USN

## Seventh Semester B.E. Degree Examination, Dec.2015/Jan.2016
# Mechanical Vibration and Vehicle Dynamics

Time: 3 hrs. Max. Marks:100

**Note:** ***Answer FIVE full questions, selecting at least TWO questions from each part.***



## PART – A

1 a. Differentiate between: i) Linear and non-linear vibration; ii) Deterministic and random vibration; iii) Transverse and torsional vibration. **(06 Marks)**

b. A harmonic motion is given by the equation x(t) = 5 sin (15t – 45) cm. Where phase angle is in radians and time in seconds. Find,
i) Period of motion ii) Frequency iii) Maximum displacement
iv) Maximum velocity v) Maximum acceleration **(06 Marks)**

c. A body is subjected to harmonic motions $x_1 = 10\sin(\omega_n t + 30)$ and $x_2 = 5\cos(\omega_n t + 60)$. What harmonic motion should be given to the body to bring it to equilibrium? **(08 Marks)**

2 a. Determine the natural frequency of the spring-mass system as shown in Fig.Q2(a). Take mass of the spring into account. (Use energy method). **(08 Marks)**

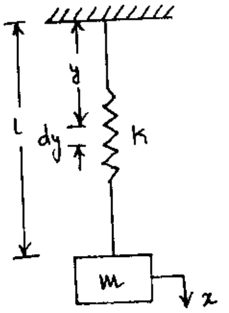

Fig.Q2(a)

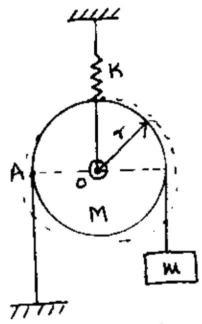

Fig.Q2(c)

b. A body of mass 5 kg is hung on two helical springs in parallel. One spring is elongated 1 cm by a force of 3N, other spring requires a force 2N for an elongation of 1cm. Calculate the natural frequency of vibration. **(04 Marks)**

c. Determine the equation of motion and the natural frequency of the system as shown in Fig.Q2(c). Using energy method. **(08 Marks)**

3 a. Explain the following terms:
i) Coulomb damping ii) Structural damping iii) Slip damping **(06 Marks)**

b. A thin plate of mass 'm' and area 'A' is attached to the end of a spring and oscillates in a various liquid as shown in Fig.Q3(b). If '$f_n$' is the frequency of oscillation of the system in air (damping is neglected) and '$f_d$' is the frequency of oscillation in liquid. Prove that $\eta = \frac{2\pi m}{A}\sqrt{f_n^2 - f_d^2}$. Where the damping force on the plate is $F_d = 2\eta A v$, v being a velocity.

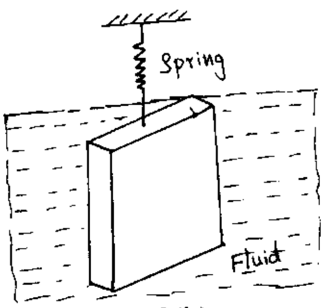

Fig.Q3(b) **(06 Marks)**

c. A spring-mass dashpot system is given an initial displacement zero and velocity of $XW_n$ where $W_n$ is the undamped natural frequency of the system. Find the equation of motion for the system, when (i) $\xi = 2.5$, (ii) $\xi = 1$. **(08 Marks)**

4 a. Define the following terms: i) Vibration isolation ; ii) Transmissibility. **(04 Marks)**

b. Show that providing damping in vibration isolation is not useful when the frequency ratio is more than 1.414 (or) $\sqrt{2}$. **(06 Marks)**

c. A mass 6 kg suspended by a spring of stiffness 1180 N/m is forced to vibrate by the harmonic force 10 N. Assuming viscous damping coefficient of 85 N-s/m, determine the resonant frequency, amplitude at resonance, phase angle at resonance, frequency corresponding to the peak amplitude. Peak amplitude and phase angle corresponding to the peak amplitude. **(10 Marks)**

## PART – B

5 a. Explain with neat diagrams the frequency measuring instruments (any two). **(10 Marks)**

b. Obtain an expression for whirling of shaft with air damping. **(10 Marks)**

6 a. Find the natural frequency and equation of motion of the system as shown in Fig.Q6(a). Using Lagrange's equation with k = 90 N/m, l = 0.25 m, $m_1$ = 2 kg, $m_2$ = 0.5 kg. **(10 Marks)**

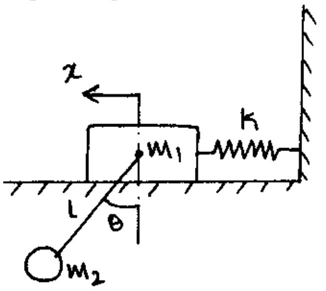

Fig.Q6(a)

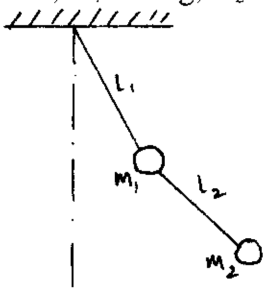

Fig.Q6(b)

b. Obtain the natural frequencies of the double pendulum as shown in Fig.Q6(b). Assume $\ell_1 = \ell$ and $\ell_2 = 2\ell$, $m_1 = m_2 = m$. **(10 Marks)**

7 Determine the normal modes of vibration if the automobile is simulated by the simplified two degree of freedom system as shown in Fig.Q7 with the following numerical values: m = 1500 kg, $\ell_1$ = 1.35 m, $\ell_2$ = 1.65 m, $\ell$ = 3m, k = 1.2 m, $k_1 = 35 \times 10^3$ N/m and $k_2 = 40 \times 10^3$ N/m. **(20 Marks)**

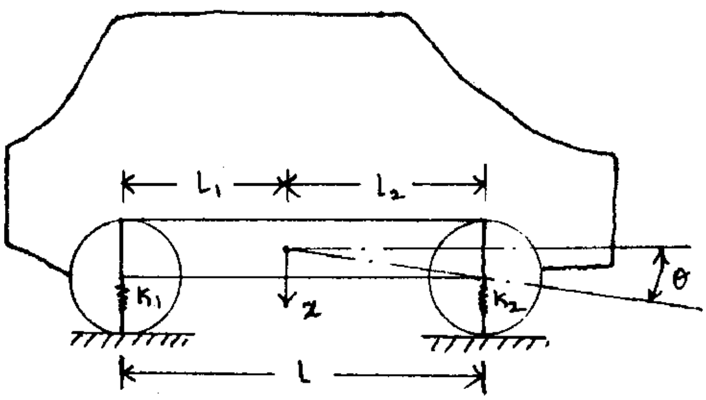

Fig.Q7

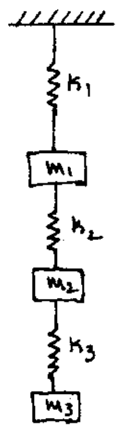

Fig.Q8

8 What is Stodola's method? Explain their steps and also find the fundamental mode of vibration and its natural frequency of the spring mass system as shown in Fig.Q8 with $k_1 = k_2 = k_3 = 1$ N/m and $m_1 = m_2 = m_3 = 1$ kg. **(20 Marks)**

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