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**Fifth Semester B.E. Degree Examination, Feb./Mar. 2022**  
**Dynamics of Machines**

Time: 3 hrs.

Max. Marks: 100

Note: Answer any FIVE full questions, selecting atleast TWO questions from each part.

**PART - A**

- 1 A slider crank mechanism is shown in Fig.Q1. The force applied to the piston is 1000N when the crank is at 60° from IDC. Calculate the driving torque  $T_2$ .

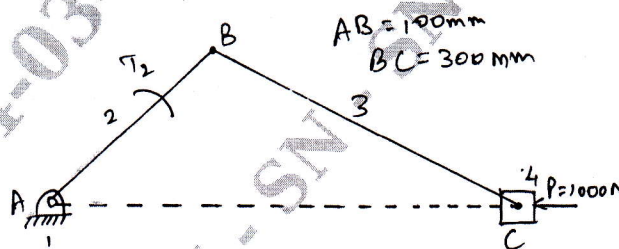


Fig.Q1

(20 Marks)

- 2 a. A connecting rod of an IC engine has a mass of 2kg and the distance between the center of gudgeon pin and centre of crank pin is 250mm. The C.G pulls at a point 100mm from the gudgeon pin along the line of centres. The radius of gyration about an axis through the C.G perpendicular to the plane of rotation is 110mm. Find the equivalent dynamical system if only one of the masses is located at gudgeon pin. If the connecting rod is replaced by two masses, one at the gudgeon pin and the other at the crank pin and the angular acceleration of the rod is 23000rad/s<sup>2</sup>, clockwise, determine the correction couple applied to the system to reduce it to a dynamically equivalent system. (10 Marks)
- b. The connecting rod of a gasoline engine is 300mm long between its centres. It has a mass of 15kg and mass moment of inertia of 7000kg-mm<sup>2</sup>. Its centre of gravity is at 200mm from its small end centre. Determine the dynamical equivalent two mass system of the connecting rod if one of the masses is located at the small end centre. (10 Marks)
- 3 a. Discuss the relation between  $E$ ,  $e_{max}$  and  $K_s$ . (05 Marks)
- b. Prove that the maximum fluctuation of energy  $C$  is given by  $C = 0.02qE$  for a flywheel. (05 Marks)
- c. During one revolution of the crank of a multi cylinder engine the areas above and below the mean turning moment line taken in order are +0.36, -0.81, +0.75, -0.64, +0.92, -0.58cm<sup>2</sup>.  
Scale : 1cm = 45° → horizontal  
Vertical scale : 1cm = 7200Nm  
Speed of engine = 150rpm  
Total fluctuation of speed 2% of mean speed.  
Find : i) Mass of flywheel ii) Area of cross section of rim.  
Neglect the effect of arms and boss and take material density as 7260kg/m<sup>3</sup> and mean peripheral speed as 1000m/min. (10 Marks)
- 4 Derive an expression for circular arc cam with flat faced follower. (20 Marks)

## PART - B

- 5 A shaft running in bearings carries masses 20, 30, 40 kg in planes A, B and C with C.G from the axis of the shaft 30mm, 20mm and 15mm respectively. The distance of planes B and C from A are 1000mm and 2000mm to the right of A. The relative angular positions of the C.G of the unbalanced masses are such that they are in static balance. Find to obtain complete dynamic balance suitable masses are introduced in planes D and E with C.G. 100mm from the axis. D is 500mm to the left of A and E 500mm to the right of C. Determine the position and magnitude of the balancing masses. (20 Marks)
- 6 A five cylinder inline engine running at 500rpm has successive cranks at  $144^\circ$  apart. The distance between the cylinder centre line is 300mm. Piston stroke = 240mm. Length to C.R = 480mm. Examine the engine for balance of primary and secondary forces and couples. Find the maximum value of these and position of central crank at which these maximum values occur. The reciprocating mass for each cylinder is 150N. (20 Marks)
- 7 a. Derive an expression for Hartnell Governor for stiffness of spring. (10 Marks)  
 b. The upper arms of a porter governor are pivoted to the axis of rotation. The length is 40cm. The lower arm pivoted on the sleeve at a distance of 2cm from the axis, their length is 30cm. Mass of each ball is 5kg the sleeve mass is 50kg. Determine the equilibrium speed for the radius of rotation of 20cm and also the effort and power for 1% speed change. (10 Marks)
- 8 a. Explain with neat sketch the principle of gyroscopic couple and also derive the expression for gyroscopic couple. (10 Marks)  
 b. Each road wheel of a motor cycle has a moment of inertia of  $2\text{kg m}^2$ . The rotating parts of the engine of the motor cycle has a moment of inertia of  $0.2\text{kg m}^2$ . The speed of the engine is 5 times the speed of the wheel and is in the same sense. The mass of the motor cycle with rider is 200kg and its CG is 500mm above ground level. The diameter of the wheel is 500mm, the motor cycle is travelling at 15m/sec on a curve of 30m radius. Determine :  
 i) Gyro couple centrifugal couple overturning couple and balancing couple in term of angle of heel and  
 ii) Angle of heel. (10 Marks)

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