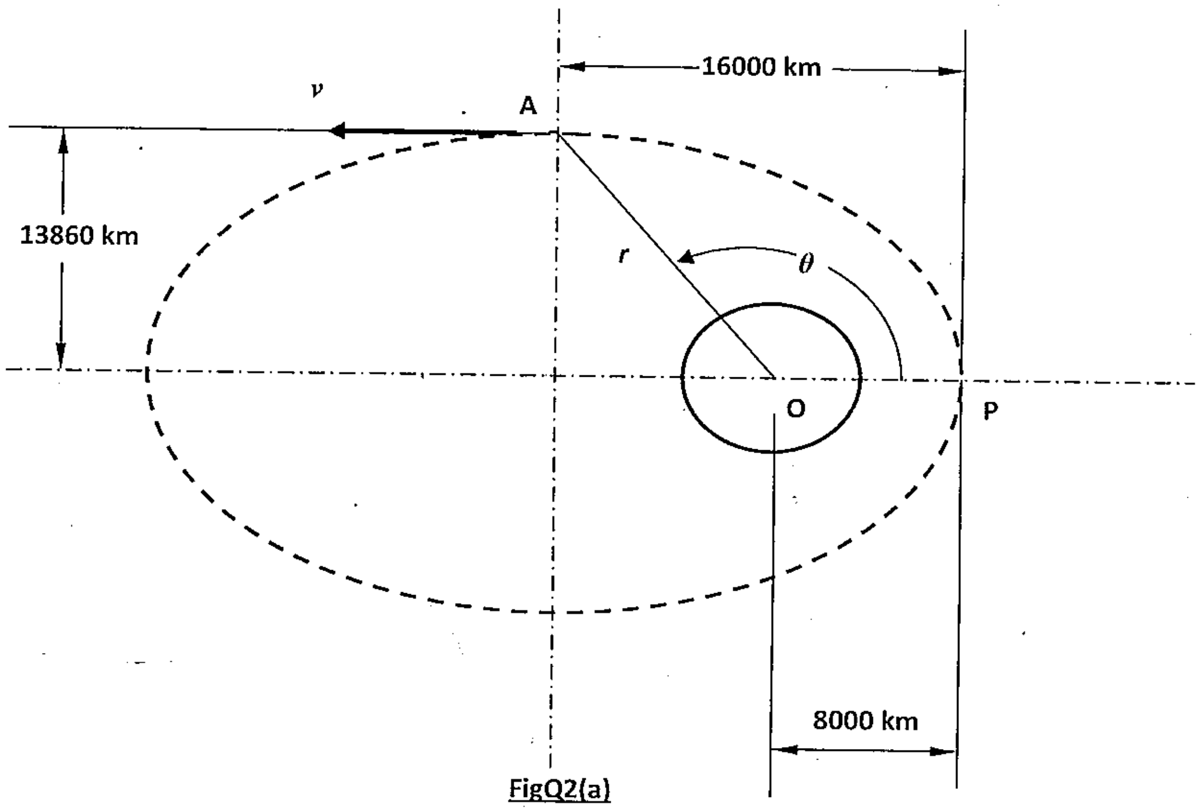
Q1(a). The pin P in **FigQ1(a)**is constrained to move in the slotted guides which move at right angles to one another. At the instant represented, A has a velocity to the right of **0.2 m/s** which is decreasing at the rate of **0.75 m/s** each second. At the same time, **B** is moving down with a velocity of **0.15 m/s** which is decreasing at the rate of **0.5 m/s** each second. For this instant calculate the radius of curvature ρ of the path followed by **P**. Is it possible also from the given data to find time rate of change of ρ. **12**



FigQ1(a)

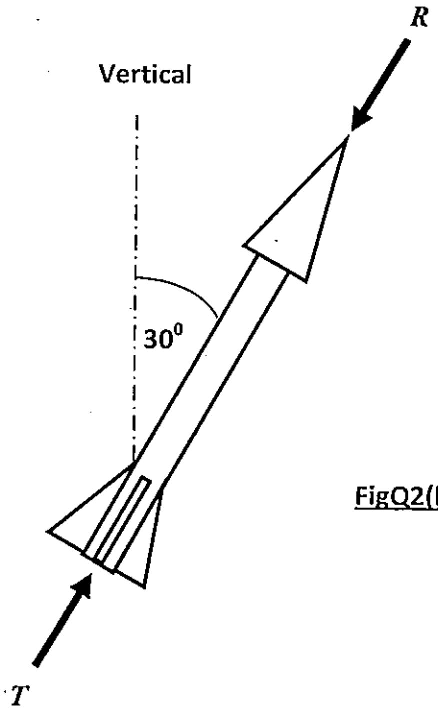
(b) A small object is released from rest in a tank of oil. The downward acceleration of the object is $a = g - kv$ where the g is the constant acceleration due to gravity. The constant k depends on viscosity of oil and shape of the object. The downward velocity of the object is v. Derive expressions for the velocity v and the vertical fall y as a function of the time t after release. **8**

