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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER B.TECH DEGREE EXAMINATION, JANUARY 2017

(Regular & Supplementary)

Course Code: **BE100**

Course Name: **ENGINEERING MECHANICS**

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions. Each question carries 5 marks

1. The greatest and least resultants of two forces F1 and F2 are 17N and 3N respectively. Determine the angle between them when their resultant is $\sqrt{149}$ N.
2. A simply supported beam AB of span 4m is carrying point loads 5kN, 2kN, and 3kN at 1m, 2m, and 3m respectively from the support A. Calculate the support reactions at A and B.
3. State and explain parallel axis theorem.
4. Distinguish static friction and dynamic friction.
5. In an office, a lift is moving upwards with an acceleration of $1.5 m/s^2$. Find the force exerted by a body of mass 30kg on the floor of the lift?
6. Explain the concept of instantaneous centre? How can you locate it?
7. Distinguish between free vibration and forced vibration.
8. What are the general conditions of simple harmonic motion?

PART B

Answer TWO questions from each SET

SET 1

Each question carries 10 marks

9. ABCD is a square , each side being 20cm and E is the middle point of AB. Forces of magnitude 7,8,12,5,9 and 6 kN act on lines of directions AB, EC, BC, BD, CA and DE respectively. Find the magnitude and direction of resultant force.
10. Three cylinders weighing 100N each and 80mm diameter are placed in a channel of width 180mm as in Figure 1. Determine the force exerted by (a) the cylinder A on B

at the point of contact (b) the cylinder B on the base and (c) the cylinder B on the wall.

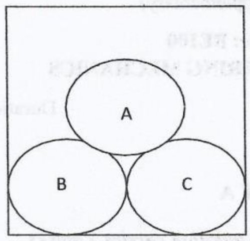

Fig.1

11. Determine the support reactions at A &B for the beam shown in Fig.2

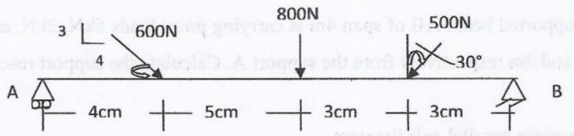

Fig.2

SET 2

Each question carries 10 marks

12. Locate the centroid of the shaded area given in figure 3.

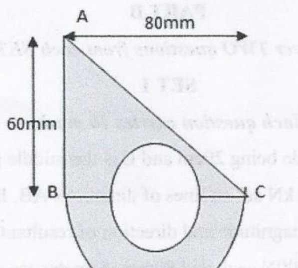

Fig.3

13. A uniform ladder of 4m length rests against a vertical wall with which it makes an angle of 45^0. The coefficient of friction between the ladder and the wall is 0.4 and that between ladder and floor is 0.5. If a man, whose weight is one-half of the weight of ladder, ascends it, how high will he be when the ladder slips?
14. An effort of 200N is required just to move a certain body up an inclined plane of angle 15^0, the force acting parallel to the plane. If the angle of inclination of the plane is made 20^0 the effort required, again parallel to the plane is found to be 230N. Find the weight of the body and the coefficient of friction.

SET 3

Each question carries 10 marks

15. For a reciprocating pump, crank OA rotates at a uniform speed of 300 rpm. The length of crank and connecting rod are 12 cm and 50cm respectively. Find (1) the angular velocity of the connecting rod AB and (ii) the velocity of piston when the crank makes an angle 30^0 with the horizontal.
16. Two blocks A and B of weight 150N and 100N are released from rest on a 30^0 inclined plane, when they are 15m apart. The coefficient of friction between the upper block A and the plane is 0.2 and that between the lower block B and the plane is 0.4. In what time block A reach block B? After they touch and move as a single unit, what will be acceleration with which it will move down?
17. A spring stretches by 0.015m when a 1.75 kg object is suspended from its end. How much mass should be attached to the spring so that its frequency of vibration is 3.0 Hz?

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BE100. Engineering Mechanics Jan 2017

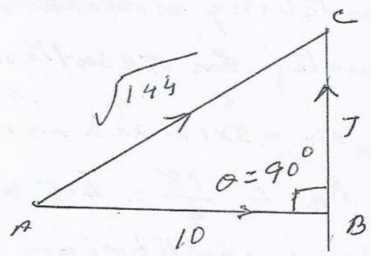
part A

1. Given

$x + y = 17 N$ — 1

$x - y = 3 N$ — 2

$R = \sqrt{149}\ N$



$1+2 : 2x = 20$

$x = 10 N$

$y = 17 - 10 = 7 N$

$R^2 = x^2 + y^2 - 2xy \cos\theta$

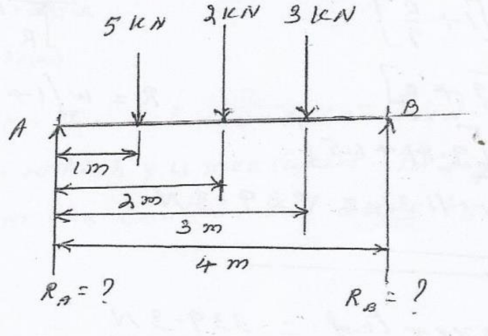
$149 = 100 + 49 - 2 \times 10 \times 7 \cos\theta$

$140 \cos\theta = 0$

$\cos\theta = 0$

$\therefore \theta = \cos^{-1} 0 = 90^0$

2.



