Internal Assessment Test II – Dec 2022

Sub:	Dynamics of Machinery	**Code:**	18ME53
Date: 02/ 12 / 2022	**Duration:** 90 mins	**Max Marks:** 50	**Sem:** V
Branch:	MECH		

Note: Answer **all** questions

		Marks	OBE CO	OBE RBT
1	A shaft carries four masses A. B. C. and D of magnitude 200kg. 300kg. 400kg and 200kg respectively and revolving at radii 80mm, 70mm. 60mm and 80mm in planes measured from A at 300mm. 400mm and 700 mm. The angle between the crank measured anticlockwise are A to B 45°. B to C 70° and C to D 120° the balancing masses are to be placed in planes X and Y. The distance between the planes A and X is 100mm between X and Y is 400mm and between Y and D is 200mm. If the balancing planes revolved at a radius of 100mm find their magnitudes and angular position.	**20**	CO2	L3
2	Four masses 150, 250, 200 & 300kg are rotating in same plane at radii of 0.25m, 0.2m, 0.3m and 0.35m respectively. These angular locations are 40°, 120° & 250° from mass 150kg respectively measured in counter clockwise direction. Find the position and magnitude of balance mass required, if its radius of rotation is 0.25m.	**10**	CO2	L3
3	Explain types of Vibration.	**8**	CO5	L1
4	Add the following motions analytically and check the solution graphically $x_1 = 4\cos(\omega t + 10^\circ)$ $x_2 = 6\sin(\omega t + 60^\circ)$	**12**	CO5	L2

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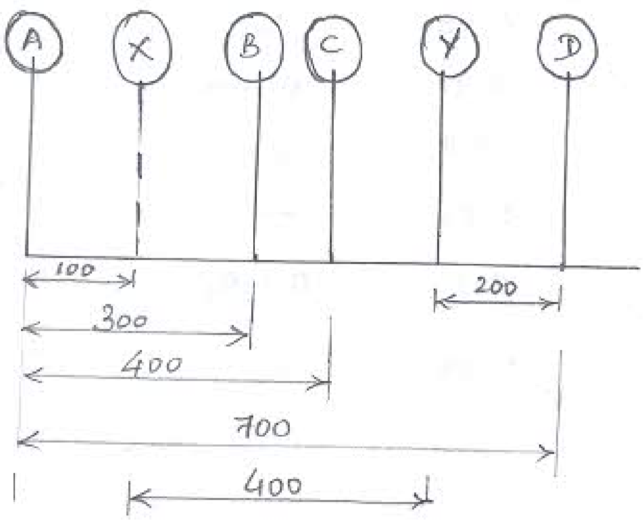
Solution for Internal Assessment Test II - Dec. 2022
Subject: Dynamics of Machinery {18ME53}

1. A Shaft Carries four masses A, B, C & D of Magnitude 200kg, 300kg, 400kg & 200 kg respectively and revolving at radii 80 mm, 70mm, 60mm & 80mm in planes measured from A at 300mm, 400mm & 700mm. The angles between the cranks measured anticlockwise are A to B 45°, B to C 70° & C to D 120°. The balancing masses are to be placed in planes X & Y. The distance b/w the planes A & X is 100 mm, between X & Y is 400mm and b/w Y & D is 200mm. If the balancing masses revolve at a radius of 100mm, find their magnitudes & angular positions.

