B.E./B.TECH. Degree Examination, December 2020

Fifth Semester

ME16505 Dynamics of Machines

(Regulation 2016)

Time: Three hours Maximum : 80 Marks

Answer **ALL** questions

PART A - (8 X 2 = 16 marks)

1. The speed of an engine varies from 210 rad/s to 190 rad/s. During a cycle the change in kinetic energy is found to be 400 Nm. The inertia of the flywheel in kgm^2 is

   (a) 0.10 (b) 0.20 (c) 0.30 (d) 0.40

2. If the ratio of the length of connecting rod to the crank radius increases, then

   (a) Primary unbalanced forces will increase

   (b) Primary unbalanced forces will decrease

   (c) Secondary unbalanced forces will increase

   (d) Secondary unbalanced forces will decrease

3. If the length of the cantilever beam is halved, then natural frequency of the mass M at the end of this cantilever beam of negligible mass is increased by a factor of

   (a) 2 (b) 4 (c) $\sqrt{8}$ (d) 8

4. When the pitching of a ship is upward, the effect of gyroscopic couple acting on it will be

   a) to move the ship towards star-board

   b) to move the ship towards port side

   c) to raise the bow and lower the stern

   d) to raise the stern and lower the bow

5. In what way is the inertia of the connecting rod of a reciprocating engine is taken into account?

6. Two masses in different planes are necessary to rectify the dynamic imbalance. Comment.

7. What types of vibrations can be executed by a massless shaft, one end of which is fixed and the other end carries a heavy disc?

8. Analyse the effect of Gyroscopic couple in a four-wheeled vehicle.

PART B - (4 X16 = 64 marks)

09. (a) A vertical, single cylinder, single acting diesel engine has a cylinder diameter 300 mm, stroke length 500 mm, and connecting rod length 4 times the crank length. The engine runs at 200 r.p.m. The mass of the reciprocating parts is 270 kg. The compression ratio is 14 and the pressure remains constant during the injection of the oil for 1/10th of the stroke. **(16)**

If the compression and expansion follow the law $p.V^{1.25}$ = constant, find:

1. Crank-pin effort, 2. Thrust on the bearings, and

3. Turning moment on the crank shaft, when the crank displacement is 45° from the inner dead centre position during expansion stroke.

The suction pressure may be taken as 0.1 N/mm^2.

(OR)

(b) The turning moment diagram for a multicylinder engine has been drawn to a scale of 1 mm = 5000 N m vertically and 1 mm = 3.5° horizontally. The areas between output torque curve and mean resistance line taken in order from one end are: **(16)**

- 340, + 21, -245, + 300, - 118, + 230, - 225, + 377 mm^2,

when the engine is running at 180 rpm. If the mass of the flywheel is 1000 kg and the total fluctuation of speed is not to exceed 3% of the mean speed, find the minimum value of the radius of gyration.

10. (a) A shaft has three eccentrics of mass 1 kg each. The central plane of the eccentrics is 50 mm apart. The distances of the centers from the axis of rotation are 20, 30 and 20 mm and their angular positions are 120° apart. Find the amount of out-of-balance force and couple at 600 rpm. If the shaft is balanced by adding two masses at a radius of 70 mm and at a distance of 100 mm from the central plane of the middle eccentric, find the amount of the masses and their angular positions. **(16)**

(OR)

(b) An inside cylinder locomotive has its cylinder centre lines 0.8 m apart and has a stroke of 0.6 m. The rotating masses are equivalent to 150 kg at the crank pin and the reciprocating masses per cylinder are 300 kg. The wheel centre lines are 1.8 m apart. The cranks are at right angles. The whole of the rotating and $2/3^{rd}$ of the reciprocating masses is to be balanced by masses placed at a radius of 0.5 m. Find (a) the magnitude and direction of the balancing masses, (b) the fluctuation in rail pressure under one wheel, (c) the variation of tractive effort and (d) the magnitude of swaying couple at a crank speed of 300 rpm. **(16)**

11. (a) A shaft 180 mm diameter is supported in two bearings 2.5 metres apart. It carries three discs of mass 250 kg, 500 kg and 200 kg at 0.6 m, 1.5 m and 2 m from the left hand. Assuming the mass of the shaft 190 kg/m, determine the critical speed of the shaft. Young's modulus for the material of the shaft is 211 GN/m^2. **(16)**

(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/min. Assuming the motion to be simple harmonic, find: 1. the amplitude of motion of the machine, 2. its phase angle with respect to the exciting force, 3. the force transmitted to the foundation, and 4. the phase angle of transmitted force with respect to the exciting force. **(16)**

12. (a) The mass of a turbine rotor of a ship is 8000 kg and has a radius of gyration of 0.75 m. It rotates at 1800 rpm clockwise when viewed from the stern. Determine the gyroscopic effects in the following cases: **(16)**

(a) If the ship traveling at 100 km/h steers to the left along a curve of 80 m radius.

(b) If the ship is pitching and the bow is descending with maximum velocity. The pitching is with simple harmonic motion with periodic time of 20 s and the total angular movement between extreme position is 10°.

(c) If the ship is rolling with an angular velocity of 0.03 rad/s clockwise when looking from stern.

In each case, determine the direction in which the ship tends to move.

(OR)

(b) In a Porter governor, the mass of the central load is 18 kg and the mass of each ball is 2 kg. The top arms are 250 mm while the bottom arms are each 300 mm long. The friction of the sleeve is 14 N. If the top arms make 45° with the axis of rotation in the equilibrium position, find the range of speed of the governor in that position. **(16)**