Let R_A = Reaction at A

R_B = Reaction at B

As the beam is in equilibrium, the moments of all the forces about any point should be zero. Now taking moments of all forces about A and equating the resultant moment to zero, we get

$$R_B \times 4 - \overset{5}{5\times1} - \overset{4}{2\times2} - \overset{9}{3\times3} = 0$$

or $R_B = \frac{18}{4} = 4.5\ kN$

Also for equilibrium $\Sigma F_y = 0$

$\therefore\ R_A + R_B = 5 + 2 + 3 = 10\ kN$

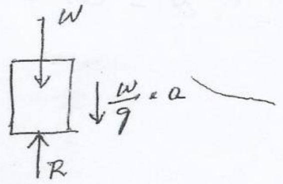
$\therefore\ R_A = 10 - R_B = 10 - 4.5 = 5.5\ kN$

$R_A = 5.5\ kN$ and $R_B = 4.5\ kN$

5. when the lift moves upwards

$a = 1.5\ \frac{m}{s^2}$

$m = 30\ kg$



$R = mg\left[1 + \frac{a}{g}\right]$

$= m\left[g + a\right]$

$= 30\left[9.81 + 1.5\right]$

$= 30 \times 11.31 = 339.3\ N$

$R = W\left(1 + \frac{a}{g}\right)$

Force exerted $= \underline{339.3\ N}$

3. **Parallel axis theorem:**

It is a transfer theorem which is used to transfer moment of inertia from one axis to another axis. These two axes should be parallel to each other and one of these axes must be a centroidal axis.

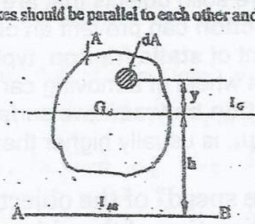


Fig. 3.78

It states that, if I_G is the moment of inertia of a plane lamina of area A, about its centroidal axis in the plane of the lamina, then the moment of inertia about any axis AB which is parallel to the centroidal axis and at a distance 'h' from the centroidal axis is given by

$$I_{AB} = \overline{I_G} + Ah^2.$$

Proof.

Consider an elemental area dA at a distance y from the centroidal axis. The first moment of elemental area about the axis AB as shown in Fig. 3.78 is dA (y + h). Second moment of elemental area about the axis AB is $dA\,(y+h)^2$. The second moment of the area about the axis AB is $\int dA\,(y+h)^2$

$$I_{AB} = \int dA\,(y+h)^2$$

$$= \int dA\,(y^2 + h^2 + 2hy)$$

$$= \int y^2 dA + \int h^2 dA + \int 2hy\,dA$$

$$= I_G + h^2 \int dA + 2h \int y\,dA$$

$$= I_G + h^2 A + 2h\,(A\bar{y})$$

$$I_{AB} = I_G + Ah^2$$

$\bar{y} = 0$, because it is the distance of centroid G from the axis from which y is measured. In fig. y is measured from the centroidal axis itself.

4. Difference between static friction and dynamic friction

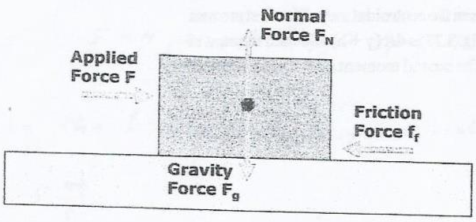
When an object isn't moving on a surface it is affected by a variable static friction force:

Static friction is **friction** between two or more solid objects that are not moving relative to each other. For example, **static friction** can prevent an object from **sliding** down a sloped surface. The coefficient of **static friction**, typically denoted a s μ_s. A more common example is a wheel of a moving car on a road.
... **Dynamic** (aka **Kinetic**) **friction** is the **friction between** two surfaces that are in relative motion with respect to each other. μ_s, is usually higher than the coefficient of **kinetic friction**.

The kinetic friction will "try to reduce the speed" of the object so its direction will always be opposite of the direction of the objects velocity.

As soon as the objects starts sliding the friction force will decrease.

Free Body Diagram



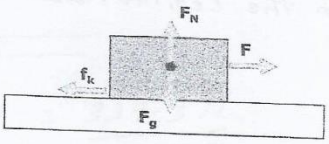
$F_g = mg$

$F_N = F_g$

$f_f = F$

Kinetic Friction

Once the Force of Static Friction is overcome, the Force of Kinetic Friction is what slows down a moving object!



$$f_k = F_N \times \mu_k$$

$$\mu_k = coefficient\ \ of\ \ kinetic\ \ friction$$

6) Explain the Concepts of instantaneous centre with figure. How can you locate it

Concept of instantaneous centre

The motion of rotation and translation of a body, at a given instant, can be considered as that of pure rotation of the body about a point. This point about which the body can be assumed to be rotating at the given instant is called instantaneous centre of rotation. Since the velocity of this point at the given instant is zero, this point is called instantaneous centre of zero velocity.