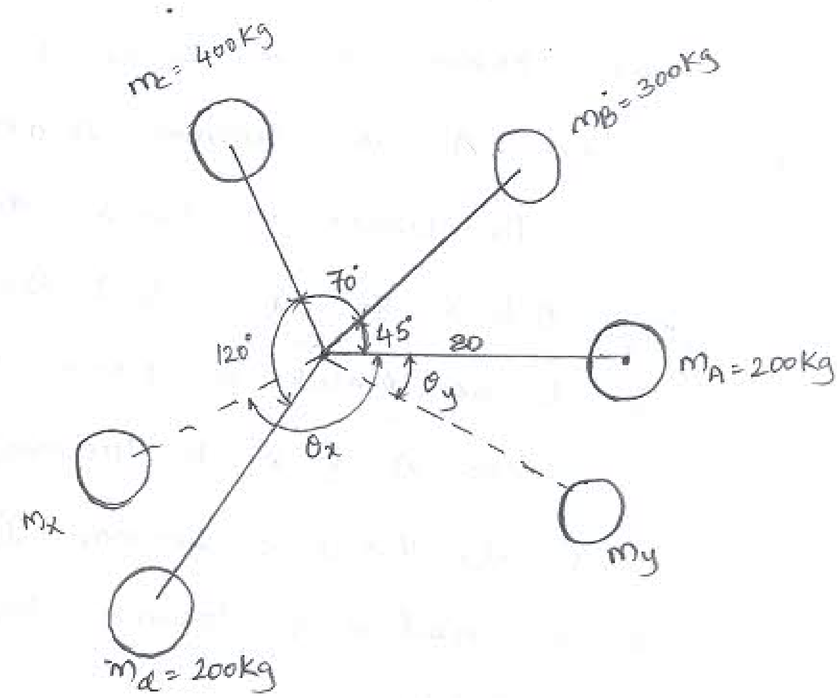
Sol:

Position of planes

All dimensions in mm.



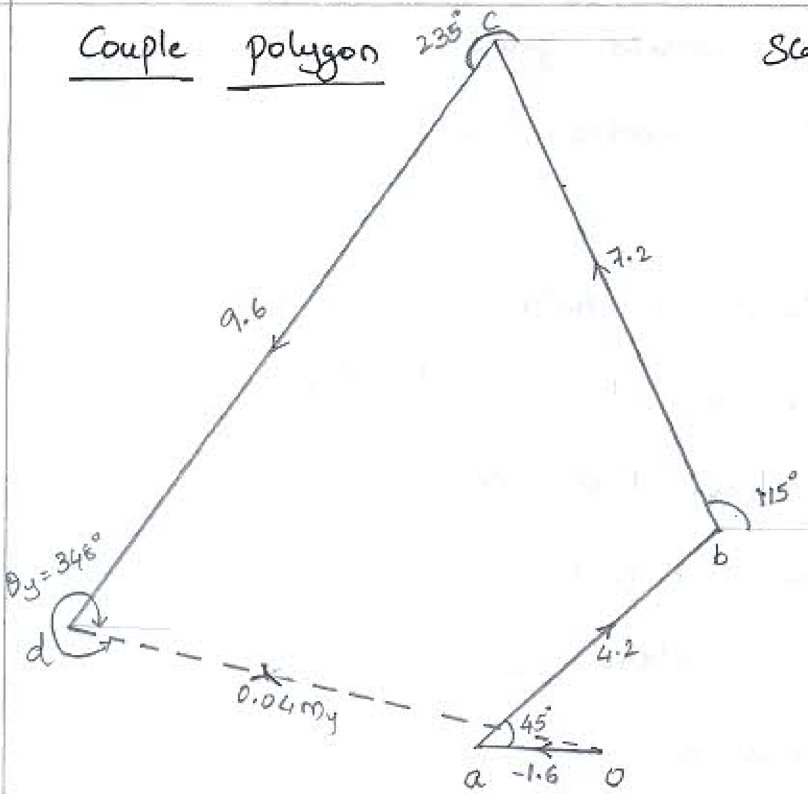
Space diagram   Scale 1cm = 20mm



Planes	Masses (m) Kg	Radius (r) m	Cent. force ÷ ω^2 (mr) Kg-m	Distance from R.P (l) m	Couple ÷ ω^2 (mrl) Kg-m²
A	200	0.08	16	-0.1	-1.6
x	m_x	0.1	$0.1m_x$	0	0
B	300	0.07	21	0.2	4.2
C	400	0.06	24	0.3	7.2
Y	m_y	0.1	$0.1m_y$	0.4	$0.04\,m_y$
D	200	0.08	16	0.6	9.6

