NEW SCHEME

ME65

USN

Sixth Semester B.E. Degree Examination, July/August 2005

Mechanical Engineering

Mechanical Vibrations

Time: 3 hrs.] [Max.Marks : 100

Note: *Answer any five full questions.*

1. a) A body is subjected to two harmonic motions
   $x_1 = 15sin(\omega t + \frac{\pi}{6})$ $x_2 = 8cos(\omega t + \frac{\pi}{6})$.
   What harmonic motion should be given to the body to bring it to equilibrium? (10 Marks)

   (b) Given a bar of cross section area A, length L, E-youngs modulus, ρ-mass/unit volume.
   i) Derive the equation governing the longitudinal vibrations of the bar.
   ii) Obtain the general solution of the differential equation derived above. (10 Marks)

2. a) A simple pendulum is shown in fig.Q2(a). Determine the natural frequency of the system, if the mass of the rod is not negligible. (10 Marks)

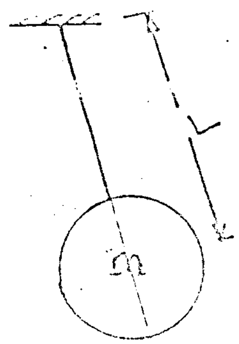


Fig. Q2 a.

   (b) A circular cylinder of mass m and mass moment of inertia I is connected by a spring of stiffness K, as shown in Fig.Q2(b). If it is free to roll without slipping, determine the natural frequency. (10 Marks)

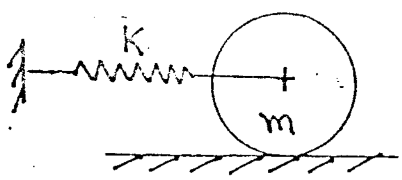


Fig. Q2. b.

Contd.... 2

3. a) For a free vibrations of an under damped spring-mass-damper system show that lograthmic decrement

$$\delta = \frac{2\pi\xi}{\sqrt{1-\xi^2}}$$

Where ξ is the damping ratio. (10 Marks)

(b) A disk of torsional pendulum has a moment of inertia of $0.6 kg - m^2$ and is immersed in a viscous fluid. The shaft is of 0.1m diameter and 0.4 m long. When pendulum is vibrating, the amplitude of successive cycles are $9^0, 6^0$ and 4^0. Determine :

i) Lograthmic decrement

ii) Damping torque at unit velocity

iii) Periodic time of vibration.

Assume the modulus of rigidity for shaft as 44 GPa. (10 Marks)

4. a) A vertical single stage air compressor having a mass of 500 kg is mounted on springs having stiffness of $1.96 \times 10^5\ N/m$ and dash pots with damping factor of 0.2. the reciprocating unbalanced mass is 20 kg. The stroke is 0.2m. Determine

i) The dynamic amplitude of vertical motion and

ii) The phase difference between the motion and exiting force if the compressor is operated at 200 rpm. (10 Marks)

(b) Determine the power required to vibrate a spring-mass-damper system with an amplitude of 15mm and at a frequency of 100 Hz. The system has a damping factor of 0.05 and a damped natural frequency of 22 Hz. The mass of the system is 0.5 kg. (10 Marks)

5. a) Explain the working principle of vibrometer (displacement measuring instrument).(10 Marks)

(b) A disk of mass 4 kg is mounted midway between bearings which may be assumed to be simple supports. The bearing span is 0.5m. The shaft is 10mm diameter and is horizontal. The C.G. of the disk is displaced 2mm from the geometric center. The damping ratio is 0.065. If the shaft rotates at 250 rpm, determine :

i) The critical speed, assuming E=196 GPa

ii) The amplitude of vibration. (10 Marks)

6. Figure Q.6 shows a rotor system. Find the natural freque[illegible] mode shape [illegible]

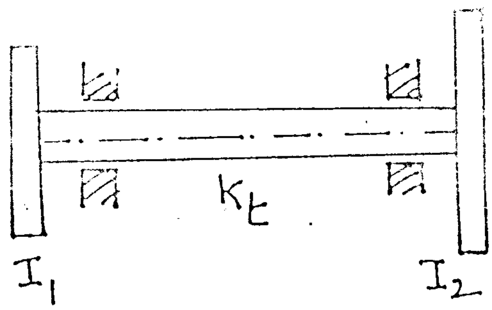


Fig. Q6.

7. Find the lowest natural frequency of transverse vibrations of the system shown in Fig.Q.7, by Rayleigh's method (20 Marks)

$E = 196\ GPa \quad I = 10^{-6} m^4 \quad m_1 = 40kg \quad m_2 = 20kg$

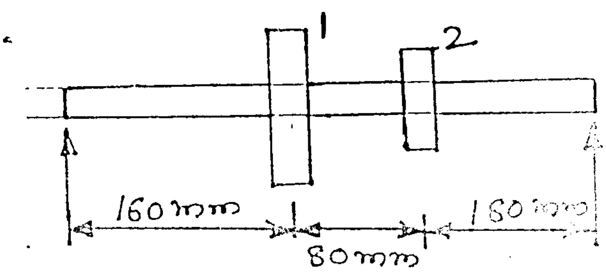


Fig. Q7

8. a) For the system shown in Fig.Q.8(a) find the lowest natural frequency by Stodola's method. (Carryout two iterations/trials).

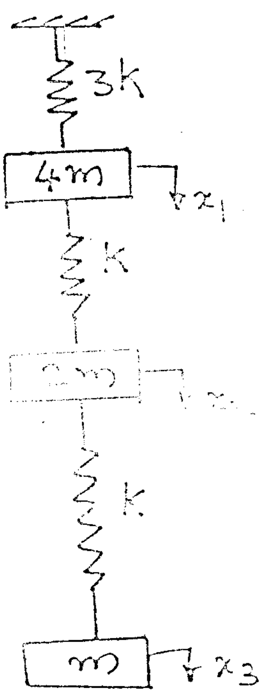


Fig. Q8(a)

(b) Determine the influence coefficients of the triple pendulum shown in Fig.8(b). (10 Marks)

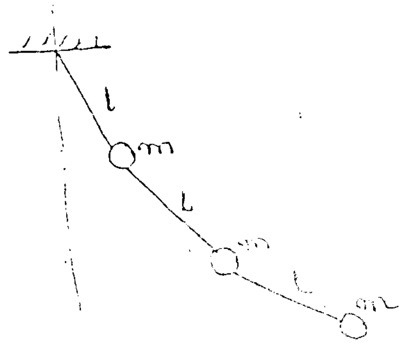


Fig. 8(b)

NEW SCHEME

ME65

Reg. No.

