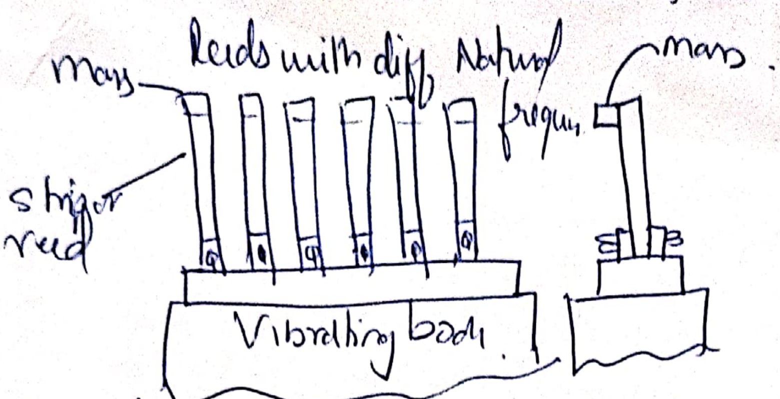
iDR.S

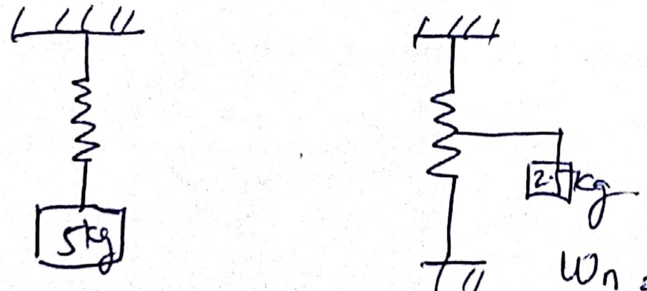
Q1.(a) Multi-Reed Frahm's tachometer



all reeds mounted on vibrating body each reed has a mass at their free end then the reed whose natural frequency is to be measured, natural frequency nearest to the excitation frequency of vibrating body vibrates with maximum amplitude due to resonance Condition.

TCP.

1.(b):-



$T_p = 0.45$ sec

$m = 5$ kg =

$K = ?$

$T_p = \frac{2\pi}{\omega}$

$\omega = \frac{2\pi}{T_p} = \frac{2 \times 3.14}{0.45}$

$= 13.95$

$\omega_n = \sqrt{\frac{K}{m}}$ $(13.95)^2 = \frac{K}{5}$

$K = 973.01$

$\omega_n = ?$

$f_n = \frac{1}{2\pi}\sqrt{\frac{K}{m}}$

$= \frac{1}{2\pi}\sqrt{\frac{973.01}{2.5}}$

$= \frac{44.11}{2\times\pi} = \boxed{7.02}$

$T_{p_2} = 2\pi\sqrt{\frac{m_2}{K_{eq}}} = 0.1598.$

Q1. C. $m = 2\,Kg$, $K = 2\,N/mm$

$C = 0.05\ N\text{-}s/mm$.

$$\omega_n = \sqrt{\frac{K}{m}} = \sqrt{\frac{2}{2}} = \sqrt{1} = 1.$$

$\omega_n = 1$

$$\zeta = \frac{c}{c_c} = \frac{c}{2m\omega_n} = \frac{0.05}{2\times2\times1} = \frac{0.05}{4} = 0.0125$$

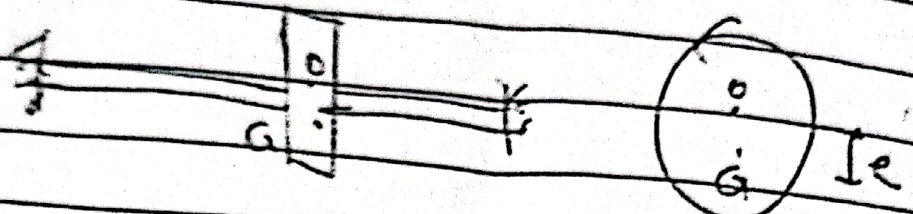
$\zeta = 0.0125$

$$\omega_d = \sqrt{1-\zeta^2}\,.\,\omega_n$$

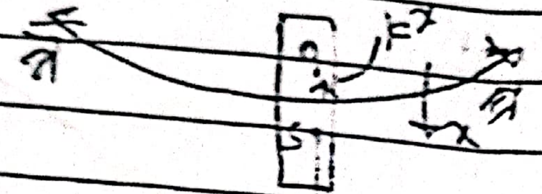
$$= \sqrt{1-(0.0125)^2} \times 1 = 0.999$$

Q.2(c) Whirling speed of a rotating shaft is the speed at which the shaft starts to vibrate violently in the transverse direction.

