Dec 2006 Paper

[Total No. of Questions : 12]

P989 [3064]-413

B.E. (Mech. & Mech. S/W)

DYNAMICS OF MACHINERY

(2003 Course)

[Time : 3 Hours] ***[Max. Marks : 100]***

Instructions to the candidates :

1. ***Answer 3 questions from Section I and 3 questions from Section II.***
2. ***Answers to the two sections should be written in separate books.***
3. ***Neat Diagrams must be drawn wherever necessary.***
4. ***Use of logarithmic tables, slide rule, Mollier charts, electronic pocket calculator and steam tables is allowed.***
5. ***Assume suitable data, if necessary.***

SECTION - I

Unit - 1

Q1). a) Explain the effect of gyroscopic couple on a swinging table fan. **[4]**

b) A four wheel trolley car has a total mass of 3000 kg. Each axle with its two wheel and gears has a total moment of inertia of 32 kg-m^2. Each wheel is of 450 mm radius. The centre distance between the two wheels on the axle is 1.4 m. Each axle is driven by a motor with a speed ratio of 1 : 3. Each motor along with its gear has a moment of inertia of 1.6 kg-m^2 and rotates in the opposite direction to that of the axle. The centre of mass of the car is 1 m above the rails. Calculate the limiting speed of the car, when it has to travel around a curve of 240 m radius without the wheels leaving the rails. **[12]**

OR

Q2). a) Explain the following terms related to Gyroscope **[4]**

i) Spinning in Gyroscope.
ii) Precession in Gyroscope.
iii) Applied Gyroscopic couple.
iv). Reactive Gyroscopic couple.

b) An aeroplane is flying at 200 km/hr. It turns towards the left and completes a quarter circle of 50 m radius. The mass of rotary engine and the propeller of the aeroplane is 425 kg and has a radius of gyration of 300 mm. The engine speed is 2000 rpm clockwise, when seen from the tail.

Determine the gyroscopic couple on the aeroplane and explain its effect with the help of neat diagrams. What would be the effect, if the aeroplane was to take a right turn, instead of left ?

Also explain the effect, if the aeroplane performs a loop in the vertical plane. **[12]**

Unit - 2

Q3). The six cylinders of a single acting, two stroke cycle diesel engine are pitched 1 m apart and the cranks are spaced at 60^o intervals. The crank length is 300 mm and the ratio of

connecting rod to crank is 4.5. The reciprocating mass per line is 1350 kg and the rotating mass is 1000 kg. The speed is 200 rpm. Show with regard to primary and secondary balance that the firing order 1-5-3-6-2-4 gives unbalance in primary moment only and the order 1-4-5-2-3-6 gives secondary moment unbalance only.

Compare the maximum values of these moments, evaluating with respect to the central plane of the engine. **[16]**

OR

Q4). a) With the help of neat sketch, explain the working of dynamic balancing machine. **[6]**

b) A three cylinder radial engine has cylinders located 120^{o} from neighbouring cylinder. Reciprocating mass of each cylinder is 1.2 kg. Length of crank is 75 mm and each connecting rod is 250 mm long. Find out maximum primary and secondary unbalance forces, if the engine runs at 2500 rpm.

Use the concept of direct and reverse crank. **[10]**

Unit - 3

Q5). a) The mass 'm' is hanging from a chord attached to the circular homogeneous disc of mass 'm' and radius 'R' as shown in Fig. 1. The disc is restrained from rotating by a spring attached at radius 'r' from the centre. If the mass is displaced downwards from rest position, determine the frequency of oscillations. **[6]**

