Printed Pages : **6**

Roll No. ....

367553(37)

BE (5th Semester)

Examination, April-May 2021

(New Scheme)

Dynamics of Machines

Time Allowed : 3 hours *Maximum Marks* : 80

Minimum Pass Marks : 28

Note : (*i*) Parts *(a)* and *(b)* of each question are compulsory. Attempt any **one** from *(c)* and *(d)*.

(*ii*) The figures in the right-hand margin indicate marks.

1. *(a)* Define sensitivity of a governor. 2

(b) Show that for a watt governor $h = \frac{895}{N^2}$, where h = height of a governor. 4

(c) A Porter governor has all four arms 250 mm long. The upper arms are attached on the axis of rotation and the lower arms are attached to the sleeve at a distance of

30 mm from the axis. The mass of each ball is 5 kg and the sleeve has a mass of 50 kg. The extreme radii of rotation are 150 mm and 200 mm. Determine the range of speed of the governor. 10

(d) In a spring loaded Hartnell type governor, the extreme radii of rotation of the balls are 80 mm and 120 mm. The ball arm and the sleeve arm of the bell crank lever are equal in length. The mass of each ball is 2 kg. If the speeds at the two extreme positions are 400 r.p.m. and 420 r.p.m., find *(i)* the initial compression of the central spring and *(ii)* the spring constant. 10

2. *(a)* Write the equation of primary and secondary unbalance forces of reciprocating masses. 2

(b) Derive the expression for variation of tractive force for an uncoupled two-cylinder locomotive engine. 4

(c) Four masses *A*, *B*, *C* and *D* as shown below are to be completely balanced :

	A	*B*	*C*	*D*
Mass (kg)	—	30	50	40
Radius (mm)	180	240	120	150

The planes containing masses *B* and *C* are 300 mm apart. The angle between planes obtaining *B* and *C* is 90°. *B* and *C* make angles of 210° and 120° respectively with *D* in the same sense. Find *(i)* the magnitude and the angular position of mass *A* and *(ii)* the position of planes *A* and *D*. 10

(d) The reciprocating mass per cylinder in a 60° V-twin engine is 1·5 kg. The stroke and connecting rod lengths are 100 mm and 250 mm respectively. If the engine runs at 2500 r.p.m., determine the maximum and minimum values of the primary forces. Also find out the resultant secondary force. 10

3. *(a)* What is the effect of gyroscopic couple during rolling on a ship? 2

(b) Discuss the effect of the gyroscopic couple on a two-wheeled vehicle when taking a turn. 4

(c) The turbine rotor of a ship has a mass of 2·2 tonnes and rotates at 1800 r.p.m. clockwise when viewed from the aft. The radius of gyration of the rotor is 320 mm. Determine the gyroscopic couple and its effect when the—

(i) ship turns right at a radius of 250 m with a speed of 25 km/hr;

(ii) ship pitches with the bow rising at an angular velocity of 0·8 rad/s;

(iii) ship rolls at an angular velocity of 0·1 rad/s. 10

(d) A four-wheeled trolley car has a total mass of 3000 kg. Each axle with its two wheels and gears has a total moment of inertia of 32 kg-m^2. Each wheel is of 450 mm radius. The centre distance between two wheels on an axle is 1·4 m. Each axle is driven by a motor with a speed ratio of 1 : 3. Each motor along with its gear has a moment of inertia of 16 kg-m^2 and rotates in the opposite direction to that of the axle. The centre of mass of the car is 1 m above the rails. Calculate the limiting speed of the car when it has to travel around a curve of 250 m radius without the wheels leaving the rails. 10

4. *(a)* Define longitudinal vibration. 2

(b) Explain vibration sensors. 4

(c) The following data are given for a vibratory system with viscous damping :

Mass = 2·5 kg, spring constant = 3 N/mm and the amplitude decreases to 0·25 the initial value after five consecutive cycles.

Determine the damping coefficient of the damper in the system. 10

(d) A machine part of mass 2 kg vibrates in a viscous medium. Determine 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 second. 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 damping? 10

5. (a) Define piston effort. 2

(b) Show that for a flywheel the maximum fluctuation of energy $\Delta E = I\omega^2 C_s$, where C_s = coefficient of fluctuation of speed. 4

(c) The crank and connecting rods of a petrol engine running at 1800 r.p.m. 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 pressure on the piston is 0·7 N/mm^2 when it has moved 10 mm from the inner dead centre. Determine—

(i) net load on the gudgeon pin;

(ii) thrust in the connecting rod;

(iii) reaction between the piston and cylinder;

(iv) the engine speed at which the above values become zero. 10

(d) The turning moment diagram for a multicylinder engine has been drawn to a scale 1 mm = 600 N-m vertically and 1 mm = 3° horizontally. The intercepted areas between the output torque curve and the mean resistance line taken in order from one end are as follows :

+ 52, – 124, + 92, – 140, + 85, – 72 and + 107 mm^2, when the engine is running at a speed of 600 r.p.m.

If the total fluctuation of speed is not to exceed $\pm$ 1·5% of the mean, find the necessary mass of the flywheel of radius 0·5 m. 10

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