Couple polygon

Scale 1 cm = 1 kg-m²



$0.04\, m_y = od$

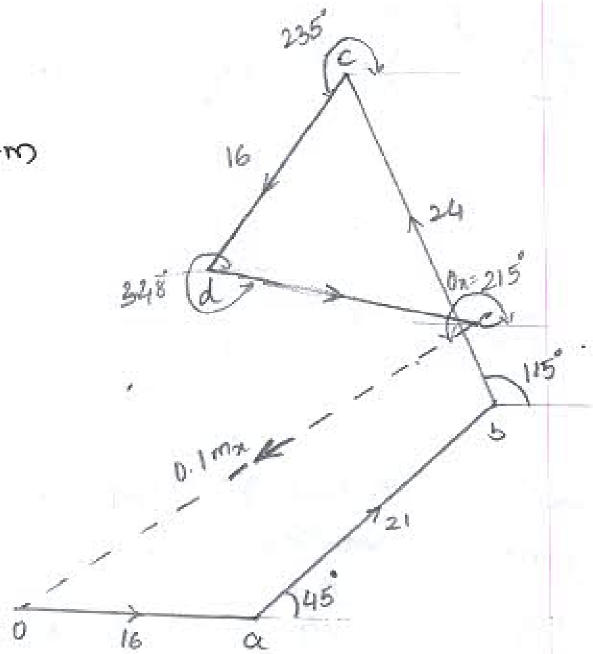
$0.04\, m_y = 7.3$ kg-m²

$m_y = 182.5$ kg.

$\theta_y = 348°$

Force polygon

Scale 2 cm = 1 kg-m



$oe = \frac{7.1}{2} = 3.55$

$0.1\, m_x = 35.5$ kg-m

$m_x = 355$ kg

$\theta_x = 215°$

2 Four masses 150, 250, 200 & 300 kg are rotating in Same plane at radii of 0.25 m, 0.2 m, 0.3 m & 0.35 m resp. There angular locations are 40°, 120° & 250° from mass 150 kg respectively measured in Counter clockwise direction. Find the position & magnitude of balance mass required, if its radius of rotation is 0.25 m.

Masses m (Kg)	Radius of rotation r (m)	Centrifugal force $\div \omega^2$ mr (kg-m)	Angular positions θ (deg)	Horizontal Components H ($mr\cos\theta$) kg-m	Vertical Components V ($mr\sin\theta$) kg-m
150	0.25	37.5	0	37.5	0
250	0.2	50	40	38.3	32.14
200	0.3	60	120	−30	51.96
300	0.35	105	250	−35.9	−98.67
				$\Sigma H = 9.9$	$\Sigma V = -14.57$

Resultant

$$R = \sqrt{(\Sigma H)^2 + (\Sigma V)^2} = \sqrt{9.9^2 + (-14.57)^2}$$

$$\boxed{R = 17.61 \text{ kg-m.}}$$

$$\tan\theta = \frac{\Sigma V}{\Sigma H} = \frac{-14.57}{9.9} = -1.47172$$

$$\theta = -55.8°$$

$$\theta_b = 180 + \theta = 180 - 55.8$$

$$\boxed{\theta_b = 124.2°}$$

3. Types of Vibration

1. Free and Forced Vibrations

Free Vibration: If a system, after an initial disturbance, is left to vibrate on its own, the ensuing vibration is known as free vibration. No external force acts on the system. The oscillation of a simple pendulum is an example of free vibration.

Forced Vibration: If a system is subjected to an external force (often, a repeating type of force), the resulting vibration is known as forced vibration.

Machine tools, electric bells etc.. are the suitable examples of forced vibration.