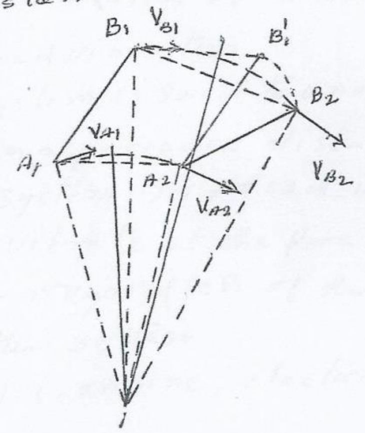


Fig.

This point is not a fixed point, and when the body changes its position, the position of the instantaneous centre also changes. The locus of the instantaneous centre as the body goes on changing its position is called centroid.

6

Properties of instantaneous centre are

i. The magnitude of velocity of any point on a body is proportional to its distance from the instantaneous centre and is equal to the angular velocity times the distance.

ii. The direction of velocity of any point on a body is proportional to the line joining that point and the instantaneous centre

The above properties are used to locate the instantaneous centre of a body.

7. Distinguish between free vibration and forced vibration

Free Vibration

A mechanical element is said to have a free vibration if the periodic motion continuous after the cause of the original disturbance is removed. The free vibration of mechanical system will eventually cease because of loss of energy from the system

External force is absent

ex: Oscillation of simple pendulum

Forced vibration

A system is said to undergo forced vibration when a periodic disturbing force acts on the system. In forced vibration the system will vibrate at the frequency of the exciting force regardless of the initial conditions of the system

Ex: I.C. engine, electric motor

8. General Conditions of Simple Harmonic motion

Simple harmonic motion.

Simple harmonic motion (SHM) is a periodic motion. Any motion which repeats after equal interval of time is called a periodic motion. For a periodic motion to be simple harmonic, it should satisfy two general conditions.

(i) The acceleration of the body performing periodic motion should be proportional to the distance of the body from a fixed point called centre of simple harmonic motion (mean position of the body)

(ii) The acceleration of the body should be directed towards the mean position.

Consider a particle moving along the circumference of a circle of radius r with a uniform angular velocity ω radians per second. Let P be the position of the particle after t seconds from the start of motion from the position A as shown in Fig. 6.8. M is the projection of particle on the horizontal diameter AB. When the particle moves along the arc ACB, the point M moves from A to B. Similarly when the particle moves along the arc BDA, the point M moves from B to A. It can be proved that the acceleration of point M is proportional to its distance from O, and is directed towards O. Such a motion is called simple harmonic motion and hence the projection of particle on the horizontal diameter executes SHM. O is the mean position and A and B are the extreme positions. Similarly the projection of particle on the vertical diameter CD also executes SHM with C and D as extreme positions.

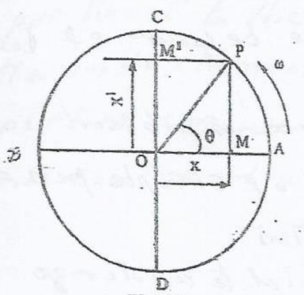
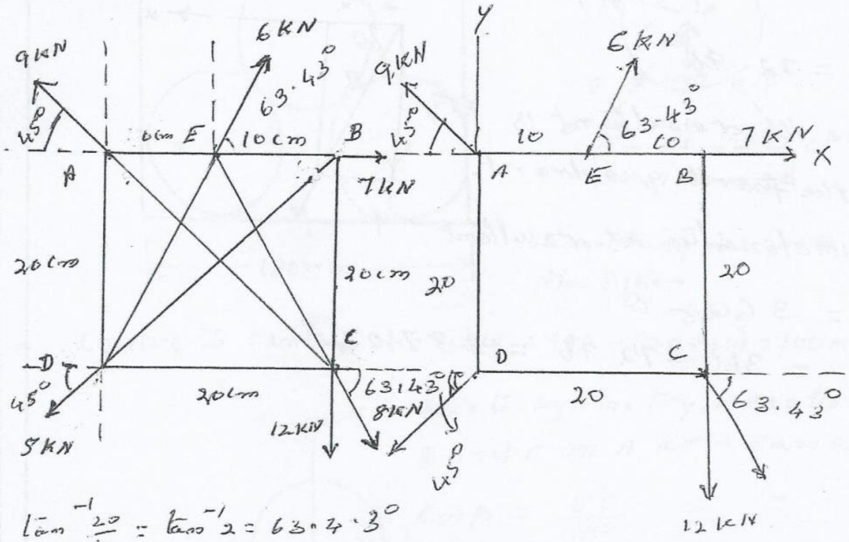


Fig. 6.8

9.