Sixth Semester B.E. Degree Examination, January/February 2006

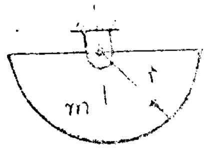
Mechanical Engineering

Mechanical Vibrations

Time: 3 hrs.) (Max.Marks : 100

Note: 1. Answer any FIVE full questions.
2. All questions carry equal marks.

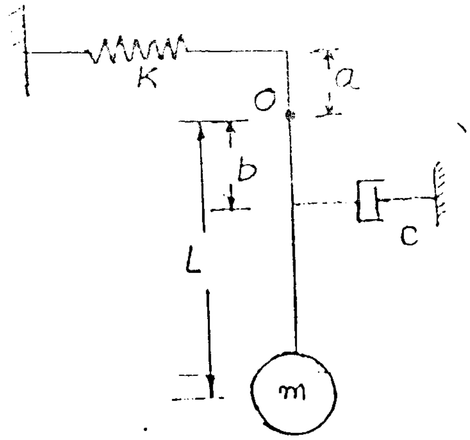
1. (a) If a semicircular isotropic disc of radius r and mass m is pivoted freely about its centre as shown in fig 1, find its natural frequency of oscillations for small angular displacements. **(8 Marks)**



(b) A solid wooden square prism of sides a and height h is immersed in a bath of distilled water upto a depth x and the prism is depressed slightly and released. Find the natural frequency of vibrations of prism if it stays upright all the time. What will be the frequency if salt water of specific gravity 1.2 is used instead of distilled water ? **(12 Marks)**

2. (a) Explain the following :
   i) Critical damping
   ii) Damping ratio
   iii) Logarithmic decrement
   iv) Damped natural frequency **(8 Marks)**

(b) A single pendulum is pivoted at point 'O' as shown in fig 2. If the mass of the rod is negligible and for small oscillations, find
   i) Critical damping, and
   ii) Damped natural frequency **(12 Marks)**



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3. (a) What is magnification factor ? Derive an expression for the same and discuss its variation with frequency ratio. **(8 Marks)**

(b) A mass of 100 kg has been mounted on spring support having a spring stiffness of $19600 N/m$ and a damping coefficient of $100 N - sec/m$. The mass is acted upon by a harmonic force of 39 Newtons at the undamped natural frequency of the set up.

Determine

i) Amplitude of vibration of the mass.

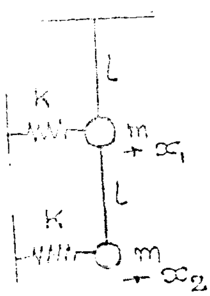
ii) Phase difference between the force and displacement.

iii) Force transmissibility ratio. (12 Marks)

4. (a) Discuss the basic principle on which vibration measuring instruments are designed. What are their practical limitations? (8 Marks)

(b) What do you understand by critical speed of shafts? Derive the necessary relations and thus, explain what is happening in the system carrying a shaft carrying an unbalanced disc at its centre is operated above and below its critical speed. (12 Marks)

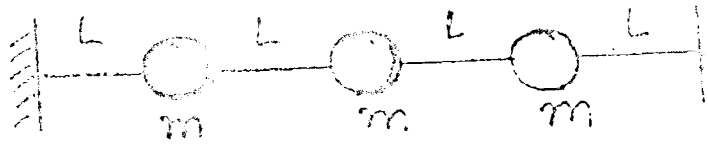
5. (a) Find the natural frequency of the double pendulum shown in fig 3. (8 Marks)



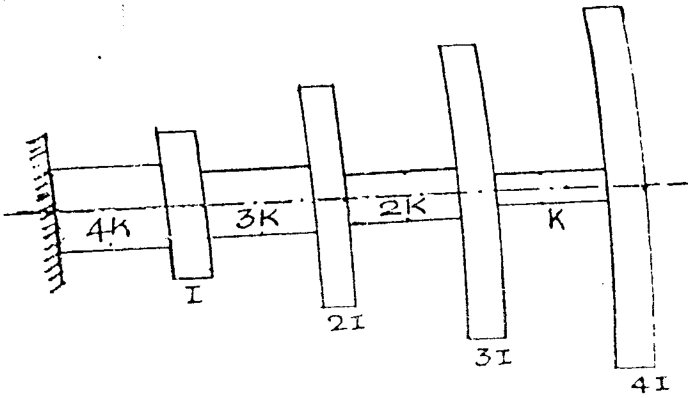
(b) Determine the ratio of amplitudes and locate the nodes for each mode of vibration if the system is to oscillate in the absence of the springs shown in the above figure. (12 Marks)

6. (a) What are Influence coefficients ? Discuss Maxwell's reciprocal theorem. (8 Marks)

(b) Determine the influence coefficients of the system shown in fig 4, and thus find fundamental frequency by iteration method. (12 Marks)



7. Determine the natural frequencies for torsional vibrations of the four degrees of freedom system shown in fig 5, by using Holzer's method. **(20 Marks)**



8. (a) Write notes on :
   i) Degrees of freedom
   ii) Amplitude
   iii) Causes of vibration
   iv) Beats
   (8 Marks)

   (b) Show that the differential equation of motion for the transverse vibration for simply supported beam of uniform cross section is given by

$$\frac{\partial^2 y}{\partial t^2} + a^2 \frac{\partial^4 y}{\partial x^4} = 0$$

(12 Marks)

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ME:21

ME65

USN

NEW SCHEME

Sixth Semester B.E. Degree Examination, July 2006
Mechanical Engineering
Mechanical Vibrations

Time: 3 hrs.] [Max. Marks:100

Note: 1. *Answer any FIVE full questions.*

1 a. Add the following harmonic motion analytically or graphically.
$x_1 = 2\cos(\omega t + 0.5)$ $x_2 = 5\sin(\omega t + 1.0)$ **(08 Marks)**

b. The governing equation of lateral vibration of beams is

$$\frac{\delta^2 y}{\delta t^2} + a^2 \frac{\delta^4 y}{\delta x^4} = 0$$

where, $a = \sqrt{\frac{EI}{\rho A}}$.

