Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 11042

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2014.

Fifth Semester

Mechanical Engineering

080120026 — DYNAMICS OF MACHINERY

(Regulation 2008)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. In a two force planar member, specify the conditions for static equilibrium.

2. More than 90% of the flywheel effect is from the rim– Justify with neat sketch.

3. A mass is attached to a shaft which is rotating at an angular speed of ω rad/s. Describe the procedure of balancing this mass by

   (a) A single mass only

   (b) Two masses in different planes.

4. Draw the primary and reverse cranks positions of a V-60° two cylinder symmetrically placed engine. The two connecting rods are coupled directly to a single crank.

5. What is the effects of gyroscope on a sea vessel (propeller type, rotation CW, the sea vessel turning Left)?

6. What is an isochronus governor?

7. Mention any four areas where vibration is desirable.

8. Derive the expression for natural frequency of vibration using Rayleigh's method.

9. Define transmissibility ratio.

10. What do you understand by torsionally equivalent shaft?

PART B — (5 × 16 = 80 marks)

11. (a) The following data relate to a horizontal reciprocating engine Mass of reciprocating parts = 120 kg. Crank length = 90 mm, Engine speed = 600 rpm. Mass of the connecting rod = 90 kg, Length between centres = 450 mm. Distance of mass centre from the small end centre = 180 mm, Radius of gyration about mass centre axis = 150 mm. Find the magnitude and the direction of the inertia torque on the crank shaft when the crank has turned 30° from the inner-dead centre.

Or

(b) An Otto cycle engine develops 50 kW at 150 rpm with 75 explosions per minute. The change of speed from the commencement to the end of power stroke must not exceed 0.5% of mean on either side. Find the mean diameter of the flywheel and a suitable rim cross- section having width four times the depth so that the hoop stress does not exceed 4 MPa. Assume that the flywheel stores 16/15 times the energy stored by the rim and the work done during power stroke is 1.40 times the work done during the cycle. Density of rim material is 7200 kg/m^3.

12. (a) A 3.6 m long shaft carries three pulleys, two at its two ends and third at the mid-point The two end pulleys has mass of 79 kg and 40 kg and their centre of gravity are 3 mm and 5 mm respectively from the axis of the shaft. The middle pulley mass is 50 kg and its centre of gravity is 8 mm from the shaft axis. The pulleys are so keyed to the shaft that the assembly is in static balance. The shaft rotates at 300 r.p.m. in two bearings 2.4m apart with equal overhang on either side. Determine :

(i) The relative angular positions of the pulleys, and (8)

(ii) Dynamic reactions at the two bearings. (8)

Or

(b) In a four crank symmetrical engine, the reciprocating masses of the two outside cylinders A and D are each 600 kg and those of the two inside cylinders B and C are each 900 kg. The distance between the cylinder axes of A and D is 5.4 metres. Taking the reference line to bisect the angle between the cranks A and D, and the reference plane to bisect the distance between the cylinder axes of A and D, find the angles between the cranks and the distance between the cylinder axes of B and C for complete balance except for secondary couples. Determine the maximum value of the unbalanced secondary couple if the length of the crank is 425 mm, length of connecting rod 1.8 m and speed is 150 r.p.m.

13. (a) A governor of Proell type has each arm 250 mm. The upper and lower ends of the arms are pivoted on the axis of the governor sleeve. Each ball has a mass of 15 kg and attached to the extension of the lower arms which are 100 mm long. The minimum and maximum radi of the governor are 125 and 175 mm The central sleeve is of mass 75 kg. Determine the range of equilibrium speeds, assuming that the extensions of the lower arms are parallel to the governor axis, at the minimum radius.

Or

(b) The mass of a turbine rotor of a ship is 8 tonnes and has a radius of gyration 0.6 m. It rotates at 1800 r.p.m. clockwise when looking from the stern. Determine the gyroscopic effects in the following cases :

(i) If the ship travelling at 100 km / h steers to the left in a curve of 75 m radius, (5)

(ii) If the ship is pitching and the bow is descending with maximum velocity. The pitching is simple harmonic, the periodic time being 20 seconds and the total angular movement between the extreme positions is 10°, and (5)

(iii) If the ship is rolling and at a certain instant has an angular velocity of 0.03 rad/s clockwise when looking from stern. (6)

14. (a) A shaft 12.5 mm diameter rotates in long bearings and a disc of mass 16 kg is secured to a shaft at the middle of its length. The span of the shaft between the bearing is 0.5 m. The mass centre of the disc is 0.5 mm from the axis of the shaft. Neglecting the mass of the shaft and taking $E = 200\ GN/m^2$, find :

(i) Critical speed of rotation in r.p.m., and (8)

(ii) The range of speed over which the stress in the shaft due to bending will not exceed $120\ MN/m^2$. Take the static deflection of the shaft for a beam fixed at both ends. (8)

Or

(b) A machine of mass 75 kg is mounted on springs of stiffness 1200 kN/m and with an assumed damping factor of 0.2. A piston within the machine of mass 2 kg has a reciprocating motion with a stroke of 80 mm and a speed of 3000 cycles/mm. Assuming the motion to be simple harmonic, find :

(i) The amplitude of motion of the machine, (4)

(ii) Its phase angle with respect to the exciting force, (4)

(iii) The force transmitted to the foundation and (4)

(iv) The phase angle of transmitted force with respect to the exciting force. (4)

15. (a) A centrifugal pump is driven through a pair of spur wheels from an oil engine. The pump runs at 4 times the speed of the engine. The shaft from the engine flywheel to the gear is 75 mm diameter and 1.2 m long, while that from the pinion to the pump is 50 mm diameter and 400 mm long. The moment of inertia are as follows : Flywheel = 1000 kg-m^2, Gear = 25 kg m^2, Pinion = 10 kg-m^2, and Pump impeller = 40 kg-m^2. Find the natural frequencies of torsional oscillations of the system. Take C = 84 GN/m^2.

Or

(b) A steel shaft ABCD 1.5 m long has flywheel at its ends A and D. The mass of the flywheel A is 600 kg and has a radius of gyration of 0.6 m. The mass of the flywheel D is 800 kg and has a radius of gyration of 0.9 m. The connecting shaft has a diameter of 50 mm for the portion AB which is 0.4 m long and has a diameter of 60 mm for the portion BC which is 0.5 m long and has a diameter of d mm for the portion CD which is 0.6 m long. Determine

(i) The diameter "d" of the portion CD so that the node of the torsional vibration of the system will be at the centre of the length BC and (8)

(ii) The natural frequency of the torsional vibrations. The modulus of rigidity for the shaft material is 80 GN/m^2. (8)