$\tan^{-1}\frac{20}{10} = \tan^{-1}2 = 63.43^\circ$

$\tan^{-1}\frac{20}{20} = \tan^{-1}1 = 45^\circ$

11.276
120.122

Resolving the forces along x - axis

$\Sigma F_x = -9\cos45 - 5\cos45 + 6\cos63.43 + 7 + 8\cos63.43$

$\Sigma F_x = -9\times0.707 - 5\times0.707 + 6\times0.4473 + 7 + 8\times0.4473$

$= -6.364 - 3.536 + 2.68 + 7 + 3.578 = 3.358N$

$\Sigma F_x = 3.358 N$

Resolving the forces along Y- axis

$\Sigma F_y = 9\sin45 + 6\sin63.43 - 5\sin45 - 12 - 8\sin63.43$

$\Sigma F_y = 6.364 + 5.366 - 3.535 - 12 - 7.155$

$\Sigma F_y = -10.96 N$

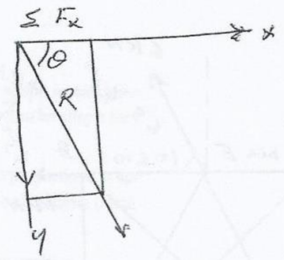
Resultant $R = \sqrt{\Sigma F_x^2 + \Sigma F_y^2} = \sqrt{(3.358)^2 + (-10.96)^2}$

$R = \sqrt{131.4} = 11.463 N$

Inclination of resultant with horizontal

$$\theta = \tan^{-1}\left|\frac{\Sigma F_y}{\Sigma F_x}\right|$$

$$\theta = 72.96^{\circ}$$

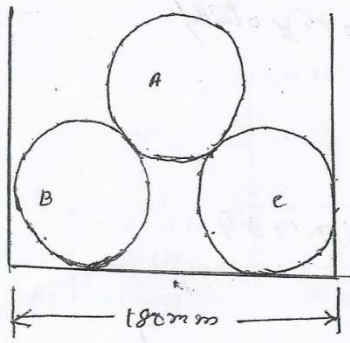


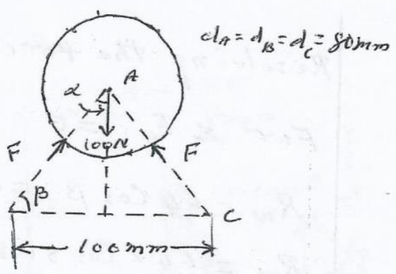
Since the resultant is in the fourth quadrant, the inclination of resultant

$$\theta_R = 360 - \theta$$

$$= 360 - 72.96 = 287.04^{\circ}$$

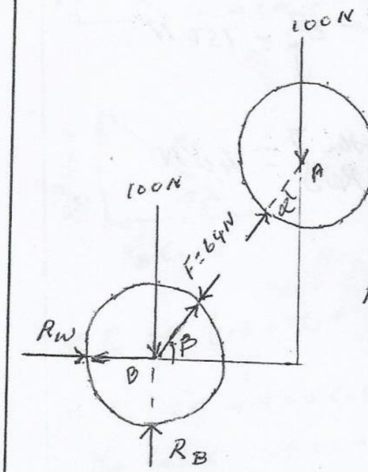
10.