1(d)



6m



$m\omega^2(x+e)$

K → stiffness of shaft

in equilibrium,

C.F. = Restoring force,

$$m\omega^2(x+e) = kx$$

$$mx\omega^2 + me\omega^2 = kx$$

$$kx - m\omega^2 x = me\omega^2$$

$$x = \frac{m\omega^2 e}{k - m\omega^2} = \frac{m\omega^2 e}{k\left(1 - \frac{m\omega^2}{k}\right)}$$

$$\boxed{\frac{x}{e} = \frac{r^2}{1 - r^2}}$$

in case of lighter side is on outer side.

$$\frac{x}{e} = \frac{r^2}{r^2 - 1}$$

Q2(a).

$$W_n = \sqrt{\frac{2k}{3m}}$$

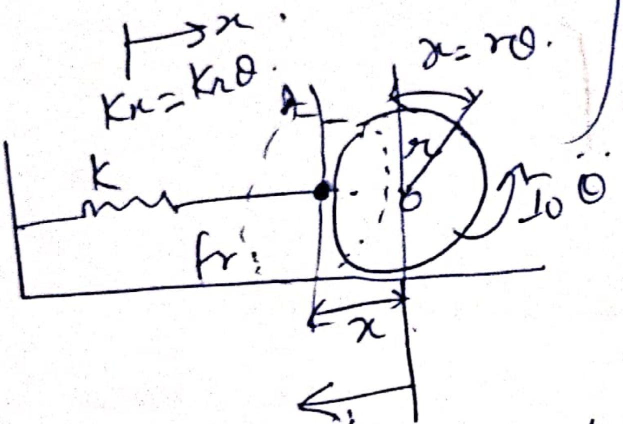
$$f_n = \frac{\omega_n}{2\pi} = \frac{1}{2\pi}\sqrt{\frac{2k}{3m}}$$

$$= \frac{1}{2\pi}\sqrt{\frac{19620}{3\times 6}} = \frac{33.015}{2\pi}$$

$$= 5.257.$$

Derivation either by energy method or Equilibrium method.

Also frequency independent of radius of mass.



angular displacement $= \theta$, linear displacement $= x_1 = r\theta$, linear velocity $- \dot{x}_1 = r\dot{\theta}$

linear acceleration $- \ddot{x}_1 = r\ddot{\theta}$. Σ internal force $+ \Sigma$ external force $= 0$

$m\ddot{x} + kr\theta - F_r = 0$ —

rotary motion of roller,

Σ ~~forces~~ torques $= 0$

Q2.

b. $N_1 = 1500$ rpm
$N_2 = 2000$ rpm

$$\omega_1 = \frac{2\pi N_1}{60} = \frac{2\times\pi\times 1500}{60} = 157.07 \text{ rad/s}$$

$$\omega_2 = \frac{2\pi N_2}{60} = \frac{2\times\pi\times 2000}{60} = 209.4395 \text{ rad/s}$$

$$\eta_{iso} = 1 - T_r$$

$$0.75 = 1 - T_r$$

$$\boxed{T_r = 0.25}$$

$$T_r = \frac{\sqrt{1+(2\xi r^2)}}{\sqrt{(1-r^2)^2+(2\xi r^2)}} \qquad \xi = 0$$

$$0.25 = \frac{1}{|1-r^2|}$$

$$0.25 = \frac{1}{|r^2-1|}$$

$$\boxed{r = 2.23}$$

$r = \omega_1/\omega_{n1}$

$2.23 = \frac{157}{\omega_{n1}}$

$\boxed{\omega_{n1} = 70.40 \text{ rad/s}}$

$r = \omega_2/\omega_{n2}$

$2.23 = \frac{209.43}{\omega_{n2}}$

$\boxed{\omega_{n2} = 93.91 \text{ rad/s}}$

$\omega_{n1} = \sqrt{\frac{g}{\delta}} = 70.40 = \sqrt{\frac{9.81}{\delta_1}}$

$\boxed{\delta_1 = 1.97 \times 10^{-3}}$

$\omega_{n2} = \sqrt{\frac{g}{\delta}} = 93.91 = \sqrt{\frac{9.81}{\delta_2}}$

$\boxed{\delta_2 = 1.112 \times 10^{-3}}$

$r = \frac{\omega_2}{\omega_{n1}} = \frac{209.43}{70.40}$

$\boxed{r = 2.97}$

$$T_{r1} = \frac{1}{|r^2 - 1|}$$

$$= \frac{1}{|2.97 - 1|}$$

$$\boxed{T_{r1} = 0.507}$$

Case II check for ω_2

$$T_{r2} = \quad r = \frac{\omega_2}{\omega_{n2}} = \frac{209.43}{93.91}$$

$$\boxed{r = 2.23}$$

$$T_{r2} = \frac{1}{|r^2 - 1|}$$

$$= \frac{1}{|2.23 - 1|}$$

$$\boxed{T_{r2} = 0.81}$$

So case 1 is right

Q3(a) $K = 100 N/mm$, $C = 2 N\text{-}sec/mm$ $m = 1 kg$.

