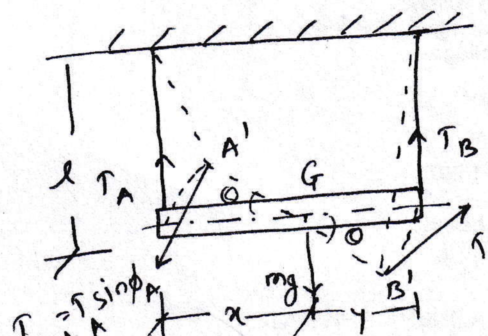
Paper Code :- U359-152 (T1) solution with marking scheme
OCTOBER 2019 / Insem (T1)

T. Y. B. Tech (Mechanical)
Course :- Dynamics of Machinery
MEVA31172

Q1] a] Bifilar suspension :- (6 marks)



m = mass of rigid body
k = radius of gyration @ G.
l = length of each string
y = distance of A from G
x = distance of B from G
α = angular accl^n of rigid body.

Taking moment at 'A' — 1 marks

$$T_B(x+y) = mgx \quad \therefore T_B = \frac{mgx}{x+y} \quad \text{— (A)}$$

Taking moment at 'B'

$$T_A(x+y) = mgy \quad \therefore T_A = \frac{mgy}{x+y} \quad \text{— (B)}$$

Body displaced from eq^m position through 'θ'

$$AA' = x\theta = \phi_A l \qquad \phi_A = \frac{\theta x}{l} \quad \text{— (C)}$$

$$BB' = \theta y = \phi_B l \qquad \phi_B = \frac{\theta y}{l} \quad \text{— (D)}$$

— 1 marks

The component of tension 'T_A' in horizontal plane

$$\sin\phi_A = \frac{T_{AH}}{T_A} \qquad T_{AH} = T_A \sin\phi_A$$

$$= T_A \phi_A \quad \text{— (E)}$$

$$T_{BH} = T_B \phi_B \quad \text{— (F)}$$

— 1 marks

putting (B) & (C) in (E)

$$T_{AH} = \frac{mgxy\theta}{l(x+y)} \quad \text{— (G)}$$

putting (A) & (D) in (F)

$$T_{BH} = \frac{mgxy\theta}{l(x+y)} \quad \text{— (H)}$$

so,

$$T = T_{AH} \times x + T_{BH} \times y$$

$$T = \frac{mgxy\theta}{l(x+y)} \times x + \frac{mgxy\theta}{l(x+y)} \times y$$

$$T = \frac{mgxy\theta}{l} \quad \text{— (I)}$$ — <u>2 marks</u>

'α' angular accel^n of connecting rod.

$$T = I_G \cdot \alpha$$

$$T = mk^2\alpha \qquad \therefore \frac{mgxy\theta}{l} = mk^2\alpha$$

$$\frac{\alpha}{\theta} = \frac{gxy}{lk^2}$$

$$\therefore f_n = \frac{1}{2\pi}\sqrt{\frac{\text{angular accel}^n}{\text{angular Dis}/^m}}$$

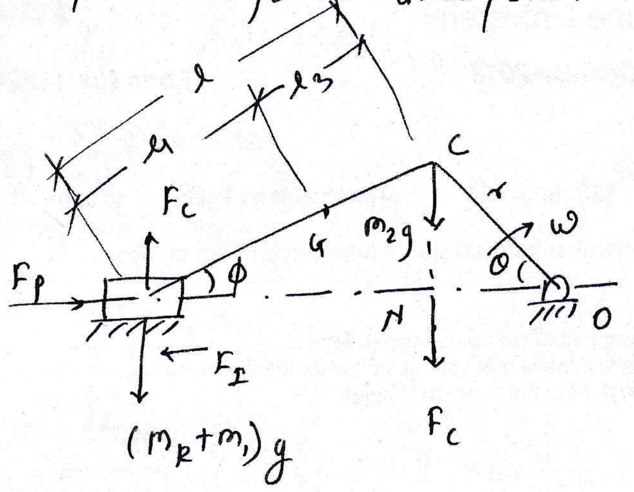
$$= \frac{1}{2\pi}\sqrt{\frac{gxy}{lk^2}}$$

$$\boxed{f_n = \frac{1}{2\pi k}\sqrt{\frac{gxy}{l}}}$$ cycle/sec or Hz

— <u>1 mark</u>

—— xox —— xox —— xox ——

Q2] a] Dynamic force analysis :- (6 marks)



