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BIMEE-007

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

00305

Term-End Examination

December, 2014

BIMEE-007 : ADVANCED DYNAMICS OF MACHINE

Time : 3 hours *Maximum Marks : 70*

Note : *Attempt any **five** questions, All questions carry equal marks. Assume any missing data if required anywhere. Use of scientific calculator is permitted.*

1. The connecting rod of a vertical reciprocating engine is 2 m long between centres and weighs 250 kg, the mass centre is 800 mm from the big end bearing when suspended as a pendulum from the gudgeon pin axis; it makes 8 complete oscillations in 22 seconds. Calculate the radius of gyration of the rod about an axis through its mass centre. The crank is 400 mm long and rotates at 200 rpm. Find the inertia torque exerted on the crankshaft when the crank has turned through 40° from the top dead centre and the piston is moving downwards. *14*

2. The crank and connecting rod of a vertical petrol engine running at 1800 rpm are 60 m and 270 mm respectively. The diameter of the piston is 100 mm and the mass of the reciprocating parts is 1·2 kg. During the expansion stroke when the crank has turned 20° from the top dead centre the gas pressure is 650 kN/m^2. Determine the

(a) Net force on the piston.

(b) Net load on the gudgeon pin.

(c) Thrust on the cylinder walls.

(d) Speed at which the gudgeon pin load is reversed in direction. *14*

3. The torque delivered by a two-stroke engine is represented by $T = (1200 + 1400 \sin \theta + 210 \sin 2\theta + 21 \sin 3\theta)$ N.m, where θ is the angle turned by the crank from the inner-dead centre. The engine speed is 210 rpm. Determine the power of the engine and the minimum mass of the flywheel if its radius of gyration is 800 mm and the maximum fluctuation of speed is to be ± 1·5% of the mean. *14*

4. A circular disc mounted on a shaft carries three attached masses of 4 kg, 3 kg and 2·5 kg at radial distances of 75 mm, 85 mm and 50 mm and at the angular positions of 45°, 135° and 240° respectively. The angular positions are measured counter-clockwise from the reference line along the x-axis. Determine the amount of the counter mass at a radial distance of 75 mm required for the static balance. *14*

5. 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. *14*

6. A shaft carrying a rotor of mass 50 kg and eccentricity 2 mm rotates at 12,000 rpm. Determine

(a) Steady state whirl amplitude.

(b) Maximum whirl amplitude during start-up conditions of the system.

Assume stiffness of the shaft as 40×10^6 N/m and external damping ratio as 0·1. *14*

7. A vertical shaft 15 mm in diameter, rotates in bearings with a span of 1 m and carries a disc of mass 15 kg midway between the two bearings. The mass centre of the disc is 0·3 mm away from the geometric axis. If modulus of elasticity of the shaft material is 200×10^9 N/m^2 and stress in the shaft is not to exceed 70×10^6 N/m^2, determine

(a) Critical or whirling speed of the shaft.

(b) Range of speed over which it is not safe to run the shaft.

Neglect mass of the shaft and damping in the system. *14*