Q2(a) An earth satellite traveling in the elliptical orbit as shown in **FigQ2(a)** has a velocity v = **17970 km/h** as it passes the end of the semi-minor axis at **A**. The acceleration of the satellite at **A** is due to gravitational attraction and is **1.556 m/s^2** from **A** to **O**. For the position **A** shown, calculate the values of $\dot{r}, \ddot{r}, \dot{\theta}, \ddot{\theta}$. **10**



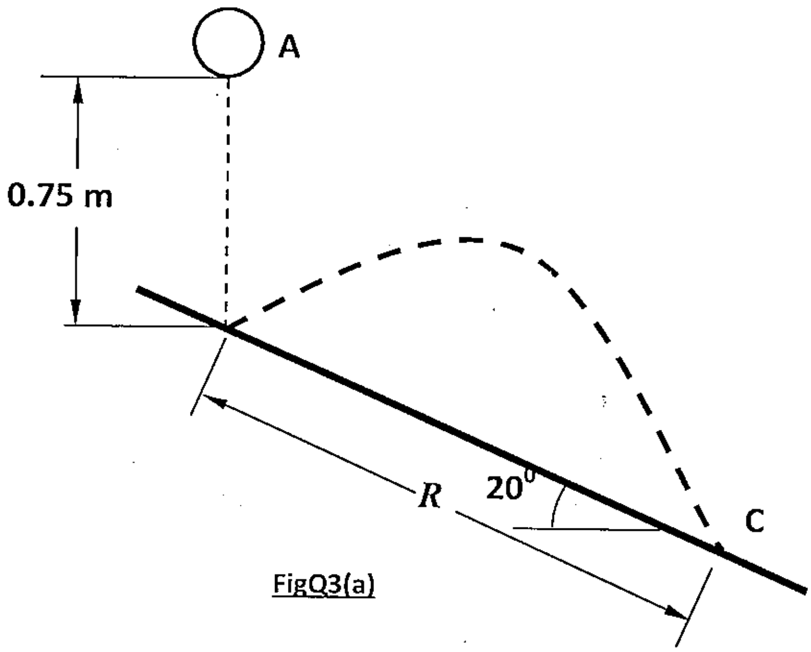
FigQ2(a)

(b) The rocket as shown in **FigQ2(b)** moves in a vertical plane and is being propelled by a thrust T of **32.0 kN**. It is also subjected to an atmospheric resistance R of **9.6 kN**. If the rocket has a velocity of **3.0 km/s** and if the gravitational acceleration is **6.0 m/s²** at the altitude of rocket, then calculate the radius of curvature of the path for the position described and the time-rate-of-change of the magnitude of the v of the velocity of the rocket. The mass of the rocket at the instant described is **2000 kg**. 10



FigQ2(b)

Q3(a) The ball is released from position A and drops 0.75 m to the incline. If the coefficient of restitution in the impact is e=0.85, calculate R. Refer to FigQ3(a). **12**

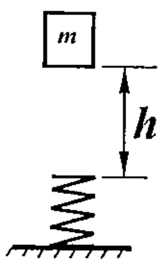


FigQ3(a)

(b) A block of mass m is allowed to drop freely from a height h above a helical spring of stiffness k. Initially, the spring is uncompressed. Prove that, **using the principle of work-energy**, the maximum compression (δ) of the spring is given by:

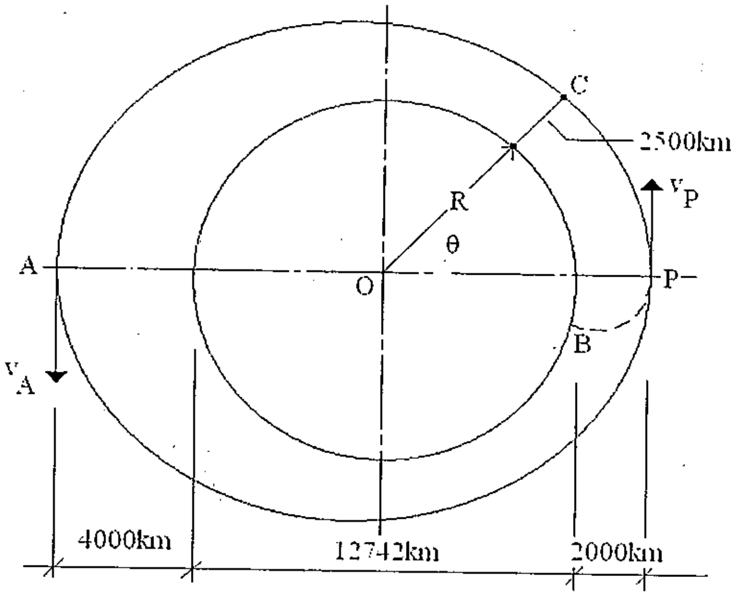
$$\delta = \delta_s + \delta_s\sqrt{1 + 2\frac{h}{\delta_s}}$$

