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BIMEE-007

B.Tech. – VIEP – MECHANICAL ENGINEERING (BTMEVI)

00833

Term-End Examination

June, 2018

BIMEE-007 : ADVANCED DYNAMICS OF MACHINES

Time : 3 hours *Maximum Marks : 70*

Note : *Attempt any **five** questions. All questions carry equal marks. Use of scientific calculator is permitted.*

1. A shaft, 1·5 m long, supported in flexible bearings at the ends carries two wheels each of 50 kg mass. One wheel is situated at the centre of the shaft and the other at a distance of 375 mm from the centre towards the left. The shaft is hollow of external diameter 75 mm and internal diameter 40 mm. The density of the shaft material is 7700 kg/m^3 and its modulus of elasticity is 200 GN/m^2.

Find the lowest whirling speed of the shaft, considering the mass of the shaft. *14*

2. 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 rpm clockwise, when looking from stern. Determine the gyroscopic couple and its effect upon the ship

(a) when the ship is steering to the left on a curve of 100 m radius at a speed of 36 km/hr.

(b) when the ship is pitching in a simple harmonic motion, the bow falling with its maximum velocity. The period of pitching is 40 seconds and the angular displacement between the two extreme positions of pitching is 12 degrees. *14*

3. A punching machine operates at the rate of 600 holes/hr. It does 45 N-m of work per square mm of sheared area in cutting a 25 mm diameter hole in a 3 mm thick plate. The machine is operated by a constant torque motor. The speed of the machine fluctuates between 250 rpm and 230 rpm. The frictional losses are 20% of the work done during punching and actual punching time per hole is 2 seconds. Find

(a) the power required to drive the punching machine,

(b) the maximum fluctuation of energy, and

(c) the mass of the flywheel required to keep the speed fluctuation in the given range. Radius of gyration of the flywheel is 500 mm. *14*

4. For a reciprocating engine, prove that the displacement (x_p), velocity (v_p) and acceleration (a_p) of the piston are given by the following expressions : *14*

Displacement

$$x_p = r\left[(1 - \cos\theta) + (n - \sqrt{n^2 - \sin^2\theta})\right]$$

Velocity

$$v_p = \omega r\left(\sin\theta + \frac{\sin 2\theta}{n}\right)$$

Acceleration

$$a_p = \omega^2 r\left(\cos\theta + \frac{\cos 2\theta}{n}\right)$$

where r = length of crank

l = length of connecting rod,

$n = \frac{l}{r}$ and

θ = inclination of the crank to the inner dead centre position.

5. A shaft is rotating at a uniform angular speed. Four masses m_1, m_2, m_3 and m_4 of magnitudes 300 kg, 450 kg, 360 kg and 390 kg respectively are attached rigidly to the shaft. The masses are rotating in the same plane. The corresponding radii of rotation are 200 mm, 150 mm, 250 mm and 300 mm respectively. The angles made by these masses with the horizontal are 0°, 45°, 120° and 225° respectively. Determine

(a) the magnitude of the balancing mass, and

(b) the position of the balancing mass, if its radius of rotation is 200 mm. *14*

6. A three-cylinder single acting engine has its cranks set equally at 120° and it runs at 600 rpm. The torque – crank angle diagram for each cycle is a triangle for the power stroke with a maximum torque of 90 N-m at 60° from the dead centre of the corresponding crank. The torque on the return stroke is sensibly zero.
Determine the

(a) power developed

(b) coefficient of fluctuation of speed if the mass of the flywheel is 12 kg and has a radius of gyration of 80 mm

(c) coefficient of fluctuation of energy

(d) maximum angular acceleration of the flywheel. *14*

7. Write short notes on the following : *7+7*

(a) D'Alembert's Principle

(b) Dynamic Force Analysis