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10AE53

Fifth Semester B.E. Degree Examination, Dec.2017/Jan.2018

### Dynamics of Machines

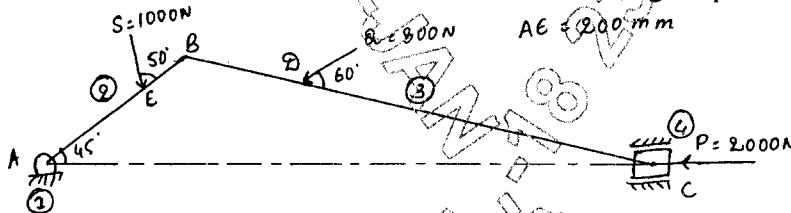
Time: 3 hrs.

Max. Marks:100

Note: Answer FIVE full questions, selecting at least TWO questions from each part.

#### PART - A

- 1 a. State the conditions for a member to be in equilibrium:
  - i) When two forces act
  - ii) When three forces act
  - iii) When two forces and a torque act. (06 Marks)
- b. A slider crank mechanism is shown in Fig.Q1(b). The force applied to the piston is 2000 N when the crank is at  $45^\circ$  from IDC. Calculate the driving torque  $T_2$ .



AB = 300 mm  
BC = 600 mm  
BD = 200 mm  
AE = 200 mm

Fig.Q1(b)

(14 Marks)

- 2 a. State and explain D'Alembert's principle. (05 Marks)
- b. Explain turning moment diagrams of 4-stroke IC Engine and multi-cylinder engine. (06 Marks)
- c. A gas engine working on Otto cycle develops 22.08 kW at 300 rpm. The coefficient of fluctuation of energy is 1.85. The fly wheel mass is 1000 kg and its radius of gyration is 0.9 m. What is the cyclic speed variation from the mean? (09 Marks)
- 3 a. Derive an expression for frictional torque in flat pivot bearing for uniform pressure and wear conditions. (08 Marks)
- b. A shaft rotating at 300 rpm transmitting 5 kW power to drive another shaft at 500 rpm through a belt. The belt is 120 mm wide and 15 mm thick. The distance between the centres of the shaft is 3 m. The effective diameter of smaller pulley is 0.75 m. Calculate the stress in the belt, if it is (i) an open belt drive, (ii) a cross belt drive. Take coefficient of friction between the belt and pulley material as 0.3. (12 Marks)
- 4 a. The revolving masses for a single crank engine are equivalent to a mass of 100 kg at radius 225 mm. Determine the magnitudes of the balancing masses at radius 600 mm in two planes 'L' and 'M' at distance of 300 mm and 900 mm from the crank, when (i) these planes are on opposite sides, (ii) these planes are on the same side. (06 Marks)
- b. Four masses  $M_1 = 100$  kg,  $M_2 = 175$  kg,  $M_3 = 200$  kg and  $M_4 = 125$  kg are fixed to the crank of 200 mm radius and revolve in planes 1, 2, 3 and 4 respectively. The angular position of the planes 2, 3 and 4 with respect to 1 are  $75^\circ$ ,  $135^\circ$  and  $240^\circ$  taken in the same sense. Distances of the planes 2, 3 and 4 from 1 are 600 mm, 1800 mm and 2400 mm. Determine the magnitude and position of the balancing masses at radius 600 mm in planes 'L' and 'M' located in the middle of 1 and 2 and in the middle of 3 and 4 respectively. (14 Marks)

**PART – B**

- 5 A four cylinder vertical engine has cranks 300 mm long. The planes of rotation of first, third and fourth crank are 750 mm, 1050 mm and 1650 mm respectively from that of the second crank and their reciprocating masses are 150 kg, 400 kg and 250 kg respectively.
- Find the mass of the reciprocating parts for the second cylinder and the relative angular positions of the crank in order that the engine may be in complete primary balance.
  - If each connecting rod of all four cylinders is 1.35m long and the speed is 300 rpm. Find maximum unbalanced secondary force and couple and crank positions at which maximum unbalanced secondary force and couple occur. **(20 Marks)**
- 6 a. A porter governor has all four arms 300 mm long, the upper arms are pivoted on the axis of rotation and lower arms are attached to the sleeve at a distance 35 mm from axis. The mass of each ball is 7 kg and the load on the sleeve is 540 N. Determine the equilibrium speed for the two extreme radii of 200 mm and 260 mm of rotation of governor balls. **(10 Marks)**
- b. In a spring loaded Hartnell governor, the extreme radii of rotation of the balls are 80 mm and 120 mm. The ball arm and 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 and 420 rpm. Find:
- The initial compression of the central spring
  - Governor effort
  - Spring stiffness
  - Governor power. **(10 Marks)**
- 7 a. With neat sketches, explain the effect of gyroscopic couple on pitching, steering and rolling of a ship. **(10 Marks)**
- b. An aeroplane make a complete half circle of 40 m radius towards left when flying at 175 km/hr. The mass of the rotary engine and propeller is 400 kg with radius of gyration 300 mm. The engine runs at 2500 rpm clockwise when viewed from rear. Find the gyroscopic couple on the aircraft. What will be the effect of the aeroplane turn towards right instead of left? **(10 Marks)**
- 8 A symmetrical cam with convex flanks operating a flat faced follower has base circle diameter of 75 mm and nose radius of 10 mm. The lift of the follower is 20 mm. The cam is symmetrical and the total angle of action is  $120^\circ$ . Determine:
- Principal dimensions of the cam.
  - Acceleration of the follower at the beginning of the lift, at the end of contact with the circular flank, at the beginning of contact with nose and at the apex of the nose. Speed of cam shaft is 600 rpm. **(20 Marks)**

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