$$\omega_n = \sqrt{\frac{K}{m}} = \sqrt{\frac{100}{1}} = \sqrt{100} = 10 \text{ rad/sec}.$$

$$\xi = \frac{c}{c_c} = \frac{c}{2 \times m \times \omega_n} = \frac{2}{2 \times 1 \times 10} = \frac{2}{20} = 0.1$$

Initial Amplitude - $x_0 = 1$, $x_n = 3$

$$\frac{x_0}{x_1} = 3$$

$$\delta = \frac{1}{n} \log\left(\frac{x_0}{x_1}\right) = \frac{1}{1} \log(3)$$

$= 1.098$

$$\delta_3 = \frac{1}{n} \log\left(\frac{x_0}{x_1}\right) = \frac{1}{3} \log(3) =$$

Q3.

b. $\delta = 0.01\,m$

$N = 4000\ rpm$

$x = 1\times10^{-3}$

$$\omega_n = \sqrt{\frac{g}{\delta}} = \sqrt{\frac{9}{0.01}} = 31.32$$

$$\boxed{\omega_n = 31.32\ rad/s}$$

$$\omega = \frac{2\pi N}{60} = \frac{2\times\pi\times4000}{60} = 418.87\ rad/s$$

$$\gamma = \frac{\omega}{\omega_n} = \frac{418.87}{31.32}$$

$$\boxed{\gamma = 13.37}$$

$$\frac{x}{y} = \frac{\gamma^2}{\sqrt{(1-\gamma^2)^2 + (2\zeta\gamma)^2}}$$

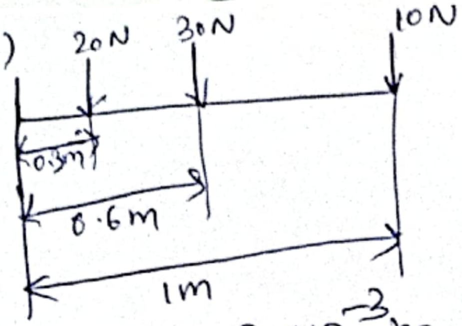
$$\frac{1\times10^{-3}}{y} = \cancel{\frac{(13.37)^2}{\sqrt{(1-(13.37)^2)^2 + (}}} \quad \frac{\gamma^2}{|1-\gamma^2|}$$

$y = 9.944\times10^{-4}\,m$

$y\omega = \cancel{416.54}\ 0.416\ m/s$

$y\omega^2 = 9.944\times10^{-4}\times418.87^2 = 174.46\ m/s$

4(a)



$y_3 = 2mm = 2\times10^{-3} m$

$\alpha_{13} = \dfrac{0.243}{c}$

$\alpha_{23} = \dfrac{0.864}{c}$

$\alpha_{33} = \dfrac{2}{c}$

$y_3 = W_1\alpha_{13} + W_2\alpha_{23} + W_3\alpha_{33}$

$\therefore\ c = 25.39$

$\alpha_{11} = 2.126\times10^{3}$

$\alpha_{22} = 0.0170$

$\alpha_{33} = 0.0787$

$\delta_1 = W_1\alpha_{11} = 0.4252$

$\delta_2 = 5.1\times10^{-3}$

$\delta_3 = 0.787$

$\omega_{n_1} = \sqrt{\dfrac{g}{\delta_1}} = 15.18$

$\omega_{n2} = 43.85$

$\omega_{n3} = 3.53$ rads.

Dunkerly's Method.

$\omega_n = 3.427$ rad/s.

Same repeat for adding 20N at 80 cm.

$\delta_3 = 0.579$

$\omega_{n3} = 4.116$ rad/s.

$\omega_n = 2.63$ after adding 20N.

