7.(a) A tapered circular rod of end diameters D and d and length L is subjected to an axial load P as in **Fig. 9**. If modulus of elasticity of the rod material is E, show that the total change in length of the bar is $\frac{4PL}{\pi EDd}$.

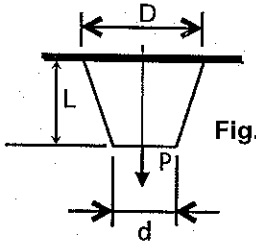

**Fig. 9**

(b) Calculate the moment of inertia of a circular cylinder of radius R, length L and weight density ρ, about its axis.

8.(a) A cantilever beam of length 2 m is loaded at the free end by 2 N. Draw the shear force and bending moment diagram.

(b) A brass bar having a cross-sectional area of 1000 mm² is subjected to axial force shown in **Fig. 10**. Draw FBD of each part and find the total change in length of the bar.
Take E = 10.5 x $10^5$ N/mm²

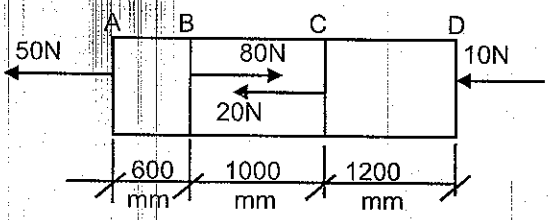

**Fig. 10.**

Ex/IT/PE/T/115/2019(OLD)

# JADAVPUR UNIVERSITY

## Bachelor in Information Technology Examination – 2019 (Old)

(1st Year – 1st Semester)

## *Engineering Mechanics*

Time : Three Hours | Full Marks : 100

*Answer **Part – A (compulsory)** (10x2=20), **any Two** from **Part – B** (2x16=32) And **any Three** from **Part – C** (3x16=48).*

**Part – A (Compulsory)** (10x2=20)

1.(a) (i) The unit of work or energy in S.I units is : (10x2=20)
(i) Newton, (ii) Pascal, (iii) Watt, (iv) Joule.

(ii) M.I. of a circular cylinder of radius R and mass M about its axis is:
(i) $(\pi/5)MR^2$, (ii) $(2/5)MR^2$, (iii) $(\pi/5)MR^3$, (iv) $(1/2)MR^2$

(b) Prove that $\cos(\bar{A}, ) = l_A l_B + m_A m_B + n_A n_B$ where $l_A$, $m_A$, $n_A$ and $l_B$, $m_B$, $n_B$ are the direction cosines of the vectors and respectively.

(c) Given $_1 = 5\bar{j} + 4\bar{k}$ and $_2 = 3\bar{i} + 6\bar{k}$. Find the magnitude of the vector product of these two vectors.

(d) Show with diagram the nature of reactive forces for the smooth pivoted joint.

(e) Equation of motion of a particle is $s = 2t^3 - t^2 - 2$, where s is displacement in meter and t is time in seconds. Find the acceleration of the particle after 1sec.

(f) The velocity of a particle of mass 4 kg is $(5\hat{i} + 3\hat{j})$ m/s when it is at the point (2,1)m. Find out its angular momentum.

(g) Draw the graph of stress-strain for a mild steel specimen indicating all types of stresses.

(h) The position vector of a point at time 't' is $r = a\cos\omega t\,\hat{i} + b\sin\omega t\,\hat{j}$
Find out the equation of its path.

(i) What is angle of friction? Show with diagram.

(j) Two equal forces of magnitude P are acting at an angle θ. Find out the resultant force and its gradient.

2.(a) A force $= 6\hat{i} - 3\hat{j} - 2$ N acts at a point P(2, 3, 4). The coordinates being given in meters. Determine moment of this force about the point of origin.

