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Question Paper Code : X10704

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2020 AND APRIL/MAY 2021

Fourth/Fifth Semester

Mechanical Engineering

ME 8594 – DYNAMICS OF MACHINES

(Common to Mechanical Engineering (Sandwich)/Mechatronics Engineering)

(Regulations 2017)

Time : Three Hours — Maximum : 100 Marks

Answer ALL questions

Use of Drawing sheet is Permitted.

PART – A **(10×2=20 Marks)**

1. Define the coefficient of fluctuation of speed.

2. Write the equation for inertia force due to reciprocating parts in IC engine.

3. Define swaying couple in partial balancing of locomotive engines.

4. What is dynamic balancing of rotating shaft ?

5. A vibrating system has the mass as 3 kg , stiffness as 100 N/m and damping coefficient of 3 Ns/m. Calculate the damping factor in the system.

6. List the applications of critically damped systems.

7. Give the general equation of forced vibration of a mechanical system.

8. List the requirements of Isolators.

9. What is controlling force diagram in a governor ?

10. Define pitching in ships.

PART – B **(5×13=65 Marks)**

11. a) The lengths of crank and connecting rod of horizontal steam engine are 300 mm and 1.2 m respectively. When the crank has moved 30° from the inner dead center, the acceleration of piston is 35 m/s^2. The average frictional resistance to the motion of piston is equivalent to a force of 500 N and net effective steam pressure on piston is 500 kN/m^2. The diameter of the piston is 0.3 m and mass of reciprocating parts is 160 kg. Determine
   - Reaction on the cross-head guides
   - Thrust on crank shaft bearing
   - Torque on the crank shaft.

(OR)

b) The turning moment diagram for a four stroke gas engine is represented by four triangles. The area form line of zero pressure are as follows : 1. Suction stroke 350 mm^2 2. Compression stroke 1400 mm^2 3. Expansion stroke 3550 mm^2 4. Exhaust stroke 500 mm^2. Each mm^2 represents 3N-m. Assuming the resisting moment to be uniform, find the mass of rim of flywheel required to keep the mean speed as 200 rpm within ±2%. The mean radius of the rim may be taken as 0.75 m. Also determine the crank position for maximum and minimum speeds.

12. a) A shaft has five masses m_1, m_2, m_3, m_4 and m_5 which revolves with same radius in planes which are equidistant from one another. The magnitudes of masses in planes 1,3 and 4 are 50 kg, 40 kg and 80 kg respectively. The position of masses 3 and 4 with respect to mass 1 are 60° and 120° respectively. Determine the weight in planes 2 and 5 and their positions with respect to plane in order to put the shaft in completely rotary balanced.

(OR)

b) The following particulars relate to an inside cylinder uncoupled locomotives

Rotating mass per cylinder	200 kg
Reciprocating mass per cylinder	240 kg
Angle between cranks	90°
Stroke length	0.5 m
Cylinder centres apart	0.8 m
Wheel centres apart	1.7 m

The whole of the rotating and two-third of reciprocating masses are balanced by masses at a radius of 0.6 m. Find the magnitude and angular position of balancing masses.

13. a) A shaft is simply supported at its ends and is of 40 mm in diameter and 2.5 m in length. The shaft carries three point loads of masses 30 kg, 70 kg and 45 kg at 0.5 m, 1 m, and 1.7 m respectively from the left support. The weight

of the shaft per meter length is given as 73.6 N. The Young's modulus for material of the shaft is 200 GN/m^2. Calculate the critical speed of shaft.

(OR)

b) A single cylinder oil engine directly drives a centrifugal pump. The rotating mass of engine, flywheel and the pump with the shaft is equivalent to a three rotor system as shown in Figure 1. The mass moments of inertia of the rotors P, Q, R are 0.2, 0.4 and 0.1 kgm^2. Find the natural frequency of torsional vibrations. The modulus of rigidity of the shaft material is 80 GN/m^2.

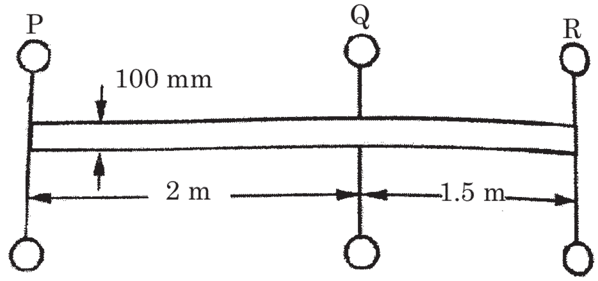

Figure 1

14. a) A weight attached to a spring of stiffness 6 N/cm has a viscous damping device when the weight was displaced and released, the period of vibration was found to be 1.8 sec and the ratio of consecutive amplitude was 4.2 : l. Determine the amplitude and the phase angle when a force F = 0.4 cos 3t acts on the system.

(OR)

b) A single cylinder engine at total weight 2 kN has to be mounted on the elastic support which permits vibrating movement in vertical directions only. The piston weights 35 N and has a vertical reciprocating motion which may be assumed simple harmonic with a stroke of 150 mm. It is desired that the maximum vibrating force transmitted through the elastic support to the foundation shall be 600 N , when the engine speed is 800 rpm and less than this at all higher speeds.

- Determine the necessary stiffness of the elastic support and the amplitude of vibrations at 800 rpm.
- If the engine speed is reduced below 800 rpm, at what speed, will the transmitted force again become 600 N.

15. a) A rear engine automobile is travelling along a curved track of 120 m radius. Each of the four wheels has a moment of inertia of 2.3 kg-m^2 and an effective diameter of 600 mm. The rotating parts of the engine have a moment of inertia of 1.25 kg-m^2. The gear ratio of the engine to the back wheel is 3.2. The engine axis is parallel to the rear axle and the crankshaft rotates in the same sense as the road wheels. The mass of the vehicle is 2500 kg and the centre of mass 520 mm above the road level. The width of the track is 1.6 m.

What will be the limiting speed of the vehicle of all four wheels maintains contact with the road surface.

(OR)

b) In a spring loaded governor of the Hartnell type, the weight of each ball is 50 N and the sleeve lift is 50 mm. The governor begins to float at 240 rpm when its radius is 110 mm. The mean speed of the governor is 20 times the range of speed when the friction is neglected. The lengths of the ball and roller arms are 12 and 10 cms. Distance of the pivot of bell crank lever from governor axis is 14 cm. Find the initial compression on the spring, taking into account of the obliquity of the arms.

PART – C **(1×15=15 Marks)**

16. a) The time period of free vibration of a mass hung from the end of a helical compression spring is 0.8 seconds. When the mass is stationary, the upper end is made to move upwards with displacement y millimeters given by

$y = 18 \sin 2\pi t$

where t is the time in seconds measured from the beginning of the motion.

Neglecting the mass of spring and damping effects, determine the vertical distance through which the mass is moved in the first seconds.

(OR)

b) A vertical petrol engine 100 mm diameter and 125 mm stroke has a connecting rod 250 mm long. The weight of the piston is 12 N. The speed is 2000 rpm. On the expansion stroke, with a crank 20° from the top dead centre, the gas pressure is 700 kN/mm^2. Determine

- Net Load on the piston
- Net load on gudgeon pin
- Crank piston effort
- Thrust on the cylinder walls
- Speed above which other things remaining same, the gudgeon load would be reversed in direction.

Solve the problem graphically and compare with analytically.