Obtain a general solution for the governing differential equation. **(12 Marks)**

2 a. The mass of a uniform rod in figure Q2 (a) is [illegible] to mass attached to it. For small oscillations, calculate the natural frequency of the system. **(08 Marks)**

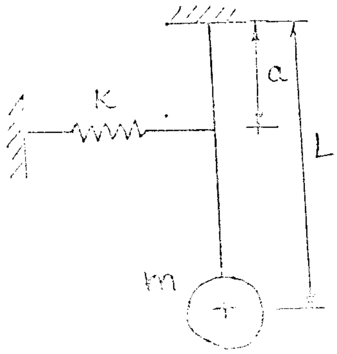

Fig. Q2 (a)

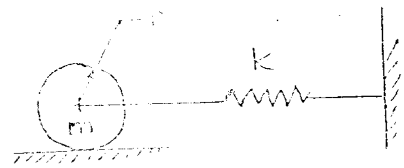

Fig. Q2 (b)

b. A [illegible] of modulus 'K' as shown in figure Q2 (b). If it is [illegible] surface without [illegible]. **(12 Marks)**

3 a. A [illegible] system is given an [illegible] of magnitude ω_n from [illegible] position. Find the [illegible] $\xi = 2.0$, where ω_n is the natural frequency of the system. **(08 Marks)**

b. A spring mass damper system has m = 3 kg, k = 100 N/m, c=3N-s/m.
Determine
 i) Damping factor
 ii) Natural frequency of damped vibration
 iii) Logarithmic decrement
 iv) The ratio of two successive amplitudes
 v) Number of cycles after which the original amplitude is below 20%. **(12 Marks)**

Contd.... 2

4 a. The mass of spring-mass-damper is excited by harmonic excitation $F_0 \sin \omega t$. Derive an expression for magnification factor or amplitude ratio of forced vibration. **(10 Marks)**

b. A 75 kg machine is mounted on springs of stiffness $K = 11.76 \times 10^5$ N/m with damping of $\xi = 0.2$. A 2 kg piston within the machine has reciprocating motion with a stroke of 0.08 m and speed of 3000 rpm. Assuming the motion of the piston to be harmonic, determine the amplitude of vibration of the machine. (10 Marks)

5 a. Sketch the dimensionless amplitude Vs frequency ratio characteristics (curves) of a vibration measuring instrument. Explain in what region it can be used as accelerometer. (10 Marks)

b. A horizontal shaft 15 mm diameter and 1 m long is held on simply supported bearings. The weight of the disk at the mid span is 15 kg. the eccentricity of the center of gravity of the disk from the center of rotor is 0.3 mm. The Youngs modulus of shaft is 200 MPa. Find the critical speed of the shaft. (10 Marks)

6 a. Determine the natural frequency of torsional vibrations of a shaft with two circular disks of uniform thickness at the ends. The masses of disks are m_1 = [illegible] kg and m_2 = 1000 kg. their radii are r_1 = 0.625 m and r_2 = 0.95 m. The length of the shaft 3m, and its diameter d = 100 mm. Modulus of rigidity of shaft is 83 GPa. (10 Marks)

b. Explain the principle of vibration absorber of the system shown in figure Q6(b). (10 Marks)

7 Find the natural frequency of the system shown in figure Q7. Use Dunkerley's method. (20 Marks)

8 Find the natural frequency of the system shown in figure Q8. Use Holzers method. (20 Marks)

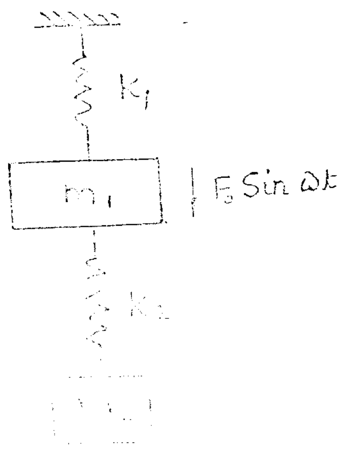

Fig. Q6(b)

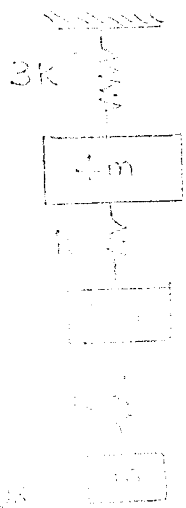

Fig. Q8

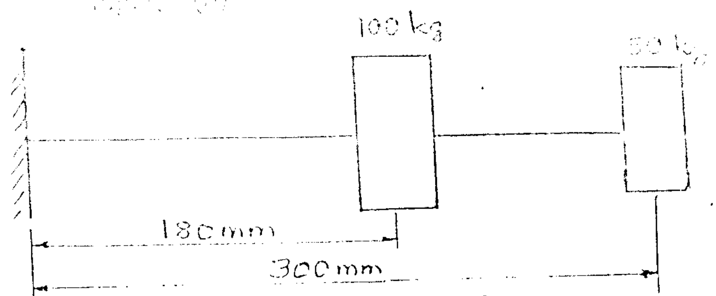

Fig. Q7

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ME65

USN

NEW SCHEME

Sixth Semester B.E. Degree Examination, July 2007
Mechanical Engineering
Mechanical Vibrations

Time: 3 hrs.] [Max. Marks:100

Note : ***Answer any FIVE full questions.***

1 a. Represent the periodic motion given by following Fig.1(a) by harmonic series. **(10 Marks)**

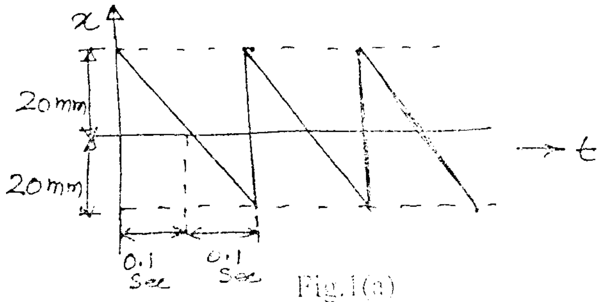

Fig.1(a)

b. Derive the wave equation for string in lateral vibrations. Obtain general expression for the lateral vibration of string. **(10 Marks)**

