ii. One type of seismograph that records earthquake can be modelled as shown in Fig. 4. For this model, determine (a) The governing equation of motion and (b) Its frequency equation and the two natural frequencies. **6**

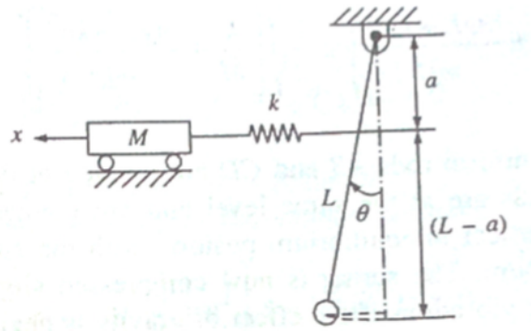

Fig. 4

OR iii. Calculate the natural frequencies of the three unequal masses attached at the quarter points of high-tension string as shown in Fig. 5. **6**

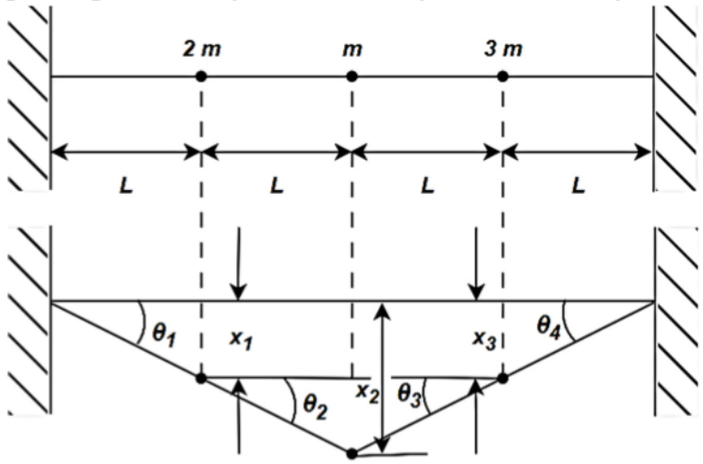

Fig. 5

Q.6 Attempt any two:

i. Explain the principle of working of vibrometer with schematic diagram. **5**

ii. What is FFT Analyzer? Explain its working principle. **5**

iii. What is condition monitoring of industrial machinery? How vibrations are used for monitoring the machine condition? **5**

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Total No. of Questions: 6 *Total No. of Printed Pages:4*

Enrollment No.....

Faculty of Engineering

End Sem Examination May-2023

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. Assume suitable data if necessary. Notations and symbols have their usual meaning.

Q.1 i. Which one is not a cause of vibration in a machine is- **1**

(a) Unbalance of rotating parts (b) Misalignment of its shaft

(c) More weight of machine (d) Dry friction between rubbing parts

ii. In the spring -mass sytem, if the mass of the system is doubled with spring stiffness halved, the natural frequency of vibration **1**

(a) Remain unchanged (b) Is doubled

(c) Is halved (d) Is quadrupled

iii. In case of underdamped system, if x_1 and x_2 are the successive amplitudes on the same side of the mean positions, then logrithmic decrement is given by- **1**

(a) $\log(x_1/x_2)$ (b) $\log(x_2/x_1)$ (c) $\log_e(x_1/x_2)$ S(d) $\log_e(x_2/x_1)$

iv. The energy dissipated by viscous damping in one cycle is given by (where `ω_d' is damped natural frequency and X is amplitude)- **1**

(a) $\pi cX(\omega_d)^2$ (b) $\pi c(\omega_d)X^2$ (c) $cX(\omega_d)^2$ (d) $c(\omega_d)X^2$

v. For forced damped vibration system, the vibration isolation is possible only when- **1**

(a) $\omega/\omega_n = 1$ (b) $\omega/\omega_n<1$ (c) $\omega/\omega_n< \sqrt{2}$ (d) $\omega/\omega_n > \sqrt{2}$

vi. The displacement transmissibility (T_d) of a vibrating body, when its base is subjected to input motion, will be equal to one at frequency ratios- **1**

(a) 0 and 1 (b) 0 and $\sqrt{2}$ (c) 1 and $\sqrt{2}$ (d) none of these

vii. A system with 2 DOF is said to be statically coupled when mass matrix is _____ and stiffness matrix is _____. **1**