Where, $\delta_s = \dfrac{mg}{k}$ is the static deflection of the spring (i.e. the deflection suffered by the spring when load mg is gently put on to it). Refer to FigQ3(b). **8**



FigQ3(b)

Q4. An artificial satellite is launched from point **B** (**FigQ4**) on the equator by its carrier rocket and inserted into an elliptical orbit with a perigee altitude of **2000 km**. If the **apogee altitude** is to be **4000 km**, compute the necessary perigee velocity v_P and the corresponding apogee velocity v_A. Also compute the velocity at point **C** where the altitude of the satellite is **2500 km**. Determine the period τ for a complete orbit. **20**

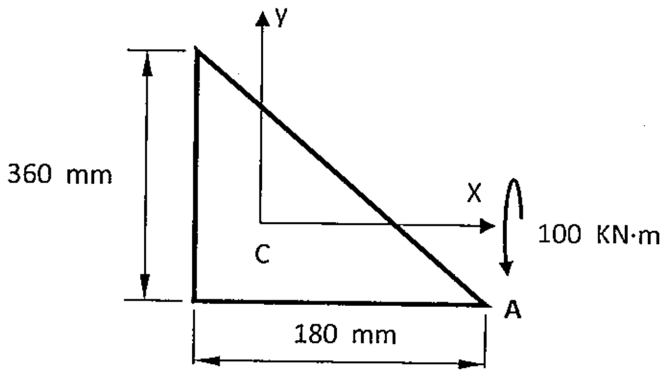


FigQ4

GROUP-B

Q5a) Derive the general equation of the bending stress at a point **P(*x*,*y*)** in the cross-section of a beam which is subjected to bending moments M_x and M_y about the x and y-axes. Note that the centroid of the beam cross-section is the origin of the co-ordinate axes. **8**

b) Using the above equation, calculate the bending stress at point **A** of the beam cross-section shown in **FigQ5(b)**. **12**



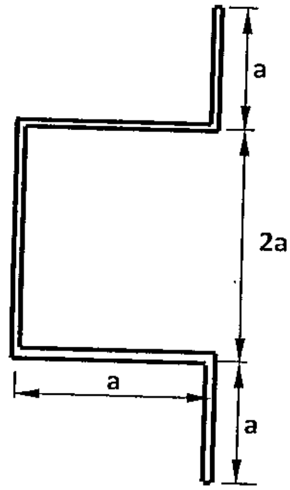
FigQ5(b)

Q6a) What is the physical significance of shear centre?

4

b) Calculate the location of the shear centre of a thin-walled beam having its cross-section as shown in **FigQ6(b)**.

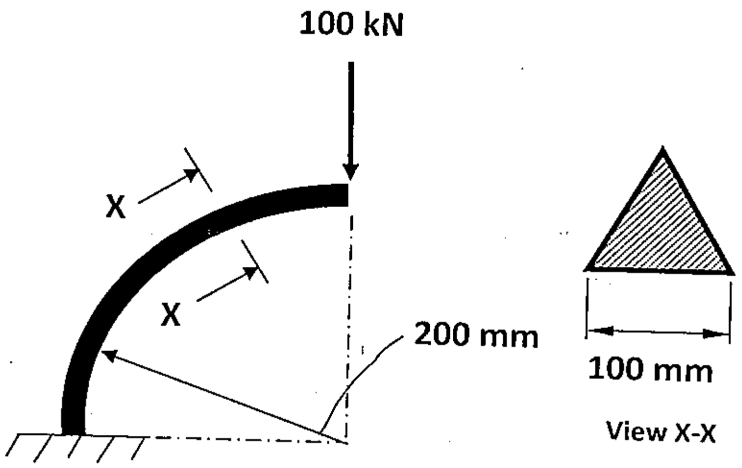
16



FigQ6(b)

Q7 A curved cantilever beam is loaded as shown in **FigQ7**. The beam has equilateral triangular cross-section. Calculate the maximum and minimum normal stresses developed in the beam.

20



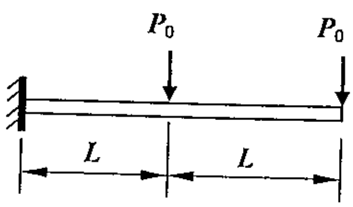
FigQ7

Q8(a) Derive Lame's equation of stresses for a thick cylinder which is subjected to an external pressure of intensity p0. Also locate the positions of maximum radial and circumferential stresses. What are the values of those maximum stresses?

10

(b) Using *Castigliano's theorem* theorem, find the deflection of the free end deflection of the following cantilever beam. Assume EI= constant. Refer to **FigQ8(b)**.

10



FigQ8(b)