2 a. For the system shown in Fig.2(a) determine equivalent stiffness and equivalent momentum. The downward displacement (x) of the block is measured from systems equilibrium position. Also find an expression for natural frequency of free vibration. **(10 Marks)**

b. A homogeneous solid cylinder of mass 'm' and radius 'r' is connected to a spring as shown in Fig.2(b). Find the expression for natural frequency of oscillation of cylinder using Newton's method. Consider cylinder rolls without slipping. **(10 Marks)**

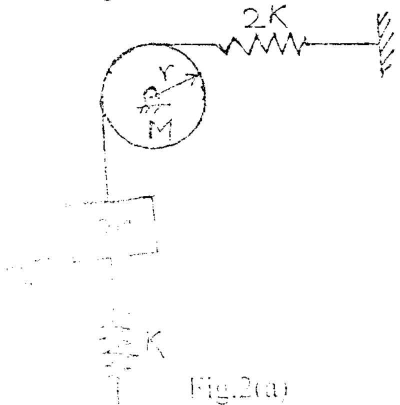

Fig.2(a)

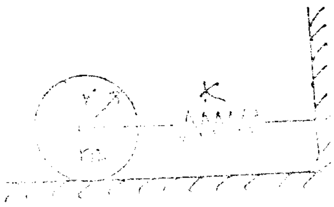

Fig.2(b)

3 a. For the system shown in Fig.3(a) determine : i) Undamped natural frequency ii) Damped natural frequency iii) Logarithmic decrement iv) If mass is initially at rest and given a velocity of 10 cm/sec, then calculate the amplitude of vibration after 5 oscillations. **(10 Marks)**

b. Obtain the condition for the system shown in Fig.3(b) to vibrate. **(10 Marks)**

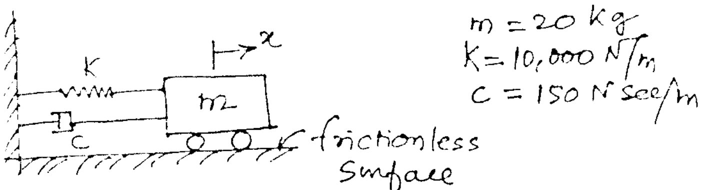

Fig. Q3(a)

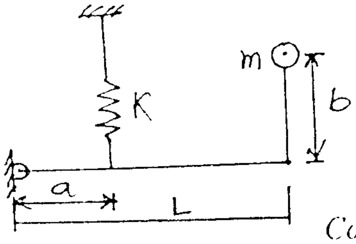

Fig.3(b)

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4 a. A 40 kg fan has a rotating un-balance of magnitude 0.1 kg-m. The fan is mounted on a beam as shown in Fig.4(a). Find the steady state amplitude of the fan when it operates at 1000 rpm. The beam is specially treated to add viscous damping of $\xi = 0.0617$.

$$E = 200\times10^9\ N/m^2; \quad I = 1.3\times10^{-6}\ m^4$$

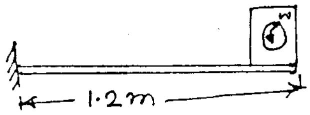

Fig.4(a) (10 Marks)

b. A 35 kg block is connected to a support through a spring of stiffness 1.4×10^5 N/m in parallel with dashpot of damping coefficient 1.8×10^3 N.sec/m. The support is given a harmonic displacement of amplitude 10mm at a frequency of 35Hz. Compute the steady state amplitude of the absolute displacement of the block. (10 Marks)

5 a. Discuss general theory of seismic instruments and obtain the condition for using it as a vibrometer. (08 Marks)

b. A seismic instrument has natural frequency of 6 Hz. What is the lowest frequency beyond which the amplitude can be measured within 2% error? Neglect damping. (06 Marks)

c. A power transmitting shaft has diameter of 30 mm and 900 mm long, and simply supported. The shaft carries a rotor of 4 kg at its mid-span. The rotor has an eccentricity of 0.5 mm. Calculate the critical speed of shaft and deflection of the shaft at its mid-span when shaft rotates at 1000 rpm. Neglect mass of shaft. For shaft material $E = 2\times10^5$ MPa. (06 Marks)

6 a. Derive the differential equations of motion for small oscillation of the pendulum as shown in Fig.6(a). Assume rods are rigid and of negligible mass. (10 Marks)

b. For the system shown in Fig.6(b) obtain the equations of motion. Also obtain the condition for system not to have elastic coupling. (10 Marks)

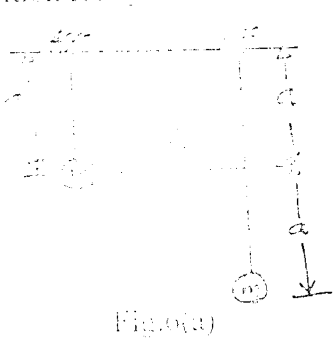

Fig.6(a)

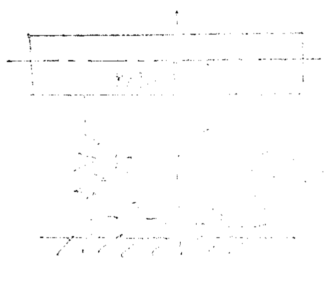

Fig.6(b)

7 Find the natural frequencies of the system shown in Fig.7 by Holzer's method.

$J_1 = 400$, $J_2 = 800$, $J_3 = 1200$ kg.m^2 (20 Marks)

$K_{t_1} = 1\times10^6$, $K_{t_2} = 2\times10^6$, $K_{t_3} = 3\times10^6$ N.m/rad

