Reg. No. :

Question Paper Code : X 20845

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2020
Fourth/Fifth Semester
Mechanical Engineering
ME 6505 – DYNAMICS OF MACHINES
[Common to Mechanical Engineering (Sandwich)/Mechatronics Engineering)
(Regulations 2013)
(Also Common to PTME 6505 – Dynamics of Machine for B.E. (Part-Time)
– Fourth Semester – Mechanical Engineering – Regulations 2014)

Time : Three Hours Maximum : 100 Marks

Answer ALL questions.

PART – A **(10×2=20 Marks)**

1. Define D-Alembert's principle for translation.

2. Define Co-efficient of fluctuation of energy of a flywheel.

3. Differentiate Static and Dynamic balancing.

4. What is meant by balancing of rotating masses ?

5. Write the expression for the equivalent stiffness of two springs connected in series.

6. List the types of damping.

7. Define vibration isolation.

8. Write down the equation for forced vibrations.

9. What is the effect of gyroscopic couple when the engine or propeller of an aeroplane rotates in anticlockwise direction when viewed from the rear or tail end while turning towards left ?

10. Define sleeve lift.

PART – B **(5×13 = 65 Marks)**

11. a) The crank-pin circle radius of a horizontal engine is 300 mm. The mass of the reciprocating parts is 250 kg. When the crank has travelled 60° from I.D.C., the difference between the driving and the back pressures is 0.35N /mm^2. The connecting rod length between centres is 1.2 m and the cylinder bore is 0.5m. If the engine runs at 250 r.p.m., and if the effect of piston rod diameter is neglected, calculate the pressure on slide bars, the thrust in the connecting rod, the tangential force on the crank-pin and the turning moment on the crank shaft.

(OR)

b) The turning moment diagram for a multi-cylinder engine has been drawn to a vertical scale of 1 mm = 650 Nm and a horizontal scale of 1 mm = 4.5°. The areas above and below the mean torque line are – 28, + 380, – 260, + 310, – 300, + 242, – 380, + 265 and – 299mm^2. The fluctuation of speed is limited to ± 1.8% of the mean speed which is 400 rpm. The density of the rim material is 7000 kg/m^3 and the width of the rim is 4.5 times its thickness. The centrifugal stress in the rim material is limited to 6 N/mm^2. Neglecting the effect of the boss, and the arms, determine the diameter and the cross-section of the flywheel rim.

12. a) A, B, C and D are four masses carried by a rotating shaft at radii 100, 125, 200 and 150 mm respectively. The planes in which the masses revolve are spaced 600 mm apart and the mass of B, C and D are 10 kg, 5 kg and 4 kg respectively. Find the required mass A and the relative angular settings of the four masses so that the shaft shall be in complete balance.

(OR)

b) A 90°-V engine has two cylinders which are placed symmetrically. The two connecting rods operate a common crank. The length of connecting rods are 320 mm each and crank radius is 80 mm. The reciprocating mass per cylinder is 12 kg. If the engine speed is 600 rpm, then find the resultant primary and resultant secondary forces. Also find the maximum resultant secondary force.

13. a) A machine mounted on springs and fitted with a dashpot has a mass of 60 kg. There are three springs, each of stiffness 12 N/mm. The amplitude of vibrations reduces from 45 to 8 mm in two complete oscillations. Assuming that the damping force varies as the velocity, determine the damping coefficient, the ratio of frequencies of damped and undamped vibrations and the periodic time of damped vibrations.

(OR)

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. 11 mm away from the geometric centre of the rotor due to certain manufacturing defect, find the amplitude of the steady-state vibration and the dynamic force transmitted to the bearing. Take E as 200 GN/m^2.

14. a) A single cylinder vertical diesel engine has a mass of 400 kg and is mounted on a steel chassis frame. The static deflection owing to the weights of the chassis is 2.4 mm. The reciprocating mass of the engine amounts to 18 kg and the stroke of the engine is 160 mm. A dashpot with a damping coefficient of 2 Ns/mm is also used to dampen the vibrations. In the steady-state of the vibrations, determine:

i) The amplitude of the vibrations if the driving shaft rotates at 500 rpm. **(7)**

ii) The speed of the driving shaft when the resonance occurs. **(6)**

(OR)

b) The mass of an electric motor is 120 kg and it runs at 1500 r.p.m. The armature mass is 35 kg and its C.G lies 0.5 mm from the axis of rotation. The motor is mounted on five springs of negligible damping so that the force transmitted is one-eleventh of the impressed force. Assume that the mass of the motor is equally distributed among the five springs.

Determine :

i) Stiffness of each spring. **(4)**

ii) Dynamic force transmitted to the base at the operating speed and **(4)**

iii) Natural frequency of the system. **(5)**

15. a) i) Discuss the effect of the gyroscopic couple on a two wheeled vehicle while taking a turn. **(7)**

ii) A turbine rotor of a ship has a mass of 20 tonnes and a radius of gyration of 0.75 m. Its speed is 2000 rpm. The ship pitches 6° above and below the horizontal position. One complete oscillation takes 20 seconds and the motion is simple harmonic. Calculate the maximum couple tending to shear the holding down bolts of the turbine and the maximum angular acceleration of the ship during pitching. **(6)**

(OR)

b) A porter governor has all four arms 300 mm long. The upper arms are pivoted on the axis of rotation and lower arms are attached to the sleeve at distance of 3.5 mm from the axis. The mass of each ball is 7 kg and mass on the sleeve is 54 kg. If the extreme radii of rotation of the balls are 200 mm and 250 mm. Determine the range of speed of the governor.

PART – C **(1×15=15 Marks)**

16. a) The following data refer to the transmission gear of a motor ship : Moment of inertia of flywheel is 4800 kg. m^2. Movement of inertia of propeller is 3200 kg. m^2, modulus of rigidity of shaft material is 80 Gpa, and the equivalent moment of inertia per cylinder is 400 kg.m^2. Assuming the diameter of the torsionally equivalent crankshaft to be 320 mm and treating the arrangement as a three-rotor system, determine the frequency of the free torsional vibrations.

(OR)

b) A governor of the proell type has each arm 250 mm long. The pivots of the upper and lower arms are 25 mm from the axis. The central load acting on the sleeve has a mass of 25 kg and the each rotating ball has a mass of 3.2 kg. When the governor sleeve is in mid-position, the extension like of the lower arm is vertical and radius of the path of rotation of the masses is 175 mm. The vertical height of the governor is 200 mm. If the governor speed is 160 rpm. when in mid position, find the length of the extension link and the tension in the upper arm.