Q4.

b. $m = 1000 kg$
$k = 500 \, kN/m \quad = \quad 500 \times 10^3$
$\zeta = 0.5$
$\lambda = 5m$
$Y = 0.01$

Vehicle speed $= \frac{80 \times 1000}{3600} = 22.22$

$f = \frac{V}{\lambda} = \frac{22.22}{5} = 4.44$

$\omega_n = \sqrt{\frac{k}{m}} = \sqrt{\frac{500 \times 10^3}{1000}} = \cancel{0.707} \quad 22.36$

$\omega = 2\pi f$
$= 2 \times \pi \times 4.44$

$\omega = 27.89$

$r = \frac{\omega}{\omega_n} = \frac{27.89}{\cancel{0.707} \; 22.36} = \cancel{39.44} =$

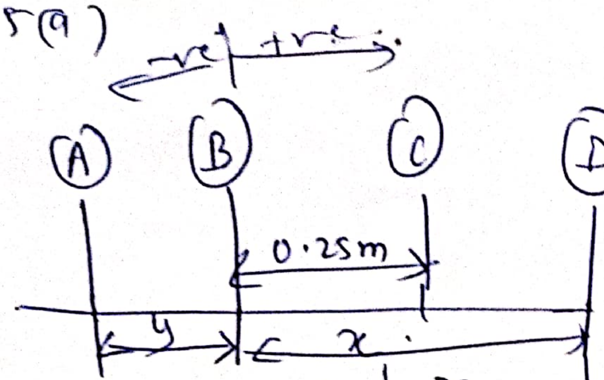
$\boxed{r = 1.24}$

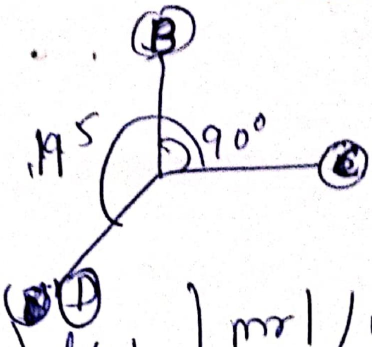
$$\frac{X}{y} = \frac{\sqrt{1+(2\zeta\gamma)^2}}{\sqrt{(1-\gamma^2)^2+(2\zeta\gamma)^2}}$$

$$\frac{X}{0.01} = \frac{\sqrt{1+(2\times 0.5\times 1.24)^2}}{\sqrt{(1-1.24^2)^2+(2\times 0.5\times 1.24)^2}}$$

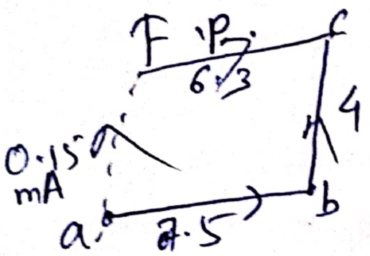
$$\boxed{X = 0.011\,m}$$

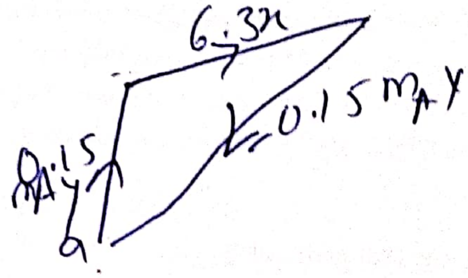
Q 5(a)





Plane	m (Kg)	r (m)	mr/w kg-m	l (m)	mrl/w kg-m
A	mA	0.15	0.15mA	-y	-0.15 mA y
B	25	0.2	5	0	0
C	40	0.1	4	0.25	1
D	35	0.18	6.3	x	6.3x



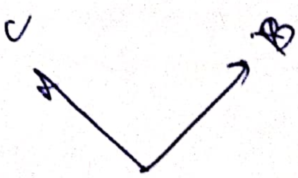


∠ =

m.A =

x =

y =



Q5(b))

$m = 5 Kg$, $K = 980 N/m = 0.980 N/mm$

$f_r = \cancel{0.025}$ $\mu = 0.025$, $x_0 = 5cm = 50mm$

1. Natural frequency:

$$\omega_n = \sqrt{\frac{K}{m}} = \sqrt{\frac{0.980}{5}} = 0.4427.$$

(ii) No. of cycles Corresponding to 50%. reduction of its intial Amplitude.

$x_n = 0.5 \times 50$

$= 25 mm$

Also, $x_n = x_0 - n \times \Delta$

$25 = 50 - n \times \Delta$ —(1)

But $\Delta = \frac{4 f_r}{K} = \frac{4 \mu R_N}{K} = \frac{4 \mu m g}{K}$.

$$= \frac{4 \times 0.025 \times 5 \times 9.81}{0.980} = 5.0051$$

$\Delta = 5.00$ —(2)

put (2) in (1)

$25 = 50 - n \times 5$

$5n = 50 - 25$

$= 25$

$n = \frac{25}{5} = 5$ cycles.

(iii) Time taken to achieve this 50% reduction

$$t = n \times \frac{2\pi}{\omega_n} = 5 \times \frac{2\pi}{\sqrt{\frac{K}{m}}}$$

$$= 5 \times \frac{2\pi}{0.4427} =$$

$= 70.928$ sec..