Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 91847

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2019

Fourth/Fifth Semester

Mechanical Engineering

ME 6505 – DYNAMICS OF MACHINES

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

(Regulations 2013)

(Also common to PTME 6505 – Dynamics of Machines 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. Distinguish between crank effort and piston effort.
2. Define D'Alembert's principle.
3. Define static balancing of shaft.
4. State the reasons for choosing multi-cylinder engine in comparison with that of the single cylinder engine.
5. What are the different types of damped vibrations ?
6. Define logarithmic decrement, using a neat sketch.
7. Brief the equation of motion $mx + sx = F_0 \sin wt$.
8. Define magnification factor and state the parameters which affect it.
9. Define governor effort.
10. Sketch a gyroscope and indicate the parts.

PART – B (5×13=65 Marks)

11. a) During a trial on steam engine, it is found that the acceleration of the piston is 36 m/s^2 when the crank has moved 30° from the inner dead centre position. The net effective steam pressure on the piston is 0.5 MPa and the frictional resistance is equivalent to a force of 600 N. The diameter of the piston is 300 mm and the mass of the reciprocating parts is 180 kg. If the length of the crank is 300 mm and the ratio of the connecting rod length to the crank length is 4.5. Find (i) reaction on the guide bars (ii) thrust on the crank shaft bearings and (iii) Turning moment on the crank shaft.

(OR)

b) A single cylinder double acting steam engine develops 150 kW at a mean speed of 80 rpm. The coefficient of fluctuation of energy is 0.1 and the fluctuation of speed is ± 2% of mean speed. If the mean diameter of the flywheel rim is 2 m and the hub and spokes provide 5% of the rotational inertia of the flywheel, find the mass and cross-sectional area of the flywheel rim. Assume the density of the flywheel material (which is cast iron) as 7200 kg/m^3.

12. a) i) Differentiate between static and dynamic balancing.

ii) A circular disc mounted on a shaft carries three attached masses 4kg, 3 kg and 2.5 kg at radial distances 75 mm, 85 mm and 50 mm and at the angular positions of 45°, 135° and 240° respectively. The angular positions are measured counter-clockwise from the reference line along x-axis. Determine the amount of the counter mass at a radial distance of 75 mm required for the static balance.

(OR)

b) An inside cylinder locomotive has its cylinder centre lines 0.7 m apart and has a stroke of 0.6 m. The rotating masses per cylinder are equivalent to 150 kg at the crank pin, and the reciprocating masses per cylinder to 180 kg. The wheel centre lines are 1.5 m apart. The cranks are at right angles. The whole of the rotating and 2/3 of the reciprocating masses are to be balanced by masses placed at a radius of 0.6 m. Find the magnitude and direction of the balancing masses.

13. a) A gun is so designed that on firing, the barrel recoils against a spring. A dash pot at the end of the recoil, allows the barrel to come back to its initial position within the minimum time without any oscillation. The gun barrel has a mass of 500 kg and recoil spring of 300 N/mm. The barrel recoils 1 m on firing. Determine :

i) The initial recoil velocity of the gun barrel, and **(7)**

ii) The critical damping co-efficient of the dash pot engaged at the end of the recoil stroke. **(6)**

(OR)

b) The following data relate to a shaft held in long bearings.

Length of the shaft – 1.2 m

Diameter of the shaft – 14 mm

Mass of a rotor at midpoint – 16 kg

Eccentricity of centre of mass of rotor from centre of rotor – 0.4 mm

Modulus of Elasticity of shaft material – 200 GN/mm^2

Permissible stress in shaft material – 70×10^6 N/m^2

Determine the critical speed of the shaft and the range of speed over which it is unsafe to run the shaft. Assume the shaft to be mass less.

14. a) A single-cylinder vertical petrol engine of total mass of 200 kg is mounted upon a steel chassis frame. The vertical static deflection of the frame is 2.4 mm due to the weight of the engine. The mass of the reciprocating parts is 18 kg and the stroke of the piston is 160 mm with SHM. If dashpot of damping coefficient of 1 N/mm/s is used to dampen the vibrations, calculate at steady state, the amplitude of forced vibrations at 500 rpm engine speed of driving shaft at which resonance will occur.

(OR)

b) A compressor supported symmetrically on four springs has a mass of 100 kg. The mass of the reciprocating parts is 2 kg which move through a vertical stroke of 80 mm with SHM. Neglecting damping, determine the combined stiffness of the springs so that the force transmitted to the foundation is $1/25^{th}$ of the impressed force. The machine crankshaft rotates at 1000 rpm. When the compressor is actually supported on springs, it is found that the damping reduces the amplitude of successive free vibrations by 25%. Find the force transmitted to the foundations at 1000 rpm, the force transmitted to the foundation at resonance and the amplitude of the vibrations at resonance.

15. a) The arms of a Porter governor are 250 mm long. The upper arms are pivoted on the axis of revolution, but the lower arms are attached to a sleeve at a distance of 50 mm from the axis of rotation. The weight on the sleeve is 600 N and the weight of each ball is 80 N. Determine the equilibrium speed when the radius of rotation of the balls is 150 mm. If the friction is equivalent to a load of 25 N at the sleeve, determine the range of speed for this position.

(OR)

b) A ship is propelled by a turbine, rotor of mass 500 kg and has a speed of 2400 rpm. The rotor has a radius of gyration of 0.5 m and rotates in clockwise direction when viewed from stern. Find the gyroscopic effects in the flowing cases :

i) The ship runs at a speed of 15 knots (1 knot = 1860 m/hr). It steers to the left in a curve of 60 m radius.

ii) The ship pitches ± 5° from the horizontal position with the time period of 20 s of simple harmonic motion.

iii) The ship rolls with angular velocity of 0.04 rad/s clockwise when viewed from stern. Also find the maximum acceleration during pitching.

PART – C **(1×15=15 Marks)**

16. a) The turning moment diagram of a four-stroke engine is assumed to be represented by four triangles, the areas of which from the line of zero pressure are

Suction stroke = 440 mm^2

Compression stroke = 1600 mm^2

Expansion stroke = 7200 mm^2

Exhaust stroke = 660 mm^2

Each mm^2 of area represents 3 Nm of energy. If the resisting torque is uniform, determine the mass of the rim of a flywheel to keep the speed between 218 rpm and 222 rpm, when the mean radius of the rim is to be 1.25 m.

(OR)

b) A shaft 30 mm diameter and 1.5 m long has a mass of 16 kg per metre length. It is simply supported at the ends and carries three isolated loads 1 kN, 1.5 kN, and 2 kN at 0.4 m, 0.6 m and 0.8 m respectively from the left support. Find the frequency of the transverse vibrations.

i) Neglecting the mass of the shaft and

ii) Considering the mass of the shaft.

Take the Young's modulus of the shaft material E as 200 GPa.