(b) A beam is subjected to forces as shown in **Fig. 1.** Find the magnitude, direction and the position of the. resultant force.
Given: tan θ =⅝ , tan α = ¾

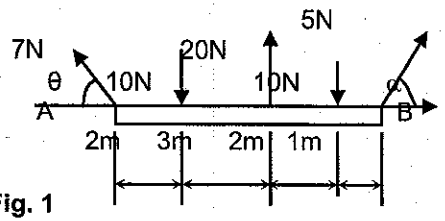


**Fig. 1**

**Part – C (Any Three)** (3x16=48)

3.(a) A roller of radius r = 12 cm and weight W =700 N is to be rolled over a step of height h = 6 cm by a horizontal force P applied to the end of a string wound around the circumference of the roller as in **Fig. 2**
Find (i) the magnitude of P required to start the roller over the step, and
(ii) the reaction at the point of contact on the step. There is sufficient friction between the roller surface and the edge of the curb to prevent slip.

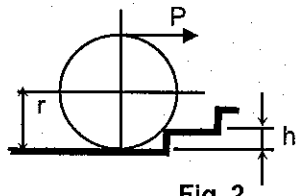


**Fig. 2**

(b) A block of weight $W_1$ = 100 N rests on a horizontal surface and supports on top of it another block of weight $W_2$ = 50 N as in **Fig. 3** . Find the magnitude of the horizontal force P applied to the lower block for its impending motion. The coefficient of. friction for all surfaces are 0.4.

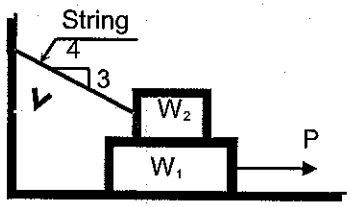


**Fig. 3**

4. (a) A uniform ladder 40 m long and having a weight 20 kg, is held from sliding by a force P applied at the lower end of the ladder a shown in **Fig. 4** . All surfaces of contact are smooth. Determine the force P.

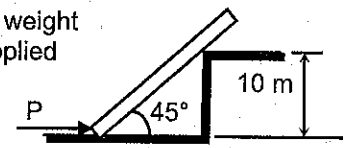


**Fig. 4**

(b) The two flywheels are mounted on a common shaft which is supported by a journal bearing between them as shown in **Fig. 5.**
Each flywheel has a mass of 40 kg, and the diameter of the shaft is 50 mm. If a 3-N.m couple M on the shaft is required to maintain rotation of the fly wheels and shaft at a constant low speed, compute:
(i) the coefficient of friction in the bearing and
(ii) the radius of the friction circle.

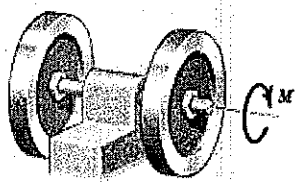


**Fig. 5**

5. (a) A link OM starts rotating anticlockwise from a horizontal position with a block 'A' sliding on it from rest as shown in **Fig.6.** The angular position of the link at any instant is given by θ = 0.5t and the position of the block as measured from O along the link is given by r = 2 – 0.3 $t^2$, θ being in radians, t being in sec and r being in meters.
Determine the velocity and acceleration of the block when θ = 60°.

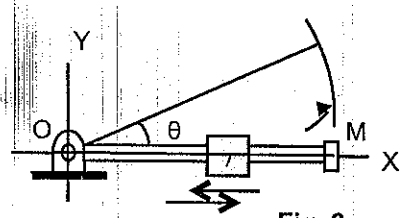


**Fig. 6**

(b) A ball is thrown at right angle to a sloping plane at an angle 37° to the horizontal. It strikes the ground at a distance of 188 m down the slope from the point of projection. Find the velocity of projection and the time of flight.

6.(a) Determine the vertical acceleration of the 30 kg cylinder as shown in **Fig.7.**

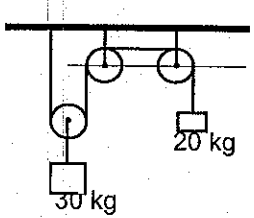


**Fig.7**

(b) A block of weight 50 N is placed on an inclined surface( μ = 0.3). The block is released at the position as shown in **Fig. 8** at a rest condition. What is the maximum compression of the spring? Take spring constant as 120 N/m.

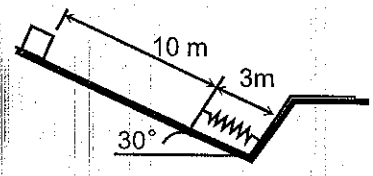


**Fig. 8**

[Turn over]