Free body diagram of the system

$$\text{Centre to centre distance} = 180 - \overset{80}{(40+40)} = 100mm$$



Due to symmetry, reactions of B and C on A are same

$$\cos\beta = \frac{50}{80}$$

$$\beta = 51.33^\circ$$

$$\alpha = 90 - 51.33 = 38.7^\circ$$

For equilibrium of A

$$2F\cos\alpha = 100N$$

$$F = \frac{100}{2\cos 38.7} = \frac{100}{2 \times 0.78} = 64$$

$$F = 64N$$

F = 64 N

consider equilibrium of lower cylinder

Resolving the forces vertically

$$R_B - 100 - 64\sin\beta = 0$$

$$R_B = 100 + 64\sin 51.33 = 100 + \overset{49.97}{64 \times 0.78} = 149.97$$

$$R_B = 150N$$

Resolving the forces horizontally

For $\Sigma F_H = 0$

$R_W - 64 \cos\beta = 0$

$R_W = 64 \times \cos 51.33 = 39.989$

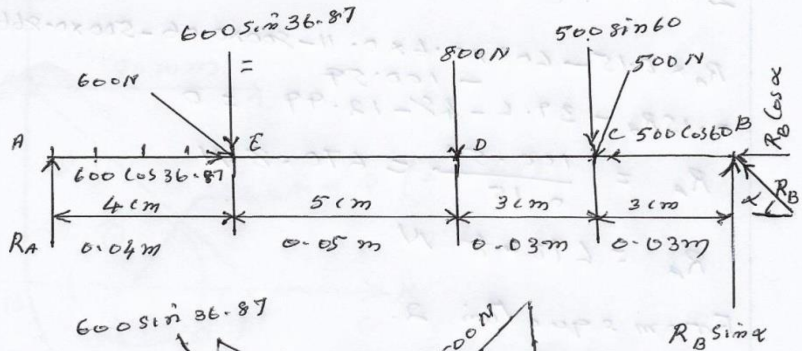
$R_W = 40 N$

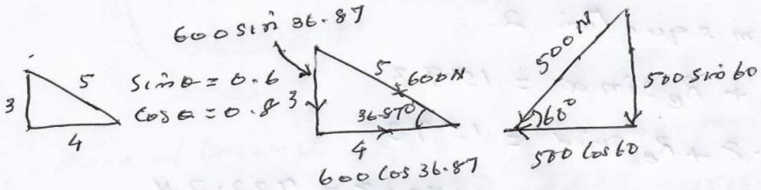
a) Force exerted by the Cylinder A on B at the point of Contact $\} = 64 N$

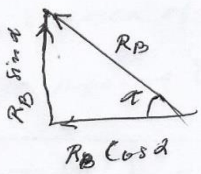
b) Force exerted by the Cylinder B on the base, R_B $\} = 150 N$

c) .... the cylinder B on the wall, R_W $\} = 40 N$

P.11







Sin 60 = 0.866

$\Sigma F_x = 0$ ($\rightarrow$ +ve, $\leftarrow$ −ve)

$-R_B \cos\alpha - 500\cos 60 + 600\cos 36.87 = 0$

$R_B \cos\alpha = -500 \times \frac{1}{2} + 600 \times \frac{4}{5} = -250 + 480 = 230$

$R_B \cos\alpha = 230\,N$ — i

$\Sigma F_y = 0$ ($\uparrow$ +ve, $\downarrow$ −ve)

$R_A + R_B \sin\alpha - 600 \sin 36.87 - 800 - 500 \sin 60 = 0$

$R_A + R_B \sin\alpha - 600 \times 0.6 - 800 - 500 \times 0.866 = 0$

$R_A + R_B \sin\alpha = 360 + 800 + 433 = 1593\,N$

$R_A + R_B \sin\alpha = 1593\,N$ — ii

$\Sigma m = 0$ ($\circlearrowright$ +ve, $\circlearrowleft$ -ve)

$R_A \times 0.15 - 600 \times 0.6 \times 0.11 - 800 \times 0.06 - 500 \times 0.866 \times 0.03 = 0$

$- 100.59$

$0.15 R_A - 39.6 - 48 - 12.99 = 0$

$R_A = \frac{100.59}{0.15} = 670.8\ N$

$R_A = 670.8\ N$

From equation 2

$R_A + R_B \sin\alpha = 1593$

$670.8 + R_B \sin\alpha = 1593$

$R_B \sin\alpha = 1593 - 670.8 = 922.2\ N$

$R_B \sin\alpha = 922.2\ N$ ——— iii

Consider equations i & iii

$\frac{R_B \sin\alpha}{R_B \cos\alpha} = \frac{922.2}{230}$

$\tan\alpha = 4.009$

$\alpha = \tan^{-1} 4.009 = 76^\circ$

$R_B \sin 76 = 922.2$

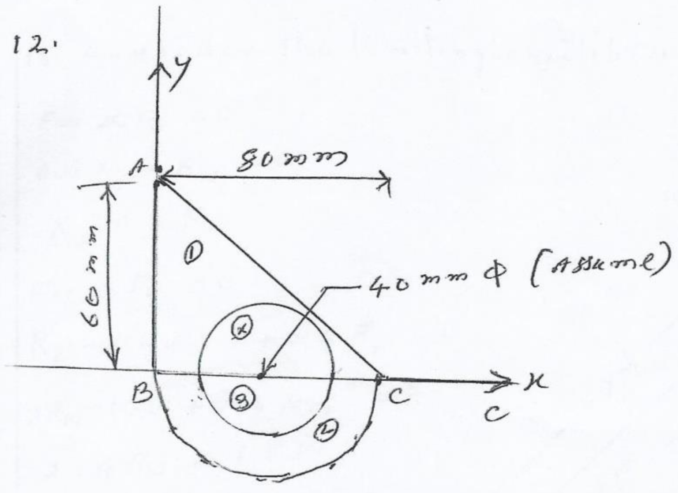
$R_B = \frac{922.2}{\sin 76} = \frac{922.2}{0.97} = 950.72 N$

Support reaction at A = R_A = 670.8 N

Support reaction at B, R_B = 950.72 N

inclined (90 - 76) = 14° to vertical

12.



