



P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belgaum)

Fifth Semester, B.E. - Automobile Engineering

Semester End Examination; Dec. - 2015

Theory of Machines - II

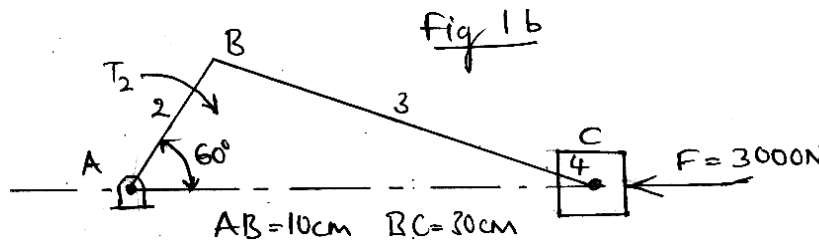
Time: 3 hrs

Max. Marks: 100

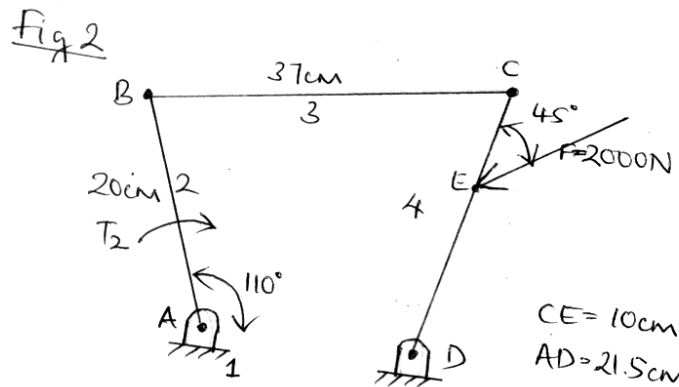
- Note:** i) Answer any **FIVE** full questions, selecting atleast **ONE** full question from each unit.
 ii) Graphical solutions must be done on drawing sheet only.
 iii) Missing data, if any, may be suitably assumed and stated.

UNIT - I

- 1 a. Explain with force vector diagrams, the conditions for equilibrium of three-force and four – force system. 5
- b. A slider crank mechanism is as shown in figure. The value of applied force on the slider 4 is 3000 N. Determine the forces on the various links and also calculate the driving torque T_2 . 15



2. A four-bar mechanism is shown. Calculate the required value of T_2 and various forces on links for equilibrium of the system. 20



UNIT - II

3. The connecting rod of a vertical reciprocating engine is 2 m long between centres and it 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. When the crank has turned through 40° from the top dead centre and the piston is moving downwards, analytically find the inertial torque exerted on the crankshaft. 20

- 4 a. Explain the need of flywheel with examples. 4
- b. Turning moment curve for one revolution of a multi cylinder engine above and below the line of mean resisting torque are given by -0.32, +4.06, -2.71, +3.29, -3.16, +2.32, -3.74, +2.71 and - 2.45 cm². The vertical and horizontal scales are 1cm = 60000 kg-cm and 1 cm = 24°C respectively. The fluctuation of speed is limited to ± 1.5 percent of speed which is 250 rpm. 16
- The hoop stress in rim material is limited to 56 kg/cm². Neglecting the effect of boss and arms, determine suitable diameter and cross – section of flywheel rim. Density of rim material is 0.072 kg/cm³. Assume width of rim equal to four times its thickness.

UNIT - III

5. Three masses 12 kg, 10 kg and 8 kg are revolving at radii 7 cm, 6 cm and 8 cm in three parallel planes A, B and C respectively on a shaft. Planes B and C are at a distance of 0.25 m from A on either side of A (B is on the left side). The three masses are placed in such a way that they are statically balanced. Find the unbalanced couple in a plane midway between A and B if the shaft revolves at 1000 rpm. 20
6. A shaft rotates in two bearings A and B 1.8 m apart and project 0.45 m beyond A and B. At the extreme ends of the shaft are attached two pulleys of masses 20 kg and 48 kg, their centre of mass being respectively 12.5 mm and 15.5 mm from the axis of the shaft. In the middle of the bearings is attached a third pulley of mass 56 kg with its centre of gravity 15.5 mm from the axis of the shaft. If the pulleys are arranged so as to obtain static balance. Determine; 20
- a) Relative angular position of the pulley.
- b) Dynamic force produced on the bearings when the speed of the shaft is 300 rpm.

UNIT - IV

7. A four crank engine has two outer cranks set at 120° to each other, and their reciprocating masses are 100 kg. The distances between the planes of rotation of adjacent cranks (from left side) are 450 mm, 750 mm and 450 mm. If the engine is to be in complete primary balance, find the reciprocating mass and the relative angular position of inner cranks, if the length of each crank is 300 mm, length of each connecting rod is 1.2 m and the speed of rotation is 240 rpm. What is the maximum secondary unbalanced force? 20
8. The pistons of a 60° V engine have a stroke of 1.2 m. The two connecting rods operate on a common crank pin and each is 0.2 m. If the mass of the reciprocating parts is 1 kg per cylinder and the crank shaft speed is 25000 rpm. Determine the maximum value of primary and secondary forces. Use direct and reverse crank method. 20

UNIT - V

9. What are the types of Governors? How is a governor different from a flywheel? 5
- b. Each arm of a porter governor is 200 mm long and is provided on the axis of the governor. The radii of rotation at the minimum and maximum speeds are 120 mm and 160 mm respectively. The mass of the sleeve is 24 kg and each revolving mass is 4 kg. The range of speed of the governor assuming that ; i) There is no friction, ii) The friction at the sleeve is 18 N. 15
- 10 a. Discuss the effect of gyroscopic couple on an airplane when it takes i) Left turn with engine rotating CCW when viewed from rear. ii) Right turn with engine rotating CCW when viewed from nose of the airplane. Make use suitable diagram to support your answer. 6
- b. A ship is propelled by a turbine rotor of mass 500 kg and has a speed of 2400 rpm. The rotor has a radius of gyration of 0.5 m and rotates in clockwise direction when viewed from stern. Find the gyroscopic effects in;
- i) The ship runs at a speed of 15 knots. It steers to the left in a curve 60 m radius.
- ii) The ship pitches $\pm 5^\circ$ from the horizontal position with the time period of 20 s of simple harmonic motion. 14
- iii) The ship rolls with angular velocity of 0.04 rad/s clock wise when viewed from stern. Also calculate the maximum acceleration during pitching.
- Note : 1 knot = 1.88 km/Hr.

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