If the frequency of the external force coincides with one of the natural frequencies of the system, a condition known as resonance occurs, and the system undergoes dangerously large oscillations. Failures of such structures as buildings, bridges, turbines, and airplane wings have been associated with the occurrence of resonance.

2. Damped and Undamped Vibrations

If the vibratory system has a damper then there is a Reduction in amplitude over every cycle vibration since the energy of the system will be dissipated due to friction. This type of vibration is called damped vibration.

If the vibratory system has no damper, then the vibration is called undamped vibration.

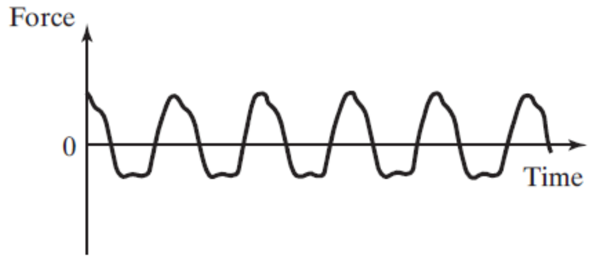
3. Linear and Nonlinear Vibration

If all the basic components of a vibratory system the spring, the mass, and the damper behave linearly, the resulting vibration is known as *linear vibration*. If, however, any of the basic components behave nonlinearly, the vibration is called *nonlinear vibration*.

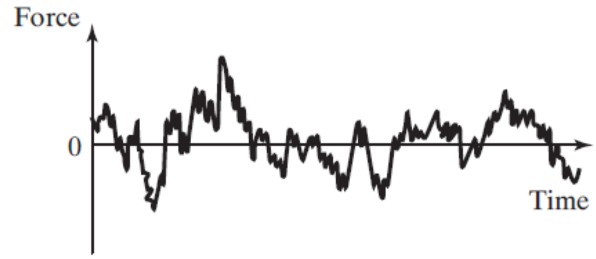
4. Deterministic and Random Vibrations

If the magnitude of the excitation force or motion acting on a vibrating system is known then the excitation is known as deterministic. The resulting vibration is called the deterministic vibration

If the magnitude of the excitation force or motion acting on a vibrating system is unknown, but the averages and deviations are known then the excitation is known as non-deterministic. The resulting vibration is called random vibrations.



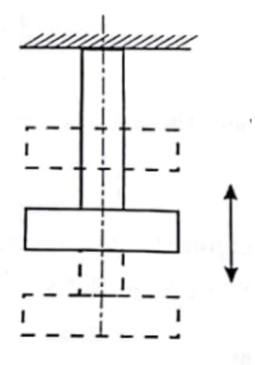
(a) A deterministic (periodic) excitation

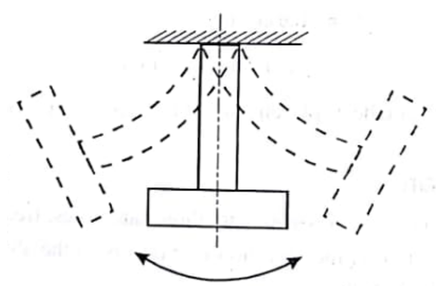


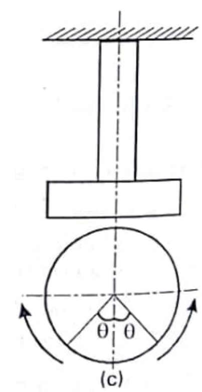
(b) A random excitation

5. Longitudinal, Transverse and Torsional Vibrations

When the particles of the shaft or disc moves parallel to the axis of shaft, then the vibrations are known as longitudinal vibrations and are shown in Figure (a).


(a)


(b)



(c)

When the particles of the shaft or disc moves approximately perpendicular to the axis of the shaft, then the vibrations are known as transverse vibrations and is shown in Figure (b).

When the particles of the shaft or disc moves in a circle about the axis of the shaft i e if the shaft gets alternately twisted and untwisted on account of vibratory motion, then the vibrations are known as torsional vibrations and is shown in Figure(c).