— 2 marks

a) Torque exerted on crank shaft due to inertia force (T_1)

$$T_1 = F_1 r \left[\sin\theta + \frac{\sin 2\theta}{2\sqrt{n^2 - \sin^2\theta}} \right]$$

— 1 marks

b) Torque exerted on crank shaft due to correction couple (T_2)

$$T_2 = -m_c (k_1^2 - k^2)\, \alpha \frac{\cos\theta}{\sqrt{n^2 - \sin^2\theta}}$$ 1 mark

(c) Torque exerted on crank shaft due to mass m_2 (T_3)

$$T_3 = (m_2 g) \times r \sin\theta$$ — 1 mark

(4) Total torque :-

$$T = T_1 + T_2 + T_3$$ — 1 mark

——— x o x ——— x o x ——— x o x ———

b] connecting rod :- (6 marks)

$l_1 = 0.15\ m$, $l_2 = 0.0666\ m$ — 1 mark

$m_1 =$ ~~0.4~~ $0.6149\ kg$, $m_2 = 1.3846\ kg$ — 2 marks

$T_c = -1.97795\ N\text{-}m$ (anticlockwise) — 3 marks b] step1:- (6 marks)

(1) $t_{p_1} = 3.5$ sec/cycle

(2) step2:- $k_1 = 0.1950$ m — 1 mark

(3) step3:- $I_{G_1} = 0.05707$ kgm^2 — 1 mark

(4) step4:- $t_p = 3$ sec/cycle — 1 mark

(5) step5:- $k = 0.1671$ m — 1 mark

(6) step6:- $I_G = 0.1817$ kgm^2 — 1 mark

(5) step7:- $I_{G_2} = 0.1246$ kgm^2 — 1 mark

xox — xox — xox

c] concept of Equivalent length of Simple pendulum:- (4 marks)

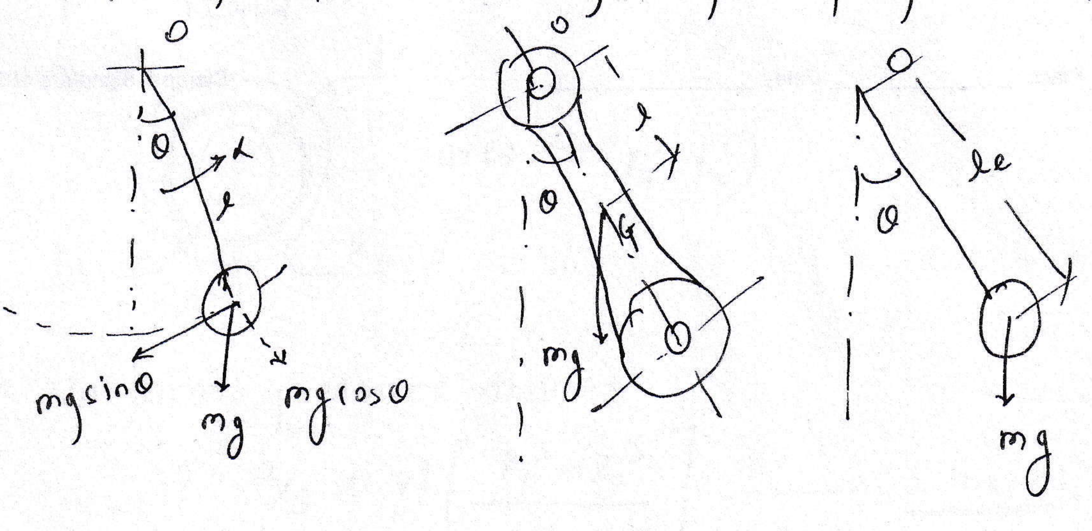


Fig - 2 marks

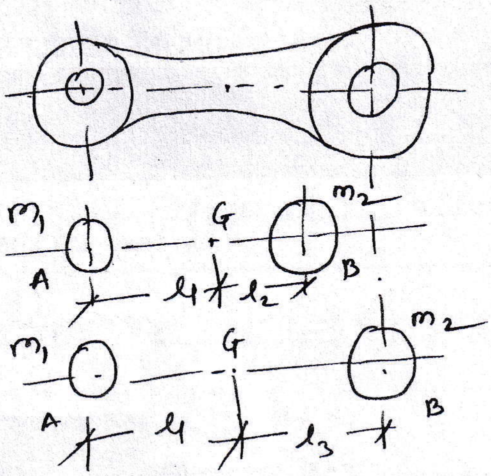
length of equivalent length

$$\therefore l_e = \frac{k^2 + l^2}{l}$$

$$= \frac{k^2}{l} + l \quad \text{— 2 marks}$$

c] - correction couple:- (4 marks).