8 Find the first two natural frequencies and modal vectors of system shown in Fig.8. Also draw mode shapes. (20 Marks)

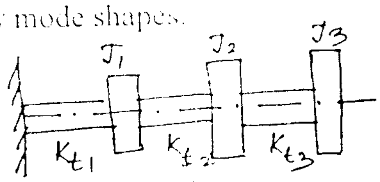

Fig. Q7

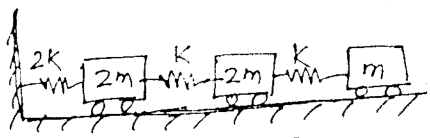

Fig. Q8

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Sixth Semester B.E. Degree Examination, Dec. 07 / Jan. 08

Mechanical Vibrations

Time: 3 hrs. Max. Marks:100

Note : *Answer any FIVE full questions.*

1 a. Determine the natural frequency of a simple spring – mass system by –
i) Newton's method, ii) Energy method, iii) Rayleigh's method. **(09 Marks)**

b. Determine the natural frequency of the system shown in Fig. Q 1(b) by energy method. **(11 Marks)**

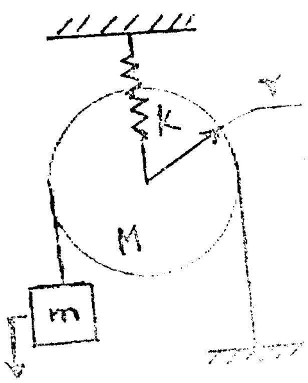


Fig. Q 1(b)

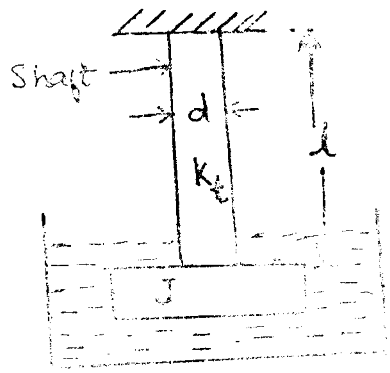


Fig. Q 2(b)

2 a. Discuss the response of –
i) Under-damped ii) critically damped and iii) over damped systems, using respective response equations and curves. **(09 Marks)**

b. For the torsional pendulum shown in Fig. Q 2(b), if the observed amplitudes on the same side of the neutral axis for successive cycles are found to decay 50% of the initial value, determine –
i) Logarithmic decrement, ii) Damping torque per unit velocity, iii) The periodic time of vibration, iv) The frequency when the disc is removed from other fluid.
$J = 0.05\ kg - m^2$, $G_{shaft} = 4.5 \times 10^{10}\ N/m^2$, $d = 0.10\ m$, $l = 0.50\ m$. **(11 Marks)**

3 a. Draw the frequency [illegible] for [illegible] ratio) for different damping [illegible] amplitude. [illegible]

b. The springs of an automobile trailer are compressed 0.1 m under its [illegible] critical speed when the trailer is traveling over a road with a profile approximated by a sine wave of amplitude 0.0[illegible] m and wave length 14 meters. What will be the amplitude of vibration at 60 km/hr? **(08 Marks)**

4 a. With a neat schematic diagram, explain seismic instrument as –
i) a vibrometer ii) an accelerometer. **(12 Marks)**

b. A rotor having a mass of 5 kg is mounted midway on a shaft of 10 mm diameter, supported at the ends by two bearings. The bearing span is 400 mm. The CG of the disc is 0.02 mm away from the geometric centre of the rotor. If the shaft rotates at 3000 rpm, find the amplitude of steady state vibrations and the dynamic force transmitted to the bearings. Neglect damping. Take $E = 1.96 \times 10^{11} N/m^2$. $K = \frac{48EI}{l^3}$ **(08 Marks)**

5 a. **Determine the equations of motion and the natural frequencies of the two–degree–of–freedom spring – mass system shown in Fig. Q 5(a).**

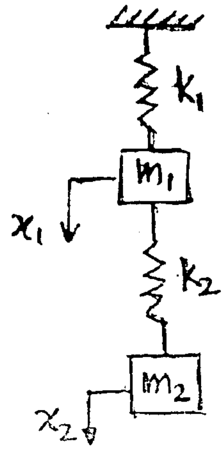


Fig. Q 5(a)

([illegible])

b. Explain the principle of dynamic vibration absorber. ([illegible])

6 Using Stodola method, determine the lowest natural frequency of the four degree – of – freedom spring –mass system shown in Fig. Q 6.

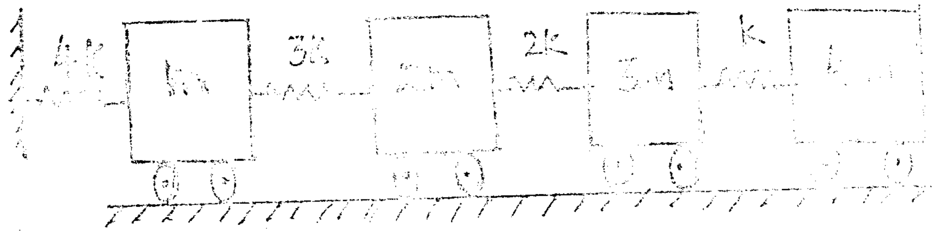
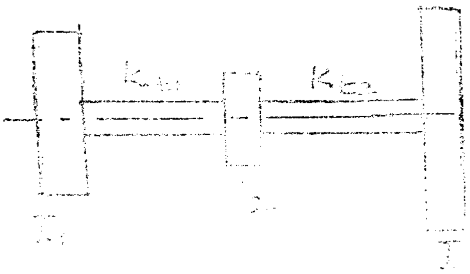


Fig. Q 6 ([illegible])

7 Using Holzer's method, find the natural frequencies of the system shown in Fig. Q 7. Assume $I_1 = I_2 = I_3 = 1$ unit and $K_{t_1} = K_{t_2} = 1$ unit.



