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B. E. (Fifth Semester) Examination, April - May 2021

(Mechanical Engg. Branch)

DYNAMICS of MACHINES

Time Allowed : Three hours

Maximum Marks : 80

Minimum Pass Marks : 28

Note : *Part (a) is compulsory from each unit and solve any* ***two*** *from (b), (c) and (d).*

Unit-I

1. (a) Explain sensitiveness of governors. 2

(b) In a Hartnell governor, the radius of rotation of the

balls is 60 mm at the minimum speed of 200 rpm. The length of the ball arm is 130 mm and the sleeve arm is 80 mm. The mass of each ball is 2 kg and the sleeve is 4 kg.

The stiffness of the spring is 25 N/mm. Determine the 7

(i) Speed when the sleeve is lifted by 50 mm.

(ii) Initial compression of the spring.

(iii) Governor effort.

(iv) Power.

(c) The mass of each ball of a Proell governor is 3 kg and the weight on the sleeve is 20 kg. Each arm is 220 mm long and the pivots of the upper and lower arms are 20 mm form the axis. For the midposition of the sleeve, the extension links of the lower arms are vertical, the height of the governor is 180 mm and the speed is 150 rpm. Determine the lengths of the extension links and the tension in the upper. 7

(d) In a porter governor, the upper and lower arms are each 250 mm long and are pivoted on the axis of rotation. The mass of each rotating ball is 3 kg and

the mass of the sleeve is 20 kg. The sleeve is in its lowest position when the arms are inclined at 30° to the governor axis. The lift of the sleeve is 36 mm. Find the force of friction at the sleeve, if the speed at the moment it rises from the lowest position is equal to the speed at the moment it falls from the highest position. Also, find the range of speed of the governor. 7

Unit-II

2. (a) What do you mean by primary and secondary unbalance in a reciprocating engine? 2

(b) *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. 7

(c) Four masses *A*, *B*, *C*, and *D* are completely balanced. Masses *C* and *D* make angle of 100° and 185° respectively with that of mass *B* in the

counter clockwise direction. The rotating masses have following properties: 7

$m_b = 20$ kg $r_a = 150$ mm

$m_c = 35$ kg $r_b = 200$ mm

$m_d = 35$ kg $r_c = 100$ mm

$r_d = 180$ mm

Planes B and C are 250 mm apart. Determine

(i) Mass A & its angular position with mass B.

(ii) Position of all the planes relative to plane of mass A.

(d) In an in-line six cylinder engine working on two stroke cycle, the cylinder centre lines are spaced at 600 mm. In the end view, the cranks are 60° apart and in the order 1-4-5-2-3-6. The stroke of each piston is 400 mm and the connecting rod length is 1 metre. The mass of the reciprocating parts is 200 kg per cylinder and that of rotating parts 100 kg per crank. The engine rotates at 300 r.p.m. Examine the engine for the balance of primary and secondary forces and couples. Find the maximum unbalanced forces and couples. 7

Unit-III

3. (a) What do you mean by : 2

(i) Pitching

(ii) Rolling

(b) A disc with radius of gyration of 60 mm and a mass of 4 kg is mounted centrally on a horizontal axle of 80 mm length between the bearing. It spins about the axle at 800 rpm counter-clockwise when viewed from the right-hand side bearing. The axle precesses about a vertical axis at 50 rpm in the clockwise direction when viewed from above. Determine the resultant reaction at each bearing due to the mass and the gyroscopic effect. 7

(c) A ship propelled by a turbine rotor which has a mass of 5 tonnes and a speed of 2100 rpm. The rotor has a radius of gyration of 0.5 m and rotates in a clockwise direction when viewed from the stern. Find the gyroscopic effects in the following conditions: 7

(i) The ship sails at a speed of 30 km/h and steers

to the left in a curve having 60 m radius.

(ii) The ship pitches 6 degree above and 6 degree below the horizontal position. The bow is descending with its maximum velocity. The motion due to pitching is simple harmonic and the periodic time is 20 seconds.

(iii) The ship rolls and at a certain instant it has an angular velocity of 0.03 rad/s clockwise when viewed from stern.

Determine also the maximum angular acceleration during pitching. Explain how the direction of motion due to gyroscopic effect is determined in each case.

(d) The total mass of a four wheeled trolley car is 1800 kg. The car runs on rails of 1.6 m gauge and rounds a curve of 24-m radius at 36 km/h. The track is banked at 10°. The external diameter of the wheels is 600 mm and each pair with all has a mass of 180 kg with a radius of gyration of 240 mm. The height of the centre of mass of the car above the wheel base is 950 mm. Determine the pressure on each rail allowing for centrifugal force and gyroscopic couple actions. 7

Unit-IV

4. (a) What are free, damped and forced vibration? Explain. 2

(b) A body having a mass of 15 kg is suspended from a spring which deflects 12 mm under the weight of mass. Determine the frequency of the free vibrations. What is the viscous damping force needed to make the motion aperiodic at a speed of 1 mm/s? 7

(c) If, when damped to this extent, a disturbing force having a maximum value of 100 N and vibrating at 6 Hz is made to act on the body, determine the amplitude of the ultimate motion.

Derive the equation of natural frequency of free longitudinal vibrations by using the Rayleigh's method. 7

(d) A mass of 10 kg is suspended from one end of a helical spring, the other end being fixed. The stiffness of the spring is 10 N/mm. The viscous damping causes the amplitude to decrease to one-tenth of the initial value in four complete oscillations. If a periodic force of 150 cos 50t N is applied at the

mass in the vertical direction, find the amplitude of the forced vibrations. What is its value of resonance? 7

Unit-V

5. (a) What are turning moment diagrams? 2

(b) The crank and connecting rod of a petrol engine, running at 1800 rpm are 50 mm and 200 mm respectively. The diameter of the piston is 80 mm and the mass of the reciprocating parts is 1 kg. At a point during the power stroke, the presure on the piston is 0.7 N/mm^2, when it has moved 10 mm from the inner dead centre. Determine: 7

(i) Net load on the gudgeon pin,

(ii) Thrust in the connecting rod,

(iii) Reaction between the piston and cylinder, and

(iv) The engine speed at which the above values become zero.

(c) In a single-acting four-stroke engine, the work done by the gases during the expansion stroke is three times the work done during the compression stroke.

The work done during the suction and exhaust strokes is negligible. The engine develops 14 kW at 280 rpm. The fluctuation of speed is limited to 1·5% of the mean speed on either side. The turning-moment diagram during the compression and the expansion strokes may be assumed to be triangular in shape. Determine the inertia of the fly wheel. 7

(d) A horizontal gas running engine at 210 rpm has a bore of 220 mm and a stroke of 440 mm. The connecting rod is 924 mm long and the reciprocating parts weigh 20 kg. When the crank has turned an angle of 30° from the inner dead centre, the gas pressures on the cover and the crank sides are 500 kN/m^2 and 60 kN/m^2 respectively. Diameter of the piston rod is 40 mm. 7

Determine:

(i) Turning moment of the crankshaft

(ii) Thrust of the bearings

(iii) Acceleration of the flywheel which has a mass of 8 kg and radius of gyration of 600 mm while the power of the engine is 22 kW.