4 $x_1 = 4\cos(\omega t + 10^\circ)$; $x_2 = 6\sin(\omega t + 60^\circ)$

Sol

$$x = A\sin(\omega t + \theta)$$

$$x = x_1 + x_2$$

$$A\sin(\omega t + \theta) = 4\cos(\omega t + 10^\circ) + 6\sin(\omega t + 60^\circ)$$

$$A\sin\omega t \cdot \cos\theta + A\cos\omega t \cdot \sin\theta = 4\cos\omega t \cdot \cos 10^\circ - 4\sin\omega t \cdot \sin 10^\circ + 6\sin\omega t \cdot \cos 60^\circ + 6\cos\omega t \cdot \sin 60^\circ$$

$$\sin\omega t(A\cos\theta) + \cos\omega t(A\sin\theta) = \sin\omega t(-4\sin 10^\circ + 6\cos 60^\circ) + \cos\omega t(4\cos 10^\circ + 6\sin 60^\circ)$$

$$\sin\omega t(A\cos\theta) + \cos\omega t(A\sin\theta) = \sin\omega t(2.305) + \cos\omega t(9.135)$$

$$A\cos\theta = 2.305 \rightarrow (1)$$

$$A\sin\theta = 9.135 \rightarrow (2)$$

Squaring & adding $A^2\cos^2\theta + A^2\sin^2\theta = 2.305^2 + 9.135^2$

$$\boxed{A = 9.42}$$

② ÷ ①

$$\frac{A \sin\theta}{A \cos\theta} = \frac{9.135}{2.305}$$

$$\tan\theta = 3.963$$

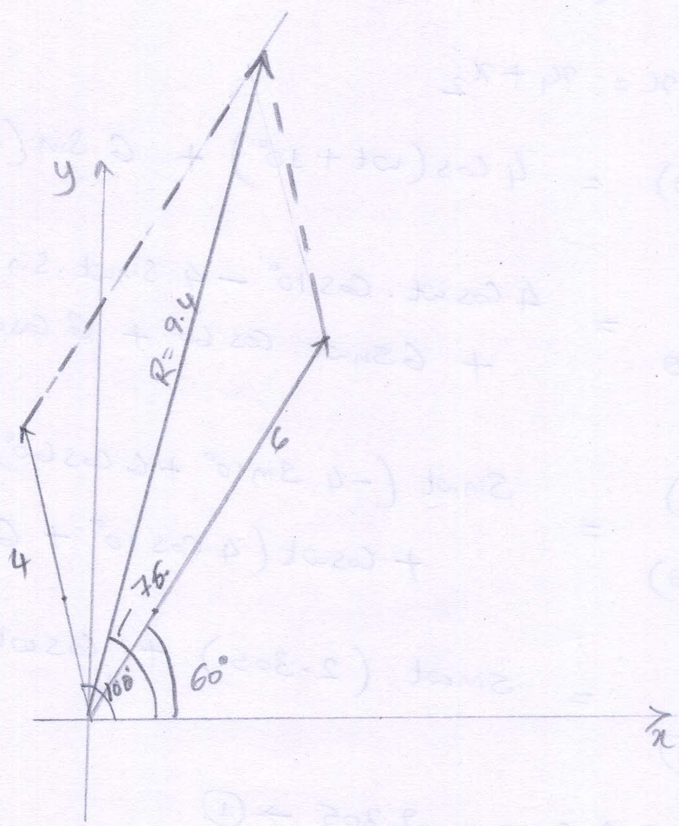
$$\boxed{\theta = 75.84^\circ}$$

$$\therefore \quad x = 9.42 \sin(\omega t + 75.84^\circ)$$

Graphical Method

$$x_1 = 4\cos(\omega t + 10^\circ) = 4\sin(\omega t + 100^\circ)$$

$$x_2 = 6\sin(\omega t + 60^\circ)$$



$$x = 9.4\sin(\omega t + 76^\circ)$$