OR iii The rotor of a turbo super charger of mass 9 kg is keyed to the centre of a 25 mm diameter shaft 40 cm between bearings, determine: **7**
(a) The critical speed of shaft,
(b) The amplitude of vibration of the rotor at a speed of 3200 rpm, if the eccentricity is 0.015 mm. and
(c) The vibratory force transmitted to the bearings at this speed.
Assume the shaft to be simply supported and that the shaft material has a density of 8×10^3 kg/m^3, Take E = 2.1×10^{11} N/m^2.

Q.5 i. Describe the demerit of dynamic vibration absorber with suitable diagram. **3**

ii. Determine the frequency of the system shown in Fig. 4. **7**
Given $K_1 = K_2 = 40$ N/m, K = 60 N/m, $m_1 = m_2 = 10$ kg.

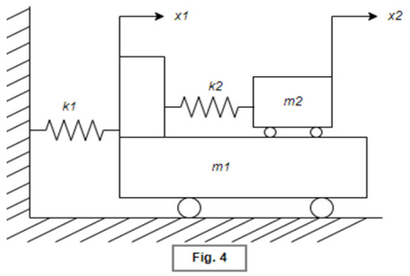

Fig. 4

OR iii. Determine the two natural frequencies and mode shapes for the system shown in Fig. 5. The string is stretched with the large tension T. **7**

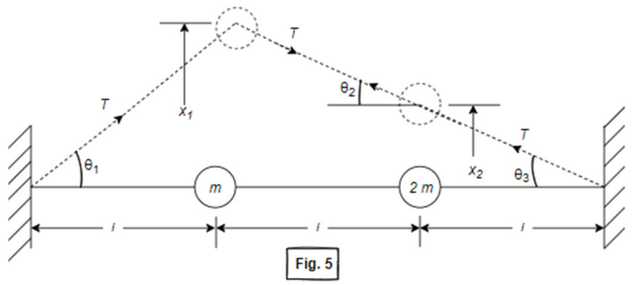

Fig. 5

Q.6 Write short note on any two:
i. Quality factor and half power points **5**
ii. Vibrometer **5**
iii. Working of FFT analyzer **5**

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Enrollment No.....

Faculty of Engineering

End Sem (Even) Examination May-2022

AU3EL08/ME3EL02 Mechanical Vibrations

Programme: B.Tech. Branch/Specialisation: AU/ME

Duration: 3 Hrs. **Maximum Marks: 60**

Note: All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c or d.

Q.1 i. Natural frequency of a system is due to- **1**
(a) Free vibration (b) Forced Vibration
(c) Resonance (d) None of these

ii. The main properties of a vibrating system are- **1**
(a) Mass and stiffness (b) Mass, stiffness and damping
(c) Stiffness and damping (d) Damping and stiffness

iii. A system is said to be over damped if damping factor for the system is- **1**
(a) More than one (b) Equal to one
(c) Less than one (d) Equal to zero

iv. The amount of damping, necessary for a system to be critically damped, is known as- **1**
(a) Damped factor (b) Magnification factor
(c) Critical damping co-efficient (d) Logarithmic decrement

v. For shaft speed more than critical speed the phase difference between displacement and centrifugal force is- **1**
(a) 0^o (b) 45^o (c) 90^o (d) 180^o

vi. A node means a section where the amplitude of vibration is- **1**
(a) Maximum (b) Half of maximum
(c) One fourth of the maximum (d) Zero

vii. There are n rotors mounted on the shaft and when subjected to torsional vibration there will be- **1**
(a) n nodes (b) (n – 1) nodes
(c) (n + 1) nodes (d) Any number of nodes

viii. In matrix iteration the natural frequency can be determined by using- **1**
(a) Flexibility influence coefficients (b) Rayleigh Method
(c) Both (a) and (b) (d) None of these

P.T.O.