8 a. [illegible]

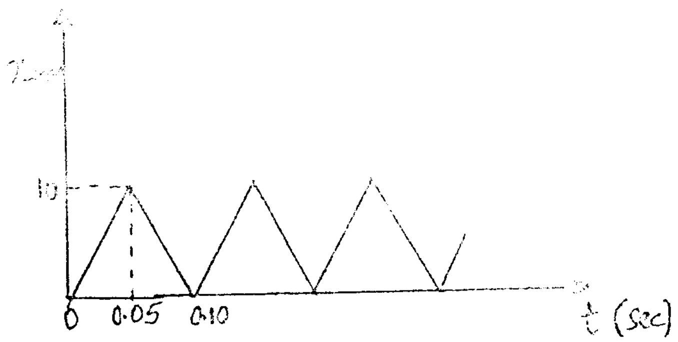


Fig. Q 8(a)

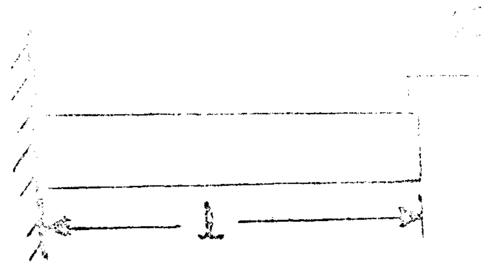


Fig. Q 8(b)

b. Derive suitable mathematical expression for longitudinal vibrations of a bar of uniform cross – section as shown in Fig. Q 8(b). **(10 Marks)**

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USN

06ME62

Sixth Semester B.E. Degree Examination, June-July 2009
Mechanical Vibrations

Time: 3 hrs. Max. Marks:100

Note: ***1. Answer any FIVE full questions, selecting at least TWO questions from each part.***
2. Assumptions if made should be stated explicitly.

PART – A

1 a. Add the following motions analytically and check the solution graphically.
$x_1 = 4\text{Cos}(wt + 10^o)$
$x_2 = 6\ \text{Sin}(wt + 60^o)$ **(10 Marks)**

b. Represent the periodic motions given by following Fig.Q.1(b) by harmonic series. **(10 Marks)**

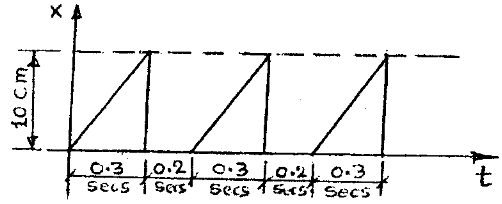


Fig.Q.1(b).

2 a. A cylinder of mass m and mass moment of inertia Jo rolling without slipping but restrained by two linear springs of stiffness k_1 and k_2 as shown in Fig.Q.2(a). Determine:
i) The natural frequency of vibration of the system
ii) The value of "a" for which the natural frequency is maximum. **(10 Marks)**

b. Determine the natural frequency of oscillation of the system shown in Fig.Q.2(b) where the mass less rigid bar is hinged at O.

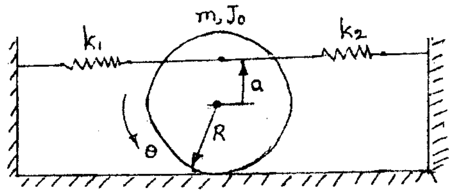


Fig.Q.2(a).

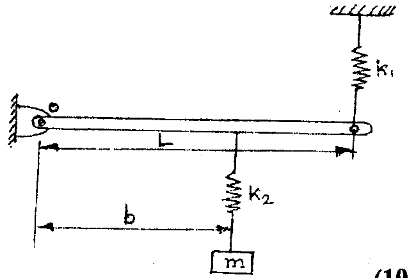


Fig.Q.2(b). **(10 Marks)**

3 a. Set up the differential equation for a spring mass damper system and obtain the complete solution for the under damped condition. **(10 Marks)**

b. A simple pendulum is pivoted at point O as shown in Fig.Q.3(b). Assuming small oscillations and neglecting the mass of the rod, find the damped natural frequency of the pendulum. **(10 Marks)**

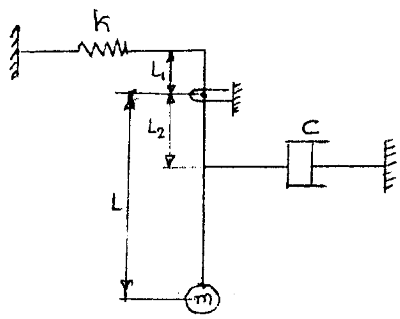


Fig.Q.3(b).

4 a. A 54 N weight is suspended by a spring with a stiffness of 1100 N/m. It is forced to vibrate by a harmonic force of 5 N. Assuming a viscous damping of C = 77 N-s/m, find

i) The resonant frequency.
ii) The amplitude at resonance
ii) The phase angle at resonance
iv) The damped natural frequencies
v) The frequency at which maximum amplitude of vibration occurs. **(10 Marks)**

b. Derive an expression for the transmissibility and transmitted force for a spring mass damper system subjected to external excitation. **(10 Marks)**

PART - B

5 a. Explain the principle of "Seismic" instrument and indicate how it can be used to measure displacement and acceleration of a vibrating body. **(10 Marks)**

b. A rotor has a mass of 12 kg and is mounted midway on a 24 mm diameter horizontal shaft supported at the ends by two bearings. The bearings are 1m apart. The shaft rotates at 2400 rpm. If the centre of mass of the rotor is 0.11mm away from the geometric centre of the rotor due to a certain manufacturing inaccuracies, find the amplitude of the steady state vibration and the dynamic force transmitted to each bearing. Take E = 200 GPa. **(10 Marks)**

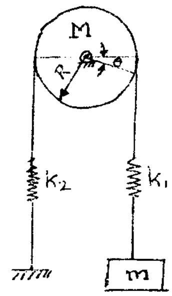
6 a. Derive the frequency equation for the Pulley – mass system shown in Fig.Q.6(a). The pulley has a mass of M and effective radius of R. Assume that the cord, which passes over the pulley, does not slip. If k_1 = 60 N/m, k_2 = 40 N/m, m = 2kg and M = 10 kg. Determine the natural frequencies and mode shapes. **(14 Marks)**

b. Explain the principle of dynamic vibration absorber? What is the main disadvantage of such an absorber? **(06 Marks)**

7 a. The governing equation of lateral vibration of beam is $\frac{\partial^2 y}{\partial t^2} + a^2 \frac{\partial^4 y}{\partial x^4} = 0$ where, $a = \sqrt{\frac{EI}{PA}}$ obtain a general solution for the governing differential equation. **(10 Marks)**

b. Find the natural frequency of vibration for the system shown in Fig.Q.7(b) by the Dunkerley's method. Take E = 1.96×10^{11} N/m^2 and I = 4×10^{-7} m^4. **(10 Marks)**

Fig.Q.6(a).