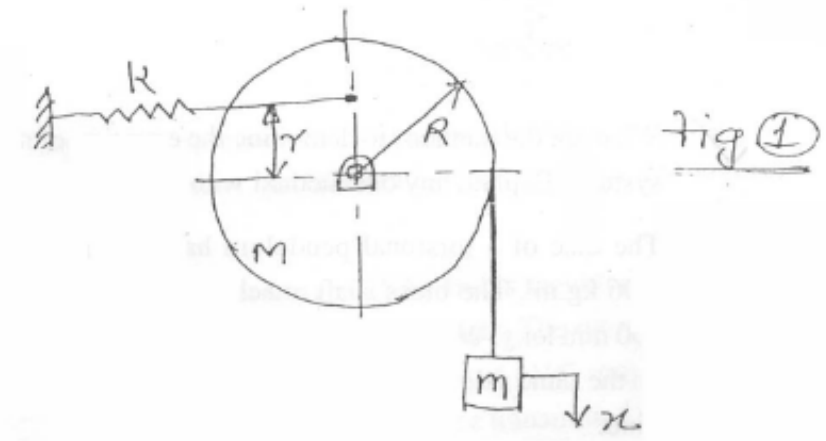


fig (1)

b) Explain the following terms with reference to free vibrations **[4]**

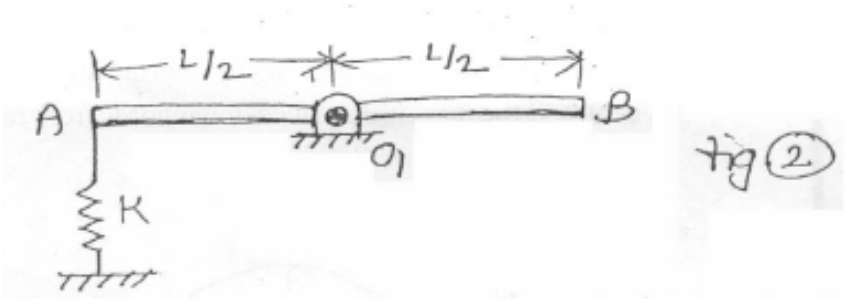
i). Critical damping coefficient.
ii). Overdamped system.
iii). Damping factor.
iv). Logarithmic decrement.

c) An underdamped shock absorber is to be designed for a motorcycle of mass 200 kg such that during a road bump, the damped period of vibration is limited to 2 secs and the amplitude of vibration should reduce to one-sixteenth in one cycle.
Find :

i). Spring stiffness.
ii). Damping coefficient of shock absorber. **[8]**

OR

Q6) a) A uniform rod of mass 'm' is supported as shown in Fig. 2. Determine the frequency of the resulting motion. **[6]**



b) What are the methods to determine the equation of motion for vibratory system ? Explain any one method with example. **[4]**

c) The disc of a torsional pendulum has a mass moment of inertia of 0.06 kg m^2. The brass shaft attached to it is of 100 mm diameter and 400 mm long. When the pendulum is vibrating, the observed amplitudes on the same side of the rest position for successive cycles are 9^o, 6^o and 4^o. Find :

i). Logarithmic decrement.
ii). Damping torque at unit velocity.
iii). Periodic time of vibration. Assume modulus of rigidity as 4.4×10^{10} N/m^2.
iv). What would the frequency be, if the disc is removed from viscous fluid ? **[8]**

SECTION - II
Unit - 4

Q7) A machine weighing 100 kg is supported on 4 springs. It has 80 mm stroke and it runs at 1000 rpm. If the springs are symmetrically placed with respect to CG of the machine, find neglecting damping, the combined stiffness of the springs in order that the force transmitted to the foundation is 1/25 times the impressed force. It is found that the damping, however small, reduces the amplitude of successive vibrations by 25%. Under this condition, find :

i). Force transmitted to foundation at 1000 rpm.
ii). Force transmitted to foundation at resonance.
iii). The amplitude of vibration at resonance, if weight of the reciprocating parts is 2 kg. **[18]**

OR

Q8) a) Derive the expression for determining the dynamic amplitude of vibration for a steady state forced vibration having an excitation force $F_0 \sin(\omega t)$. **[10]**

b) An electric motor weighs 25 kg and is mounted on a rubber pad which deflects by 1 mm due to motor weight. The rotor weighs 5 kg and has an eccentricity of 0.1 mm and rotates at 1500 rpm. Find the amplitude of vibration of the motor and the force transmitted to the foundation under the following conditions : **[8]**

i) There is no damping.
ii) Damping factor = 0.1

Unit - 5

Q9) A motor generator set consists of two armatures 'A' and 'C', as shown in Fig. 3, with a flywheel 'B' connected between them. The modulus of rigidity of the connecting shaft is 84×10^9 N/m^2. The system can torsionally vibrate with one node at x = 95 mm from 'A' the flywheel being at antinode. Find :

i). The position of the another node.