A_1 = Area of triangle $= \frac{1}{2} \times 80 \times 60 = 2400\ mm^2$

A_2 = Area of semicircle $= \frac{\pi D^2}{4 \times 2} = \frac{\pi \times 80^2}{8} = 2513.27\ mm^2$

A_3 = Area of circle $= \frac{\pi d^2}{4} = \frac{\pi \times 40^2}{4} = 1256.64\ mm^2$

Area (A_i)	x_i	y_i	$A_i x_i$	$A_i y_i$
2400	$\frac{1}{3} \times 80 = 26.67$	$\frac{1}{3} \times 60 = 20$	64008	48000
2513.27	40	$-\frac{4R}{3\pi} = -16.97$	100530	-42650.19
1256.64	40	0	50265.6	0

$$x_c = \frac{A_1 x_1 + A_2 x_2 - A_3 x_3}{A_1 + A_2 - A_3} = \frac{64008 + 100530 - 50265.6}{2400 + 2513.27 - 1256.64} = \frac{114272.4}{3657.13}$$

$x_c = 31.25\ mm$

$$y_c = \frac{A_1 y_1 + A_2 y_2 - A_3 y_3}{A_1 + A_2 - A_3} = \frac{48000 - 42650.19}{3657.13} = \frac{5349.81}{3657.13}$$

$y_c = 1.46\ mm$

Centroid (31.25 mm, 1.46 mm)

13. consider the limiting equilibrium of the ladder

For $\Sigma F_H = 0$

$0.5 R_f - R_W = 0$

$R_f = 2 R_W$

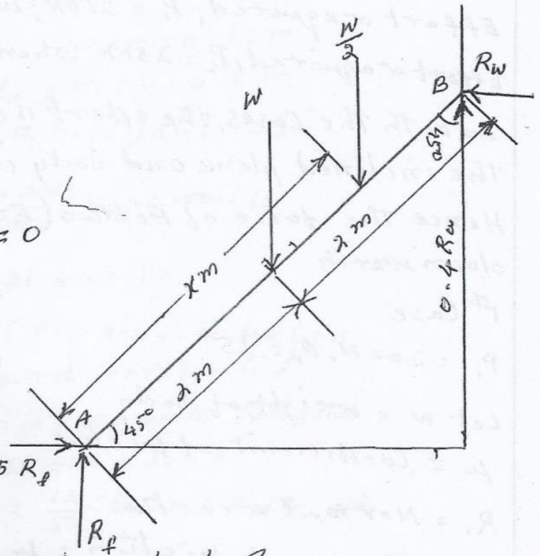
For $\Sigma F_y = 0$

$R_f - W - 0.5W + 0.4 R_W = 0$

$2R_W - 1.5W + 0.4 R_W = 0$

$2.4 R_W = 1.5 W$

$R_W = \frac{1.5 W}{2.4} = 0.625 W$



For $\Sigma M = 0$, taking moment about A

$W \times 2 \cos 45 + 0.5W \times x \cos 45 - 0.4 R_W \times 4 \cos 45 - R_W \times 4 \sin 45 = 0$

$(2W + 0.5xW - 1.6 R_W) \cos 45 = 4 R_W \sin 45 \qquad \tan 45 = 1$

$2W + 0.5xW - 1.6 \times 0.625W = 4 \times 0.625W \frac{\sin 45}{\cos 45}$

$2 + 0.5x - 1.6 \times 0.625 = 4 \times 0.625$

$2 + 0.5x - 1 = 2.5$

$0.5x = 1.5$

$x = \frac{1.5}{0.5} = \underline{3 m}$

14. Sol. Given

Effort required, $P_1 = 200N$; when inclination, $\theta_1 = 15^\circ$

Effort required, $P_2 = 230N$, when inclination $\theta_2 = 20^\circ$

In both the cases, the effort is applied parallel to the inclined plane and body is just to move up.

Hence the force of friction ($F = \mu R$) will be acting downwards

1st Case

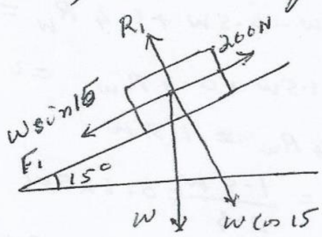


Fig. 1

$P_1 = 200N, \theta_1 = 15^\circ$

Let W = weight of body

μ = Coefficient of friction

R_1 = Normal reaction

F_1 = Force of friction $= \mu R_1$

The body is in equilibrium under the action of forces shown in fig. 1

Resolving the forces along the plane

$W \sin 15 + F_1 = 200$

$W \sin 15 + \mu R_1 = 200$ — i ($\because F_1 = \mu R_1$)

Resolving the forces normal to the plane

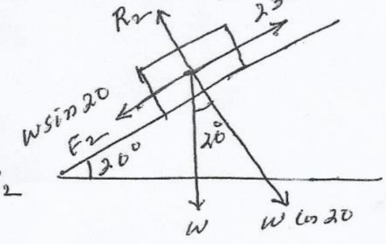
$R_1 = W \cos 15$

substituting the value of R_1 in equ (i)