(a) Diagonal, diagonal (b) Diagonal, non-diagonal

(c) Non-diagonal, diagonal (d) Non-diagonal, non-diagonal

viii. Which of these methods of multi DOF systems use inverse of mass matrix? **1**

(a) Lagrange's method (b) Influence coefficient method
(c) Rayleigh's method (d) Matrix method

ix. An accelerometer must have the value of frequency ratio `r'– **1**

(a) Below 1 (b) Between 1 & 3
(c) Above 3 (d) None of these

x. Condition monitoring of machines include which type of maintenance- **1**

(a) Preventive (b) Breakdown
(c) Predictive (d) All of these

Q.2 i. Mention the various ways of classifying vibrations with brief explanation of each. **4**

ii. Determine the natural frequency of the system as shown in Fig. 1 **6**

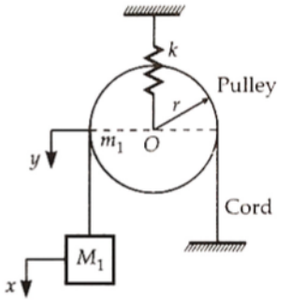

Fig.1

OR iii. Find the natural frequency of ANY ONE of the two vibratory systems shown in Fig. 2.1 or 2.2 **6**

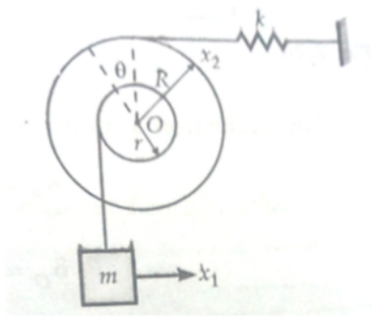

Fig. 2.1

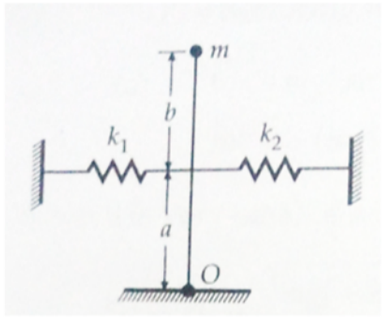

Fig. 2.2

Q.3 i. Give four comparisons between viscous and coulomb damping. **2**

ii. A body of 5 kg is supported on a spring of stiffness 200N/m and has a viscous damper connected to it which produces a resistance of 0.002 N at a velocity of 1 cm/sec. In what ratio will the amplitude of vibration be reduced after 5 cycles. **3**

iii. Determine the suitable expression for equation of motion of damped vibratory system as shown in Fig. 3. Find the critical coefficient of damping when a= 0.10 m; b=0.13m, k= 4900N/m; m =1.5 kg. **5**

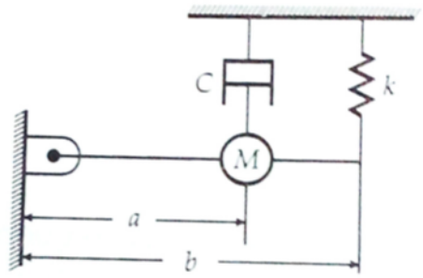

Fig. 3

OR iv. A horizontal spring mass system with a coulomb damping has a mass of 5.0 kg attached to a spring of stiffness 980 N/m. If the coefficient of friction is 0.025, calculate –(a) The frequency of free vibrations, (b) The number of cycles corresponding to 50% reduction in amplitude if the initial amplitude is 5.0 cm and (c) Time taken for 50% reduction. **5**

Q.4 Attempt any two:

i. Draw the graphs of variation of magnification factor (A) v/s frequency ratio (r) and give four comments for a damped system subjected to harmonic excitation. **5**

ii. A machine weighing 1670 N is mounted on spring having stiffness k=10790N/cm. The piston within the machine weighing 20N reciprocates with a stroke of 7.5 cm and machine has a speed of 6000 rpm. Assuming the motion of piston as simple harmonic determine- (a) Amplitude of vibration of machine, (b) The transmissibility and (c) force transmitted to the support taking ζ =0.2. **5**

iii. The springs of an automobile trailor are compressed by 0.1 under its own weight. Find the critical speed when the trailer is passing over a road with a profile of sine wave whose amplitude is 80 mm and wavelength is 14 m. Find the amplitude of vibration at a speed of 60 km/hr. **5**