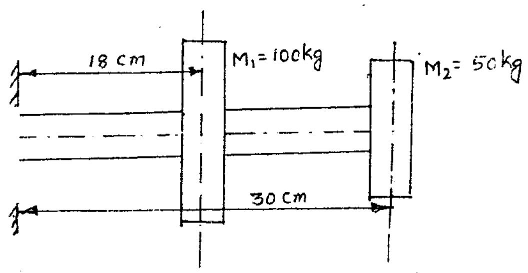
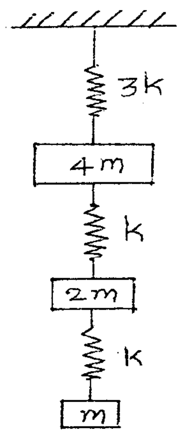


Fig.Q.7(b).

8 a. Write a note on influence coefficients. **(05 Marks)**

b. Find the natural frequency of the system shown in Fig.Q.8. Use Holzers method. **(15 Marks)**

Fig.Q.8(b)



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06ME62

Sixth Semester B.E. Degree Examination, Dec.09/Jan.10
Mechanical Vibrations

Time: 3 hrs. Max. Marks:100

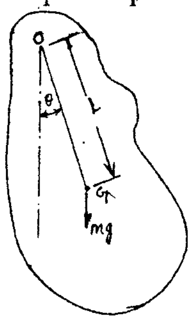
Note: *1. Answer any FIVE full questions.*
2. Assume suitable data if necessary.

1 a. Define the following terms :
i) Simple harmonic motion ; ii) Resonance ; iii) Degree of freedom. **(06 Marks)**

b. Add the following motion analytically and find the amplitude and phase angle.
x1 = 2 Cos (wt + 0.5)
x2 = 5 Sin (wt + 1.0) **(06 Marks)**

c. Find the time period of vibration of a compound pendulum, shown in Fig.1(c). **(08 Marks)**

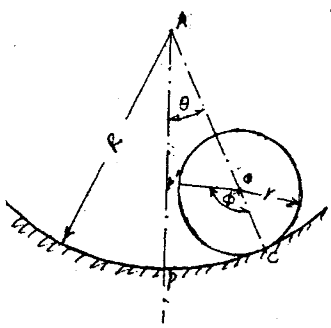
Fig.1(c)



2 a. Define "Logarithmic decrement" and show that it can be expressed as $\delta = \frac{1}{n} \ln \left(\frac{x_o}{x_n}\right)$ where
n is the number of cycles
x_o initial amplitude
x_n amplitude after 'n' cycles. **(08 Marks)**

b. A cylinder of mean 'M' and radius 'r' rolls without slipping on a cylindrical surface of radius 'R' as shown in Fig.2(b). Find the natural frequency for small oscillations about the lowest point. **(12 Marks)**

Fig.2(b)



3 a. Define the term "Transmissibility". Derive the expression for 'Motion transmissibility'. **(08 Marks)**

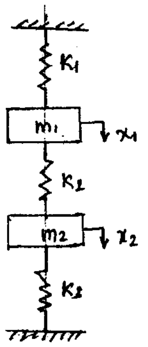
b. A 75 kg machine is mounted on springs of stiffness K = 11.76 x 10^5N/m with an assumed damping factor of $\xi = 0.2$. A 2kg piston within the machine has a reciprocating motion with a stroke of 0.08m and a speed of 300 c.p.m. Assuming the motion of the piston to the harmonic, determine the amplitude of vibration of the machine and the vibration force transmitted to the foundation. **(12 Marks)**

4 a. Discuss the basic principle on which vibration measuring instruments are designed. What are their practical limitations? **(08 Marks)**

b. A disc of mass 4kg is mounted midway between bearings which may be assumed to be simple supports. The bearing span is 480mm. The steel shaft, which is horizontal is 9mm in diameter. The CG of the disc is displaced 3mm form the geometric centre. The equivalent viscous damping at the centre of the disc-shaft may be taken as 49 N sec/m. If the shaft rotates at 760 rpm, find the maximum stress in the shaft and compare it with dead load stress in the shaft. Also, find the power required to drive the shaft at this speed. **(12 Marks)**

5 a. Set up the differential equation of motion for the system shown in Fig.5(a) and hence derive the frequency equation and obtain the two natural frequencies of the system. Sketch the mode shapes. **(12 Marks)**

Fig.5(a)



b. A section of pipe pertaining to a certain machine vibrates with large amplitude at a compressor speed of 220 rpm. For analyzing this system, a spring – mass system was suspended from the pipe to act as an absorber. A 1kg absorber mass tuned to 220 cpm resulted in two resonant frequencies of 188 and 258 cpm. What must be the mass and the spring stiffness of the absorber, if the resonant frequencies are to lie outside the range of 150 and 310 cpm? **(08 Marks)**

6 a. Show that the differential equation of motion for the transverse vibration for simply supported beam of uniform cross nation is given by $\frac{\partial^2 y}{\partial t^2} + a^2 \frac{\partial^4 y}{\partial x^4} = 0$. **(12 Marks)**

b. Write notes on:
i) Longitudinal vibration of bars ; ii) Torsional vibration of circular shaft. **(08 Marks)**

7 For a three degree of freedom system shown in Fig.7, find the lowest natural frequency by Stodola's method. **(20 Marks)**

8 Calculate all the natural frequencies of a three rotor system shown in Fig.8 by Holzer's method.
Take $J_1 = J_2 = J_3 = 1$ and
$Kt_1 = Kt_2 = 1$ **(20 Marks)**