ix. Dynamic vibration absorber is suitable for- **1**

(a) Constant speed machines (b) Varying speed machines

(c) Zero speed range machines (d) None of these

x. Accelerometer is designed with- **1**

(a) Low frequency (b) High frequency

(c) Zero frequency (d) None of these

Q.2 i. Differentiate between damped and transient vibration. **2**

ii. Find the natural frequency of the system shown in Fig. 1 **3**

K_1=5000 N/m, K_2= K_3 = 8000 N/m, m=25 kg

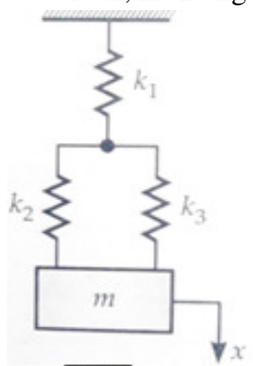

Fig. 1

iii. In an Indicator mechanism as shown in Fig. 2, the crank arm is pivoted at point O and has a mass moment inertia I. Find the natural frequency of the system. In the figure symbols have their usual meanings. **5**

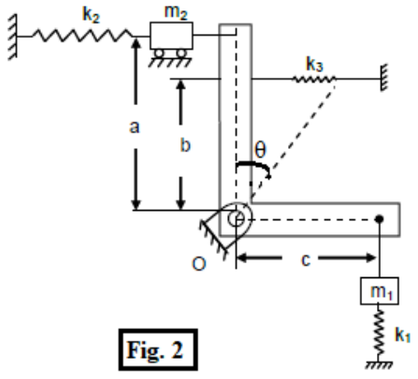

Fig. 2

OR iv. Determine the natural frequency of the mass m = 15 kg as shown in Fig. 3, assuming that the cords do not stretch and slide over the pulley rim. Assume that the pulley has no mass. **5**

K_1=8000 N/m, K_2= 6000 N/m

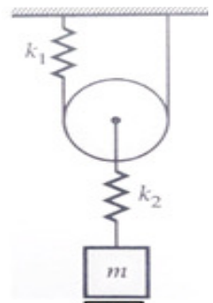

Fig. 3

Q.3 i. Differentiate between Coulomb and Structural damping. **2**

ii. The disc of a torsional pendulum has a moment of inertia of 600 kg-cm^2. The brass shaft of pendulum has a diameter of 10 cm and length of 40 cm. When the pendulum is vibrates in viscous oil, the amplitude on the same side of the rest position are 9^o, 6^o and 4^o successive cycles. Determine: **8**

(a) Logarithmic decrement (b) Damping torque at unit velocity

(c) Periodic time of vibration

Assume for the brass shaft, G= 4.4 x 10^{10} N/m^2.

OR iii. A gun barrel of mass 600 kg has a recoil spring of stiffness 294000N/m. If the barrel recoils 1.3 meters on firing, determine, **8**

(a) The initial recoil velocity of the barrel,

(b) The critical damping coefficient of the dashpot which is engaged at the end of the recoil stroke.

(c) The time required for the barrel to return to a position 5 cm from the initial position

Q.4 i. Discuss in brief, transmissibility and isolation. **3**

ii. A machine supported symmetrically on four springs has a mass of 80 kg. The mass of the reciprocating parts is 2.2 kg which move through a vertical stroke of 100 mm with simple harmonic motion. Neglecting damping, determine the combined stiffness of the springs so that the force transmitted to the foundation is 1/20th of the impressed force. The machine crankshaft rotates at 800 rpm. **7**

If, under actual working conditions, the damping reduces the amplitudes of successive vibrations by 30%, find:

(a) The force transmitted to the foundation at 800 rpm,

(b) The force transmitted to the foundation at resonance, and

(c) The amplitude of the vibrations at resonance.

