CBCS SCHEME

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21ME51

Fifth Semester B.E. Degree Examination, June/July 2024
Theory of Machines

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. Define the following :
(i) Mechanism
(ii) Machine
(iii) Link
(iv) Kinematic pair.
(v) Degree of freedom. **(10 Marks)**

b. Explain with a neat diagram, the crank and slotted lever mechanism. **(10 Marks)**

OR

2 a. What is completely constrained motion and partially constrained motion? Explain with example. **(04 Marks)**

b. In a Slider crank mechanism, the crank OB is 30 mm long and the connecting rod BC is 120 mm long. The crank rotates at a uniform speed of 300 rpm clockwise about center 'O'. For a crank position ∠BOC equal to 60 degree, draw the configuration and find
(i) Velocity of position C and angular velocity of connecting rod BC.
(ii) Acceleration of Piston C and angular acceleration of connecting rod BC. **(16 Marks)**

Module-2

3 a. Discuss the static equilibrium of,
(i) Two forces.
(ii) Three forces.
(iii) Member with two forces and a torque. **(06 Marks)**

b. A four bar mechanism under the action of two external forces is shown in Fig. Q3 (b). Find the required input torque on the link AB for static equilibrium. The dimensions of the links are AB = 50 mm, BC = 66 mm, CD = 55 mm, CE = 25 mm, CF = 30 mm, angle BAD = 60° and AD = 100 mm.

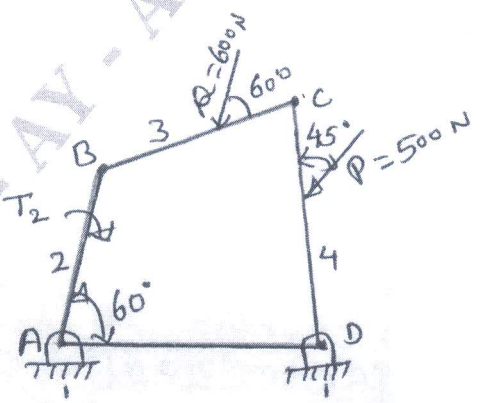

Fig. Q3 (b) **(14 Marks)**

OR

4 a. State and explain D'Alembert's principle. **(06 Marks)**

b. When the crank is 45 degree from the inner dead centre on the down stroke, the effective steam pressure on the piston of a vertical steam engine is 2.5 bars. The diameter of the cylinder = 0.75 m, Stroke of the piston = 0.50 m and length of the connecting rod = 1 m. Determine the torque on the crank shaft, if the engine runs at 350 rpm and the mass of the reciprocating parts is 200 kg. **(14 Marks)**

Module-3

5 a. State and prove the law of gearing for constant velocity ratio. **(10 Marks)**

b. Two involute gears with number of teeth 28 and 45 are in mesh. If they have standard addendum of 3 mm and pressure angle is 20 degree, find the following :

(i) Path of approach
(ii) Path of recess
(iii) Contact ratio.

Assume module is 3 mm. **(10 Marks)**

OR

6 The arm C of an epicyclic gear train rotates at 100 rpm in anticlockwise direction. The arm carries two wheels A and B having 36 and 45 teeth respectively. The wheel A is fixed and the arm rotates about the centre of wheel A. Find the speed of wheel B. What will be the speed of B, if wheel A instead of being fixed makes 200 rpm clockwise? **(20 Marks)**

Module-4

7 a. Explain briefly static balance and dynamic balance as applied to revolving masses in different planes. **(06 Marks)**

b. A shaft carries four masses A, B, C and D of magnitude 200 kg, 300 kg, 400 kg and 200 kg respectively and revolving at radii 80 mm, 70 mm, 60 mm and 80 mm respectively. The distance from the plane A are 300 mm, 400 mm and 700 mm. The angles between the cranks measured anticlockwise are A to B 45°, B to C 70° and C to D 120°. The balancing masses are to be placed in planes X and Y, the distance between the planes A and X is 100 mm, between X and Y is 400 mm and between Y and D is 200 mm. If the balancing masses at a radius of 100 mm, find their magnitudes and angular positions. **(14 Marks)**

OR

8 a. With usual notations, explain the primary and secondary unbalanced forces of reciprocating masses. **(04 Marks)**

b. Derive an expression for speed of a porter governor with usual notations taking friction into account. **(08 Marks)**

c. In a spring loaded Hartnell governor the extreme radii of rotation of the balls are 80 mm and 120 mm. The balls 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 rpm and 420 rpm. Find :

(i) Spring stiffness
(ii) Initial compression of the control spring.
(iii) Sleeve lift. **(08 Marks)**

Module-5

9 a. Define logarithmic decrement. Show that logarithmic decrement δ is given by $\frac{2\pi\zeta}{\sqrt{1-\zeta^2}}$ for underdamped system. **(08 Marks)**

b. A spring mass damper system has m = 3 kg, K = 100 N/m, C = 3 N-sec/m. Determine
(i) Damping factor
(ii) Natural frequency of damped vibration.
(iii) Logarithmic decrement.
(iv) The ratio of two successive amplitudes.
(v) Number of cycles after which the original amplitude is below 20%. **(12 Marks)**

OR

10 a. Derive an expressions for the natural frequency of free transverse vibration for a simply supported beam or shaft carrying several loads by using,
(i) Dunkerley's method.
(ii) Energy method. **(10 Marks)**

b. The following data relate to a shaft held in long bearings :
Length of shaft = 1.2 m
Diameer of shaft = 14 mm
Mass of a rotor at mid point = 16 kg
Eccentricity of centre of mass of rotor from centre of rotor = 0.4 mm
Modulus of elasticity of shaft material = 200 GN/m^2
Permissible stress in shaft materials = 70×10^6 N/m^2
Determine the critical speed of the shaft and the range of speed over which it is unsafe to run the shaft. Assume the shaft to be mass less. **(10 Marks)**

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