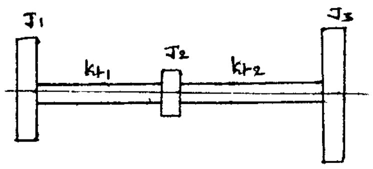


Fig.8

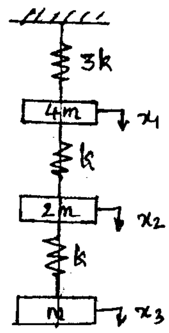


Fig.7

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06ME62

Sixth Semester B.E. Degree Examination, May/June 2010
Mechanical Vibrations

Time: 3 hrs. Max. Marks:100

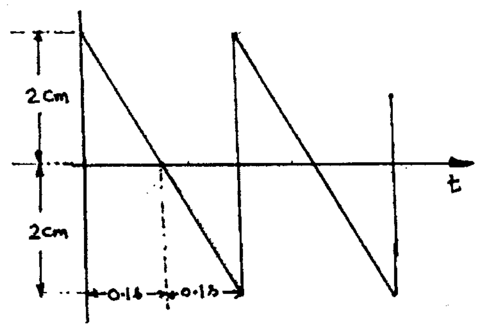
Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Differentiate between : i) Linear and non linear vibrations ; ii) Deterministic and random vibrations. **(04 Marks)**

b. A periodic motion observed on the oscilloscope is shown in Fig.1(b). Represent this motion by harmonic series. **(10 Marks)**

Fig.1(b)



c. Determine the resultant of the following harmonic motions analytically $x_1 = 3 \sin(wt + \pi/3)$ and $x_2 = 5 \sin(wt + 2\pi/3)$. **(06 Marks)**

2 a. Determine the natural frequency of spring – mass sytem taking the mass of the spring in to account. **(10 Marks)**

b. A cylinder of radius r rolls without slipping on a cylindrical surface of radius R as shown in Fig.2(b). Derive the equation for natural frequency of small oscillaitons about the lowest point. Use energy method. **(10 Marks)**

Fig.2(b).

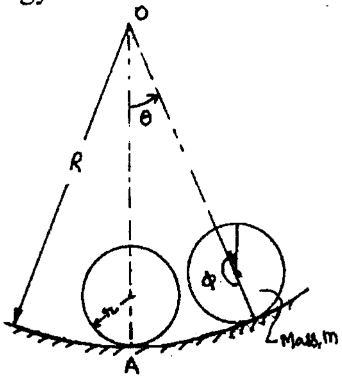
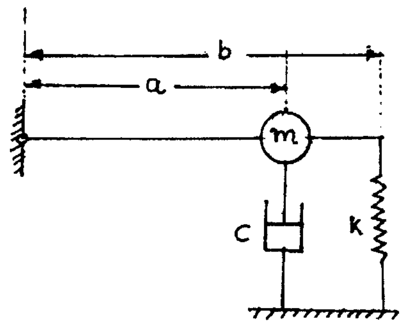


Fig.3(b).



3 a. Write the differential equation of motion for the system shown in Fig.3(a). Determine : i) Undamped natural frequency ; ii) Critical damping coefficient ; iii) Damping ratio ; iv) Damped natural frequency. **(10 Marks)**

b. In a single degree damped vibrating system, a suspended mass of 18 kg makes 10 oscillations in 8 seconds. The amplitude decreases to 25% of the initial value after 5 cycles. Determine : i) Damped natural frequency ; ii) Logarithmic decrement ; iii) Undamped natural frequency ; iv) Spring constant ; v) Damping coefficient. **(10 Marks)**

4 a. A mass of 6.12 kg, suspended by a spring of stiffness 1.2 kN/m, is forced to vibrate by a harmonic force of 10N. Assume viscous damping of 86 Ns/m. Find :
i) Frequency at resonance ; ii) Amplitude at resonance ; iii) Phase angle at resonance ; iv) Frequency corresponding to peak amplitude ; v) Peak amplitude. **(10 Marks)**

b. A machine of mass 75 kg is mounted on springs of stiffness 12 kN/cm with an assumed damping factor 0.2. A piston within the machine of mass 2 kg has a reciprocating motion with a stroke of 7.5 cm and a speed 50 Hz. Assuming the motion of the piston to be harmonic, determine : i) Amplitude of the machine ; ii) Transmissibility ; iii) Force transmitted to the foundation ; iv) The phase angle of the transmitted force with respect to the exciting force. **(10 Marks)**

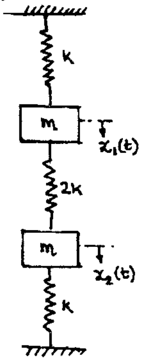
PART – B

5 a. Explain the working principle of vibrometer, with their range of frequency of operation. **(08 Marks)**

b. A disc of mass 4 kg is mounted on a shaft midway between bearings which may be assumed to be simple supports. The bearing span is 0.5m. The steel shaft is horizontal and is 1 cm in diameter. The centre of gravity of the disc is displaced 3 mm from the geometric centre. The equivalent viscous damping may be taken as 49 N.s/m. If the shaft rotates at 800 rpm, find the maximum stress in the shaft and compare it with dead load stress in the shaft. Also find the power required to drive the shaft. Take $E = 2 \times 10^{11} N/m^2$. **(12 Marks)**

6 a. For the system shown in Fig.6(a), determine : i) Equation of motion ; ii) Natural frequencies ; iii) Normal modes of the system. **(08 Marks)**

Fig.6(a)



b. What is a dynamic vibration absorber? Show that for such a system, it's natural frequency should be equal to the frequency of the applied force. **(12 Marks)**

7 a. Determine the fundamental natural frequency of the system shown in Fig.7(a) by Stodola method. **(10 Marks)**

Fig.7(a)

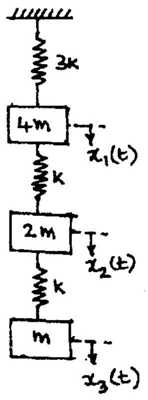
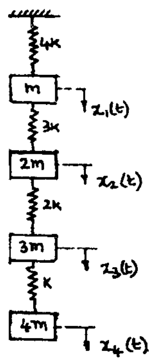


Fig.7(b)



b. Determine the fundamental natural frequency of the system shown in Fig.7(b) by Dunkerleys equation. **(10 Marks)**

8 a. Derive the equation governing the longitudinal vibrations of the bar and obtain the general solution of the differential equation derived above. **(10 Marks)**

b. Derive suitable expression for longitudinal vibrations for a rectangular uniform cross sectional bar of length *l* fixed at one end and free at the other end. **(10 Marks)**

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