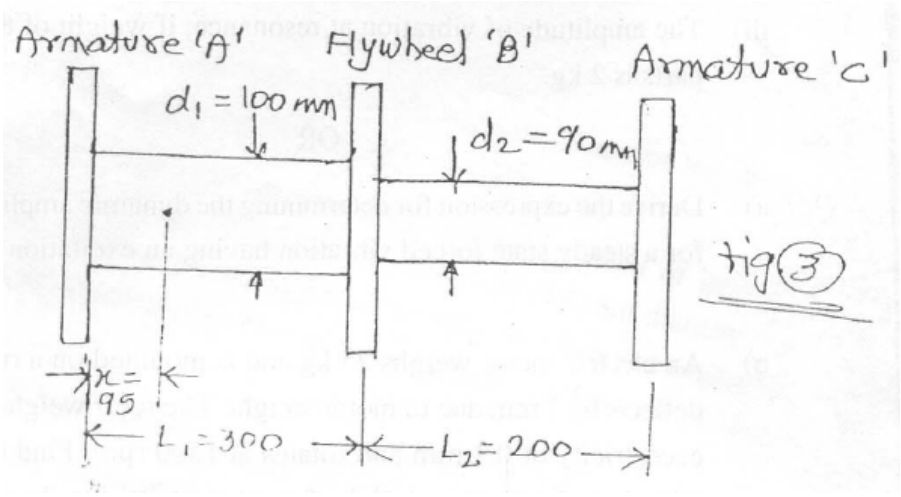
ii). The natural frequency of vibration.

iii). The radius of gyration of armature 'C'.

Use the following data.

Masses : M_A = 400 kg, M_B = 500 kg, M_C = 300 kg.

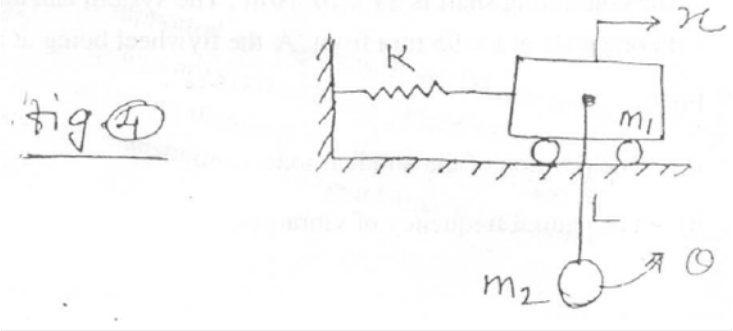
Radius of gyration : K_A = 300 mm, K_B = 375 mm. **[16]**



OR

Q10) a) What do you understand by a semi-definite or degenerate system ? Give two examples of systems that are degenerate ? **[6]**

b) Determine the natural frequencies and amplitude ratios for the system shown in Fig. 4. The pendulum rod is pivoted in the mass m_1. **[10]**



Unit - 6

Q11) a) Explain with neat diagrams any two of the following. **[10]**

i) FFT spectrum Analyser.

ii) Vibration model of seismic pickup.

iii) Single reed frequency meter.

b) A shaft of length of 0.75 m supported freely at the ends is carrying a body of weight 90 N at 0.25 m from one end. Find the natural frequency of transverse vibration. Assume E = 200 GN/m^2. The shaft diameter is 0.05 m. **[6]**

OR

Q12) a) Explain the whirling of vertical shaft carrying a single rotor without damping and show that the deflection of the shaft is given by the following expression. **[8]**

$$y = \frac{\left(\frac{\omega}{\omega_n}\right)^2 e}{\left[1 - \left(\frac{\omega}{\omega_n}\right)^2\right]}$$

Draw suitable diagram.

b) Explain the working principle of : **[8]**

i) Vibrometer
ii) Accelerometer
iii) Frequency meter
iv) Seismic instrument.

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