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Question Paper Code: 31751

B.E. / B.Tech. DEGREE EXAMINATION, NOV 2016

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. Differentiate between force and motion transmissibility.
9. How governors are classified?
10. Define the condition for asynchronous governor.

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/m^2 and that on the crank end side is 70 kN/m^2. 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) A single cylinder double acting steam engine develops 150 *kW* at a mean speed of 80 *r.p.m*. 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 *meter* 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. (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 cranks and connecting rods of a 4-cylinder in-line engine running at 1800 *rpm* are 60 *mm* and 240 *mm* each respectively and the cylinders are spaced 150 *mm* apart, if the cylinders are numbered 1 to 4 in sequence from one end, the cranks appear at intervals of 90° in an end view in the order 1 - 4 - 2 – 3. The reciprocating mass corresponding to each cylinder is 1.5 *kg*. Determine unbalance primary and secondary forces, if any. And the unbalanced primary and secondary couples with reference to central plane of the engine. (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 steel shaft 1.5*m* long is 95*mm* in diameter for the first 0.6*m* of its length, 60*mm* in diameter for the next 0.5*m* of the length and 50 *mm* in diameter for the remaining 0.4 *m* of its length. The shaft carries two flywheels at two ends, the first having a mass of 900 *kg* and 0.85 *m* radius of gyration located at the 95 *mm* diameter end and the second having a mass of 700 *kg* and 0.55 *m* radius of gyration located at the other end. Determine the location of the node and the natural frequency of free torsional vibration of the system. The modulus of rigidity of shaft material may be taken as 80 GN/m^2. (16)

14. (a) A 400 *kg* motor supported by four springs, each of constant 150 *kN/m*, and a dashpot of constant c = 6500 *Ns/m* is constrained to move vertically. Knowing that the unbalance of the rotor is equivalent to a 23 *g* mass located at a distance of 100 *mm* from the axis of rotation. For a speed of 800 *rpm* determine the amplitude of the fluctuating force transmitted to the foundation and the amplitude of the vertical motion of the motor. (16)

Or

(b) A machine part of mass 2 *kg* vibrates in a viscous medium. Determine them 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 *s*and the total angular displacement between the two extreme positions of pitching is 12 *degrees*. (16)