Marking Scheme
AU3EL08/ME3EL02 Mechanical Vibrations

Q.1	i.	Natural frequency of a system is due to- (a) Free vibration		**1**
	ii.	The main properties of a vibrating system are- (b) Mass, stiffness and damping		**1**
	iii.	A system is said to be over damped if damping factor for the system is- (a) More than one		**1**
	iv.	The amount of damping, necessary for a system to be critically damped, is known as- (c) Critical damping co-efficient		**1**
	v.	For shaft speed more than critical speed the phase difference between displacement and centrifugal force is- (d) 180^o		**1**
	vi.	A node means a section where the amplitude of vibration is- (d) Zero		**1**
	vii.	There are n rotors mounted on the shaft and when subjected to torsional vibration there will be- (b) (n – 1) nodes		**1**
	viii.	In matrix iteration the natural frequency can be determined by using- (a) Flexibility influence coefficients		**1**
	ix.	Dynamic vibration absorber is suitable for- (a) Constant speed machines		**1**
	x.	Accelerometer is designed with- (b) High frequency		**1**
Q.2	i.	Damped vibration	1 mark	**2**
		Transient vibration	1 mark	
	ii.	Find the natural frequency of the		**3**
		Equivalence Stiffness - 3809.52 N/m	2 marks	
		Natural frequency – 1.96 Hz	1 mark	
	iii.	Kinetic energy of the system	1 mark	**5**
		Potential energy of the system	1 mark	
		Differentiation of total energy	1 mark	
		Natural frequency of the system	2 marks	
OR	iv.	Movement of mass m	2 marks	**5**
		Equivalent stiffness	1 mark	
		Natural frequency of the mass - 2.9 Hz	2 marks	

Q.3	i.	Differentiate between		**2**
		Coulomb damping	1 mark	
		Structural damping	1 mark	
	ii.	(a) Logarithmic decrement – 0.405	1 mark	**8**
		(b) Damping torque at unit velocity – 32.83 N-m/rad	4 marks	
		(c) Periodic time of vibration – 1.48 x 10^{-3} sec	3 marks	
OR	iii.	A gun barrel of mass 600 kg has a recoil spring of stiffness 294000N/m. If the barrel recoils 1.3 meters on firing, determine,		**8**
		(a) The initial recoil velocity of the barrel- 28.77 m/sec	1 mark	
		(b) The critical damping coefficient – 26563 N-sec/m	1 mark	
		(c) The time required for the barrel to return to a position 5 cm from the initial position		
		Natural frequency	1 mark	
		Time period	1 mark	
		Time of recoil	1 mark	
		Constant value using initial condition	1 mark	
		Total time	2 marks	
Q.4	i.	Transmissibility	1.5 marks	**3**
		Isolation	1.5 marks	
	ii.	Natural frequency	1 mark	**7**
		Combined Stiffness	1 mark	
		(a) The force transmitted to the foundation at 800 rpm	2 marks	
		(b) The force transmitted to the foundation at resonance	2 marks	
		(c) The amplitude of the vibrations at resonance	1 mark	
OR	iii	(a) The critical speed of shaft	3 marks	**7**
		(b) The amplitude of vibration of the rotor at a speed of 3200 rpm, if the eccentricity is 0.015 mm	2 marks	
		(c) The vibratory force transmitted to the bearings at this speed	2 marks	
Q.5	i.	Demerit of dynamic vibration absorber	2 marks	**3**
		Diagram	1 mark	
	ii.	FBD	2 marks	**7**
		Equation of motion	2 marks	
		Rearrange in matrix form	1 mark	
		Frequency	2 marks	
OR	iii.	Equations of motion	2 marks	**7**
		Natural frequencies	3 marks	
		Mode shapes for the system	2 marks	

Q.6		Write short note on any two:		
	i.	Quality factor	2 marks	**5**
		Half power point	1 mark	
		Diagram with complete explanation	2 marks	
	ii.	Vibrometer		**5**
		Principle	1 mark	
		Working	2 marks	
		Diagram / graph	2 marks	
	iii.	Working of FFT analyzer		**5**
		Working principle	2 marks	
		Graph velocity Vs Acceleration explanation	2 marks	
		Graph	1 marks	

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