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Question Paper Code: 35701

B.E. / B.Tech. DEGREE EXAMINATION, MAY 2022

Fifth Semester

Mechanical Engineering

01UME501 - DYNAMICS OF MACHINERY

(Regulation 2013)

Duration: Three hours

Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 2 = 20 Marks)

1. Define applied and constraint force.
2. What is meant by coefficient of fluctuation of energy?
3. Can a single cylinder engine be fully balanced? Why?
4. Define direct and reverse crank methods of balancing reciprocating parts.
5. What happens to the natural frequency of vibration of a spring mass system, when the mass of the spring is not neglected?
6. What are the different types of vibrations?
7. What is the vibration isolation?
8. List the factors affects the critical speed of a shaft.
9. Express the sensitiveness of the governor.
10. Calculate the causing precession for a disc which is spinning with an angular velocity of ω rad/sec and angular velocity of precession ω_p rad/sec about the axis of spin.

PART - B (5 x 16 = 80 Marks)

11. (a) A horizontal steam engine running at 120 rpm, has a bore of 250 mm and stroke of 400 mm. The connecting rod is 0.6 m and mass of the reciprocating parts is 60 kg. When the crank has turned through an angle of 45° from the inner dead centre, the steam pressure on the cover end side is 550 kN/m² and that on the crank end side is 70 kN/m². Considering the diameter of the piston rod equal to 50 mm, determine: turning moment on the crank shaft, thrust on the bearing and acceleration of the flywheel, if the power of the engine is 20 kW, mass of the flywheel 60 kg and radius of gyration 0.6 m. (16)

Or

- (b) The turning moment diagram of a four stroke engine is assumed to be represented by four triangles, the areas of which the line of zero pressure are
Suction stroke = 440 mm²
Compression stroke = 1600 mm²
Expansion stroke = 7200 mm²
Exhaust stroke = 660 mm²
Each mm² of area represents 3N.m of energy. If the resisting torque is uniform, determine the mass of the rim of a flywheel to keep the speed between 218 and 222rpm when the mean radius is to be 1.25m. (16)
12. (a) A shaft carries four masses A, B, C and D of magnitude 200 kg, 300 kg, 400 kg and 200 kg respectively and revolving at radii 80 mm, 70 mm, 60 mm and 80 mm in planes measured from A at 300 mm, 400 mm and 700 mm. The angles between the cranks measured anticlockwise are A to B 45°, B to C 70° and C to D 120°. The balancing masses are to be placed in planes X and Y. The distance between the planes A and X is 100 mm, between X and Y is 400 mm and between Y and D is 200 mm. If the balancing masses revolve at a radius of 100 mm, find their magnitudes and angular positions. (16)

Or

- (b) The stroke of each piston of 6 cylinder 2 stroke inline engine is 320mm and the connecting rod is 800mm long. The cylinder centre lines are spaced at 500mm. the crank are at 60° apart and firing order is 145236. The reciprocating mass per cylinder is 100kg and the rotating parts are 50kg per crank. Determine the out – of – balance force and couples about the mid plane if the engine rotates at 200rpm. (16)

13. (a) (i) Derive the expression for various damping conditions in a free vibration. (6)
- (ii) The potential energy V of a linear spring-mass system is defined as $64x^2$ where x is the displacement in meters measured from the neutral equilibrium position. The kinetic energy T of the system is given by $8x^2$. Determine the differential equation of motion for the system and find the period of its oscillation. Neglect energy loss. (10)

Or

- (b) A vertical shaft of 5 mm diameter is 200 mm long and is supported in long bearings at its ends. A disc of mass 50 kg is attached to the centre of the shaft. Neglecting any increase in stiffness due to the attachment of the disc to the shaft, find the critical speed of rotation and the maximum bending stress when the shaft is rotating at 75% of the critical speed. The centre of the disc is 0.25 mm from the geometric axis of the shaft. $E = 200 \text{ GN/m}^2$. (16)

14. (a) A coil of spring stiffness 4 N/mm supports vertically a mass of 20 kg at the free end. The motion is resisted by the oil dashpot. It is found that the amplitude at the beginning of the fourth cycle is 0.8 times the amplitude of the previous vibration. Determine the damping force per unit velocity. Also find the ratio of the frequency of damped and undamped vibrations. (16)

Or

- (b) A machine part of mass 2 kg vibrates in a viscous medium. Determine the damping coefficient when a harmonic exciting force of 25 N results in a resonant amplitude of 12.5 mm with a period of 0.2 s. If the system is excited by a harmonic force of frequency 4 Hz what will be the percentage increase in the amplitude of vibration when damper is removed as compared with that with damping. (16)

15. (a) (i) Derive the expression for the lift of the porter governor considering friction between the sliding parts. (8)
- (ii) A rail car has a total mass of 4 tonnes. There are two axles, each of which together with its wheels and gearing has a total moment of inertia of 30 kgm^2 . The centre distance between the two wheels on an axle is 1.5 m and each wheel is of 375 mm radius. Each axle is driven by a motor, the speed ratio between the two being 1:3. Each motor with its gear has a moment of inertia of 15 kgm^2 and runs in a direction opposite to that of its axle. The centre of gravity of the car is 1.05 m above the rails. Determine the limiting speed for this car, when it rounding a curve of 240 m radius such that no wheel leaves the rail. Consider the centrifugal and gyroscopic effects completely. Assume that no cantis provided for outer rail. (8)

Or

- (b) The turbine rotor of a ship has a mass of 3500 kg. It has a radius of gyration of 0.45 m and a speed of 3000 r.p.m. clockwise when looking from stern. Determine the gyroscopic couple and its effect upon the ship:
- (i) When the ship is steering to the left on a curve of 100 m radius at a speed of 36 km/h.
- (ii) When the ship is pitching in a simple harmonic motion, the bow falling with its maximum velocity. The period of pitching is 40 sand the total angular displacement between the two extreme positions of pitching is 12 degrees. (16)