Q.5 i. Explain coordinate coupling in a two DOF system with suitable example. **4**

Marking Scheme

AU3EL08 (T) / ME3EL02(T) Mechnical Vibrations

Q.1	i)	Which one is not a cause of vibration in a machine is- a) unbalance of rotating parts b) misalignment of its shaft **c) more weight of machine** d) dry friction between rubbing parts	**1**
	ii)	In the spring -mass sytem, if the mass of the system is doubled with spring stiffness halved , the natural frequency of vibration a) remain unchanged b) is doubled **c) is halved** d) is quadrupled	**1**
	iii)	In case of underdamped system, if x_1 and x_2 are the successive amplitudes on the same side of the mean positions, then logrithmic decrement is given by-a) log(x1/x2) b) log(x2/x1) **c) $\log_e$(x1/x2)** d) $\log_e$(x2/x1	**1**
	iv)	The energy dissipated by viscous damping in one cycle is given by- (where `ω_d' is damped natural frequency and X is amplitude) a) $\pi cX(\omega_d)^2$ **b) $\pi c(\omega_d)X^2$** c) $cX(\omega_d)^2$ d) $c(\omega_d)X^2$	**1**
	v)	For forced damped vibration system, the vibration isolation is possible only when- a) $\omega/\omega n = 1$ b) $\omega/\omega n<1$ c) $\omega/\omega n< \sqrt{2}$ **d) $\omega/\omega n > \sqrt{2}$**	**1**
	vi)	The displacement transmissibility (Td) of a vibrating body, when its base is subjected to input motion, will be equal to one at frequency ratios- a) 0 and 1 **b) 0 and $\sqrt{2}$** c) 1 and $\sqrt{2}$ d) none of these	**1**
	vii)	A system with 2 DOF is said to be statically coupled when mass matrix is ..... and stiffness matrix is ..... a) diagonal, diagonal **b) diagonal, non-diagonal** c)non-diagonal, diagonal d) non-diagonal, non-diagonal	**1**
	viii)	Which of these methods of multi DOF systems use inverse of mass matrix a) Langrange's method b) Influence Coefficient method c) Rayleigh's method **d) Matrix method**	**1**
	ix)	An accelerometer must have the value of frequency ratio `r'– **a) below 1** b) between 1 & 3 c) Above 3 d)None of these	**1**
	x)	Condition monitoring of machines include which type of maintenenace – a) preventive b) breakdown **c) predictive** d) all of these	**1**
Q.2	i.	Four ways of classification	**1X4**
	ii.	Derivation of governing equation	**5**
		Expression of natural frequency	**1**
OR	iii.	Derivation of governing equation	**5**

		Expression of natural frequency	**1**
Q.3	i.	Four comparisons between viscous and coulumb damping	**1/2 X4**
	ii.	Calculation of ω_n	**1**
		Calculation of Cc	**1**
		Calculation of ratio	**1**
	iii.	Equation of motion	**4**
		Calculation of Cc	**1**
OR	iv.	a) the frequency of free vibrations	**1**
		b) the number of cycles	**2**
		c) time taken for 50% reduction.	**2**
Q.4	i.	Graphs ofmagnification factor v/s frequency ratio	**1**
		Four comments	**4**
	ii.	a) amplitude of vibartion of machine	**3**
		b) the transmissibility and	**1**
		c) force transmitted	**1**
OR	iii.	a) critical speed	**3**
		b) amplitude of vibration	**2**
Q.5	i.	Sketch of system	**1**
		Equation of motion	**3**
	ii.	a) Governing equation of motion	**4**
		b) its frequency equation and	**1**
		c) the two natural frequencies.	**1**
OR	iii.	Determination of three frequencies	**2x3**
Q.6	i.	Schematic diagram	**1**
		Principle of working	**4**
	ii.	What is FFTAnalyzer	**1**
		Working principle of FFT Analyzer.	**4**
	iii.	What is condition monitoring	**1**
		Vibrations for monitoring the machine condition.	**4**

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[2]

[3]