$W \sin 15 + \mu \times W \cos 15 = 200$

or $W(\sin 15 + \mu \cos 15) = 200$ — ii

2nd Case



$P_2 = 230N$ and $\theta_2 = 20^\circ$

R_2 = Normal reaction

F_2 = Force of friction $= \mu R_2$

15. Given

Speed of Crank, $N = 300$ rpm

Length of Crank, $l_{cr} = 12$ cm $= 0.12$ m

Length of Con.rod, $l_c = 50$ cm $= 0.5$ m

Angle of Crank with horizontal $\theta = 30^\circ$

$$\omega_{OA} = \frac{2\pi N}{60} = \frac{2\pi \times 300}{60} = 31.4 \text{ rad/s}$$

$$V_A = \omega_{OA} \times OA = 31.4 \times 0.12$$

$= 3.77$ m/s (Perpendicular to OA 60° inclined with horizontal.

Let the inclination of AB with horizontal be ϕ, then $OA \sin 30 = AB \sin\phi$

$$\sin\phi = \frac{OA \sin 30}{AB} = \frac{12}{50} \sin 30 = 0.12$$

Solution $\phi = 6.89^\circ$

The direction of velocity of point A is perpendicular to OA. The direction of velocity of point B is horizontal. Therefore the point of intersection of the line OA produced and the vertical from B is the intantaneous centre I

$\phi = 6.89^\circ$

$\angle A + \angle I + \angle B = 180^\circ$

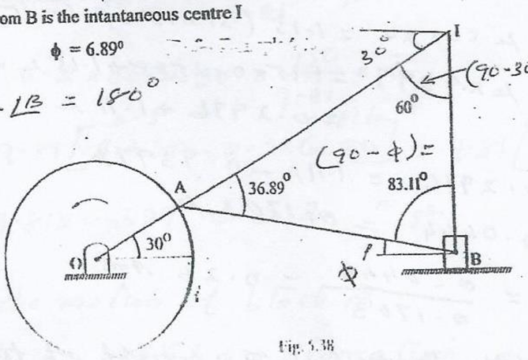


Fig. 5.38

$$\frac{AB}{\sin 60} = \frac{BI}{\sin 36.89} = \frac{AI}{\sin 83.11}$$

$$BI = \frac{AB \sin 36.89}{\sin 60} = \frac{50 \sin 36.89}{\sin 60} = 34.66 \text{ cm}$$

$$AI = \frac{AB \sin 83.11}{\sin 60} = \frac{50 \sin 83.11}{\sin 60} = 57.32 \text{ cm}$$

$V_A = 3.77$ m/s

$V_A = \omega_{AB} \times AI$

Angular velocity of connecting to rod,

$$\omega_{AB} = \frac{3.77}{0.5732} = 6.58 \text{ rad/s}$$

Velocity of piston, $V_B = \omega \times BI = 6.58 \times 0.3466$

$= 2.28$ m/s

Resolving the forces along the plane

$W \sin 20 + F_2 = 230$

$W \sin 20 + \mu R_2 = 230$ — iii

Resolving the forces normal to the plane

$R_2 = W \cos 20$

Substituting the value of R_2 in equ. iii, we get

$W \sin 20 + \mu \times W \cos 20 = 230$

or $W(\sin 20 + \mu \cos 20) = 230$ — (iv)

Dividing equation (iv) by equ (ii)

$$\frac{W(\sin 20 + \mu \cos 20)}{W(\sin 15 + \mu \cos 15)} = \frac{230}{200}$$

or $$\frac{\sin 20 + \mu \cos 20}{\sin 15 + \mu \cos 15} = 1.15$$

$\sin 20 + \mu \cos 20 = 1.15(\sin 15 + \mu \cos 15)$

$0.342 + \mu \times .9397 = 1.15 \times 0.2588 + 1.15 \mu \times 0.9659$

$= 0.2976 + 1.11 \mu$

$0.342 - 0.2976 = 1.11\mu - 0.9397\mu$

$0.0444 = 0.1703 \mu$

$\mu = \frac{0.0444}{0.1703} = 0.26$ Ans

weight of the body (W): The weight of the body is obtained by substituting the value of μ in equ (iv)

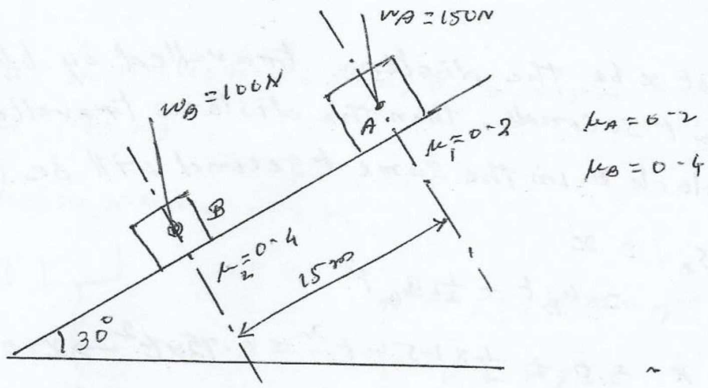
$W(\sin 20 + \mu \cos 20) = 230$ ie $W(0.342 + 0.26 \times 0.9397) = 230$

or $W(0.342 + 0.2443) = 230$

$0.5863 W = 230$

$W = \frac{230}{0.5863} = 392.3 N$ Ans

16.



