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B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2019

Fourth Semester

Mechanical and Automation Engineering

AN 6402 : KINEMATICS AND DYNAMICS OF MACHINERY

(Common to : Robotics and Automation Engineering)

(Regulations 2013)

Time : Three Hours | Maximum : 100 Marks

Answer ALL questions

PART – A (10×2=20 Marks)

1. Define the Grubler's criterion for plane mechanism with mathematical expression.
2. Write the two components of acceleration.
3. Define module in gears.
4. What is meant by undercutting of gears ?
5. Define crowning of pulley.
6. What is creep in the case of belt ?
7. What are the general methods of static force analysis of mechanism ?
8. How a single revolving mass is balanced by two masses revolving in different planes ?
9. Define isolation factor.
10. Define dynamic magnifier.

PART – B (5×13=65 Marks)

11. a) The following data are for a disc cam mechanism with roller follower. Minimum radius of the cam 35 mm, lift of the follower 40 mm, offset of the follower 10 mm right, roller diameter 15 mm. Cam rotation angles are as mentioned below. During ascent 120°, dwell 80°, during descent 80°, dwell 80°, cam rotates in clockwise direction and the follower motion is simple harmonic during ascent and descent. Draw the cam profile.

(OR)

b) A cam, with a minimum radius of 25 mm, rotating clockwise at a uniform speed is to be designed to give a roller follower, at the end of a valve rod, motion described below :

i) To raise the valve through 28 mm during 60° rotation of the cam
ii) To keep the valve fully raised through next 45°
iii) To lower the valve during next 90° and
iv) To keep the valve closed during rest of the revolution

The diameter of the roller is 15 mm. Draw the profile of the cam when the line of stroke of the valve rod is offset by 12mm towards right of the axis of the cam shaft. The displacement of the valve, while being raised and lowered, is to take place with uniform acceleration and retardation.

12. a) Determine the contact ratio for two involute gears which are meshing. Use the following data. Module 6 mm, pressure angle 18°, pinion teeth 25, gear teeth 50, addendum 0.8 times module.

(OR)

b) In a reverted epicyclic gear train, the arm F carries two gears A and D and a compound gear B-C. The gear A meshes with gear B and the gear D meshes with gear C. The numbers of teeth on A, D and C are 80, 48 and 72 respectively. Find the speed and direction of gear D when gear A is fixed and arm F makes 200 rpm counter clockwise.

13. a) The thrust of propeller shaft in marine engine is taken up by a number of collars integral with the shaft which is 300 mm in diameter. The thrust on the shaft is 200 kN and the speed is 75 rpm. Taking coefficient of friction 0.05 and assuming intensity of pressure as uniform and equal to 0.3 N/mm^2, find the external diameter of the collars and number of collars required, if the power lost in friction is not to exceed 16 kW.

(OR)

b) A shaft rotating at 90 rpm drives another shaft at 225 rpm and transmits10.5 kW through a belt. The belt is 115 mm wide and 12 mm thick and the coefficient of friction between the belt and the pulley is 0.25. The distance between the shaft is 2.75 m and the smaller pulley is 600 mm diameter. Calculate the stress in the belt if it is

i) an open belt drive (6)

ii) cross belt drive. (7)

14. a) In IC engine mechanism, the crank radius is 400 mm and connecting rod is 950 mm long. The diameter of piston is 100 mm and net gas pressure acting on piston is 15 MPa. Find :

i) thrust in connecting rod (3)

ii) piston side thrust (3)

iii) torque acting on crank shaft (3)

iv) radial force or load on main bearings when crank has made 45° from TDC. (4)

(OR)

b) A single -cylinder vertical engine has a bore of 300 mm and a stroke of 400 mm. The connecting rod is 1000 m long , the mass of reciprocating parts is 140 kg. On the expansion stroke, with the crank at 30° from the top dead centre , the gas pressure is 0.7 MPa. If the engine runs at 250 rpm, determine

i) net force acting on the piston (3)

ii) resultant load on the gudgeon pin (3)

iii) thrust on the cylinder walls (3)

iv) the speed above which, other things remaining same, the gudgeon pin load would be reversed in direction. (4)

15. a) A shaft carries four rotating masses A, B, C and D along its axis. The mass A may be assumed to be concentrated at a radius 200 mm, B at 260 mm, C at 140 mm and D at 170 mm. The masses of B, C and D are 32 kg, 52 kg, 42 kg respectively. The planes of revolution of B and C are 300 mm apart. The angle between B and C is 90°, angle between B and D is 210° and angle between C and D is 120° Determine :

i) the magnitude and angular position of mass A (6)

ii) the positions of planes A and D. (7)

(OR)

b) In a forced vibratory system a body having 2 kg mass vibrates in a viscous fluid. The harmonic exciting force of 20 N acting on the mass results in a resonance amplitude of 15 mm with a period of 0.15 sec. Determine the damping coefficient of viscous fluid. If the system is excited by the same harmonic force but at a frequency of 5 cycles/sec. What will be the amplitude of forced vibrations with and without damper ?

PART – C (1×15=15 Marks)

16. a) In a steam engine, the length of the connecting rod is 300 mm. The stroke is 150 mm. The crank position is 45° from inner dead centre The crank shaft speed is 600 r.p.m. (clockwise). Using analytical method. determine :
    i) Velocity and acceleration of the slider, and (7)
    ii) Angular velocity and angular acceleration of the connecting rod. (8)

(OR)

b) The obliquity ratio of a vertical reciprocating engine is 4.5. The engine bore and the crank radius are 60 mm and 40 mm respectively. The mass of the reciprocating parts is 1 kg. The difference in gas pressure acting on the two sides of the piston is 5 bar and the effective gas pressure acts downwards towards the crank shaft, when the crank has moved 50° from the top dead centre position. Determine when crank speed 2000 rpm, the piston effort, loads on the gudgeon pin and crank pin, the cylinder wall thrust and the thrust on the crank bearing. Neglect inertia of the connecting rod.