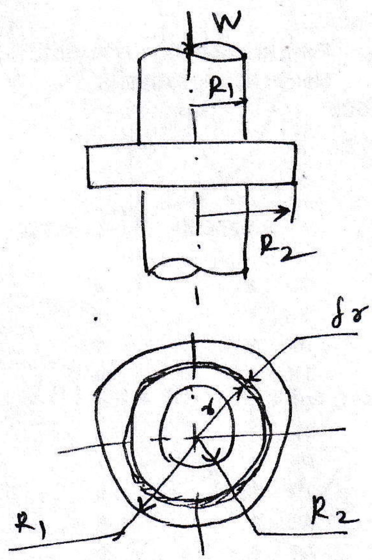
Fig. with explanation 2 marks



$T_c = m l_1 (l_3 - l_2) \alpha$ —— 2 marks

—— xox —— xox —— xox ——

Q3] a] Flat collar thrust bearing:- (6 marks)



—— Fig - 2 marks

$area = \pi (R_1^2 - R_2^2)$

* Uniform pressure theory

$$T = \frac{2}{3} \mu W \left[\frac{R_1^3 - R_2^3}{R_1^2 - R_2^2} \right]$$ —— 2 marks

* Uniform wear theory

$$T = \frac{1}{2} \mu W (R_1 + R_2)$$ —— 2 marks.

—— xox —— xox —— xox ——

b] For $2\theta = 30°$ $P = 350\ N$ —— 2 marks

For $2\theta = 90°$ $P = 319.69\ N$ —— 2 marks

(4 marks)

c] * self-locking of brakes:- $(x \le \mu . a)$

$R_n = \frac{Pl}{x - \mu . a}$ $P = \frac{R_n (x - \mu a)}{l}$ — 2 marks

* self-energizing :- $(P > 0)$

$P = \frac{R_n (x - \mu a)}{l}$ $R_n . x = Pl + \mu R_n a$

— 2 marks

—— xox —— xox —— x.x ——

Q 4] a] Torque expression of "Cone clutch":- (6 marks)

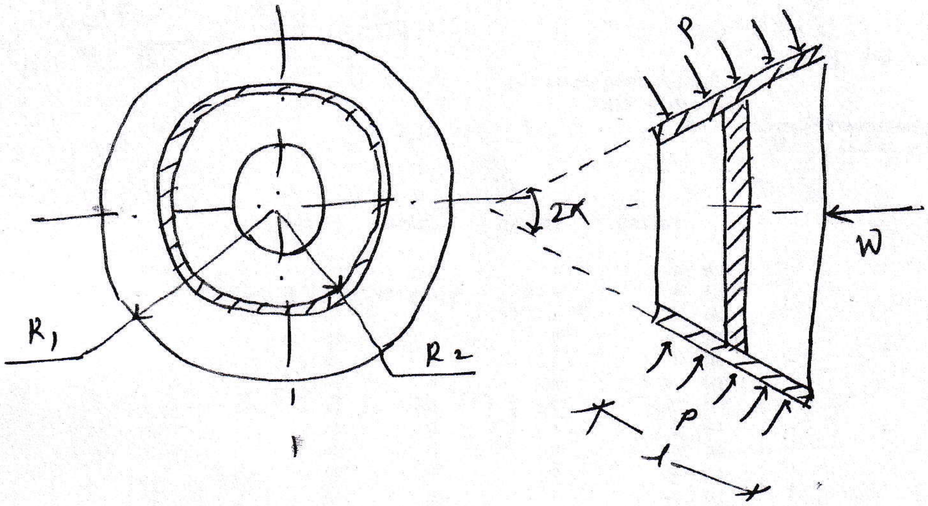


Fig:-

2 marks

1) Uniform pressure theory

$$T = \frac{2}{3} \mu W \left[\frac{R_1^3 - R_2^3}{R_1^2 - R_2^2} \right] \operatorname{cosec} \alpha$$

2 marks

2) Uniform wear theory

$$T = \frac{1}{2} \mu W (R_1 + R_2) \operatorname{cosec} \alpha$$

2 marks.

—— xox —— xox —— x.x ——

b] $R_1 = 0.22 m$ — 2 marks

$R_2 = 0.177 m$

$W = 714.42 N$ — 2 marks

—— xox —— xox ——

c] centrifugal clutch:- Fig — 2 marks

Explanation — 2 marks