Solution: Consider the motion of block A

Net force = mass × acceleration

$m_A g \sin\theta - \mu_1 R_{NA} = m_A \times a_A$

$m_A g \sin\theta - \mu_1 m_A g \cos\theta = m_A \times a_A$

$150 \sin 30 - 0.2 R_{NA} = \frac{150}{9.81} \times a_A$

$150 \sin 30 - 0.2 \times 150 \cos 30 = \frac{150}{9.81} \times a_A$

$a_A = 9.81 [\underset{0.5}{\sin 30} - \underset{0.866}{0.2 \times \cos 30}] = 9.81 [0.5 - 0.173]$

$a_A = 9.81 \times 0.327 = 3.2 \ m/s^2$

Consider the motion of block B

Net force = mass × acceleration

$m_B g \sin\theta - \mu_2 R_{NB} = m_B \times a_B$

$100 \sin 30 - 0.4 m_B g \cos 30 = m_B \times a_B \quad | \because m_B = \frac{W_B}{g}$

$100 \times 0.5 - 0.4 \times 100 \times 0.866 = \frac{100}{9.81} \times a_B$

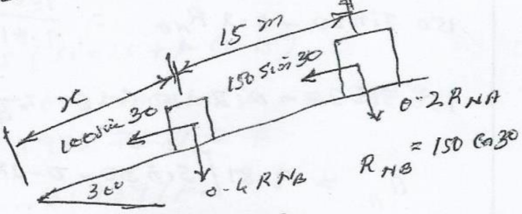
$\underset{15.36}{50 - 34.64} = \frac{100}{9.81} \times a_B$

$a_B = \frac{15.36 \times 9.81}{100} = 1.5 \ m/s^2$

Let x be the distance travelled by block B in t seconds, then the distance travelled by block A in the same t second will be (15+x)

$$S_B = x$$
$$= u_B t + \frac{1}{2} a_B t^2$$
$$x = 0 + \frac{1}{2} \times 1.5 \times t^2 = 0.75 \times t^2 \rightarrow x = 0.75\, t^2$$
$$10 + x = 0 + \frac{1}{2} \times a_A t^2 = \frac{1}{2} \times 3.2\, t^2$$
$$10 + x = 1.6\, t^2$$
$$10 + x - x = 1.6\, t^2 - (0.75\, t^2)$$
$$10 = 0.85\, t^2$$
$$t = \sqrt{\frac{10}{0.85}} = 3.43 \text{ s}$$

Net force = mass$_{mt}$ × a



$R_{NA} = 100 \cos 30$

$$\left(\frac{150+100}{9.81}\right) a = (150 \sin 30 + 100 \sin 30) - (0.2 \times 150 + 0.4 \times 100) \cos 30$$

$$\left(\frac{250}{9.81}\right) a = 125 - 70 \times 0.866 = 64.38$$

(60.62; 30 + 40; 0.866)

$$a = \frac{64.38 \times 9.81}{250} = 2.53 \text{ m/s}^2$$

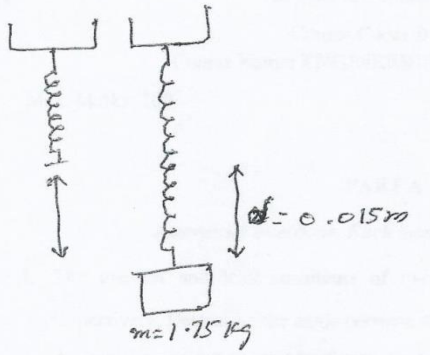
Block A reach block C after 3.43 s

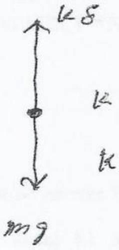
Acceleration = 2.53 m/s²

17. static deflection of mass, $\delta = 0.015\,m$

mass, $m = 1.75\,kg$

To find m when $f = 3\,Hz$





$$\Sigma F_y = m a_y = 0$$

$$k\delta - mg = 0$$

$$k = \frac{mg}{\delta}$$

$$= \frac{1.75 \times 9.8}{0.015} \quad \frac{kg \; m/s^2}{m}$$

$$K = 1143.33$$

$$k = 1.143 \times 10^3 \frac{N}{m}$$

$$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}} \longrightarrow 4\pi^2 f^2 = \frac{k}{m}$$

$$m = \frac{K}{4\pi^2 f^2} = \frac{1143.3}{4\pi^2 \times 3^2} = 3.22\,kg$$

mass required to be attached $= 3.22\,kg$

Note This is a straightforward application of Hooke's Law and the equation of S.H.M.