CBCS SCHEME

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21MT51

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

Time: 3 hrs. Max. Marks: 100

Note: **1.** ***Answer any FIVE full questions, choosing ONE full question from each module.***
2. ***Use of design data handbook may be used.***

Module-1

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

b. Find the degrees of freedom for the following mechanism, Fig.Q1(b)(i) & (ii).

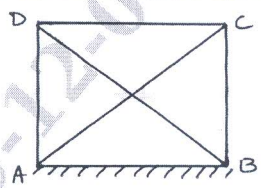

Fig.Q1(b)(i)

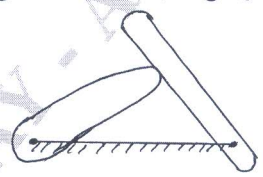

Fig.Q1(b)(ii) **(04 Marks)**

c. Explain with a neat sketch pendulum pump. **(06 Marks)**

OR

2 a. Explain with a neat sketch for the following:
(i) Peaucellier's mechanism (ii) Robert's mechanism **(10 Marks)**

b. Explain with a neat sketch of (i) Ackerman steering gear mechanism (ii) Pantograph. **(10 Marks)**

Module-2

3 a. Derive the expression for ratio of belt tension in flat belt drives. **(06 Marks)**

b. Derive the expression for centrifugal tension in flat belt drive. **(06 Marks)**

c. A leather belt is required to transmit 7.5 kW from a pulley 1.2 m in diameter, running at 250 rpm. The angle embraced is 165° and the coefficient of friction between the belt and the pulley is 0.3. If the safe working stress for leather belt is 1.5 MPa, density of leather 1 mg/m^3 and thickness of belt 10 mm, determine the width of the belt taking centrifugal tension into account. **(08 Marks)**

OR

4 A cam with a minimum radius of 50 mm, rotating clockwise at a uniform speed, is required to give a knife edge follower the motion as described below.
(i) To move outwards through 40 mm during 100° rotation of the cam.
(ii) To dwell for next 80°
(iii) To return to its starting position during next 90°
(iv) To dwell for the rest period of a revolution i.e. 90°

Draw the profile of the cam when the line of stroke of the follower passes through the centre of the cam shaft.

The displacement of the follower is to take place with uniform acceleration and uniform retardation. Determine the maximum velocity and acceleration of the follower when the cam shaft rotates at 900 rpm. **(20 Marks)**

Module-3

5 a. Define machine design and explain classification of machine design. **(10 Marks)**

b. State and explain design considerations. **(10 Marks)**

OR

6 a. Explain the following theories of failure:
(i) Maximum shear stress theory (ii) Distortion energy theory **(10 Marks)**

b. A rod of circular section is to sustain a torsional moment of 300 kN-m and a bending moment of 200 kN-m. Selecting 45 C8 steel (σ_{yt} = 353 MPa) and assuming factor of safety = 3, determine the diameter of rod as per the following theories of failure:
(i) Maximum shear stress theory (ii) Distortion energy theory **(10 Marks)**

Module-4

7 a. Define stress concentration and explain any four methods of reducing stress concentration. **(10 Marks)**

b. A flat plate subjected to a tensile force of 5 kN is shown in Fig.Q7(b). The plate material is grey cast iron (σ_u = 200 MPa). Determine the thickness of the plate. Factor of safety is 2.5.

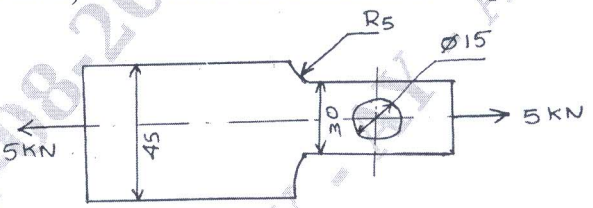

Fig.Q7(b) **(10 Marks)**

OR

8 a. Explain the following:
(i) Soderberg equation when a member is subject to fatigue axial loading.
(ii) Cumulative fatigue damage. **(10 Marks)**

b. A stepped shaft of circular cross section shown in Fig.Q8(b) is subjected to variable load which is completely reversed with a value equal to 100 kN. It is made of SAE 1045 steel annealed (σ_u = 586.4 MPa, σ_y = 309.9 MPa, σ_{-1} = 289.3 MPa). Determine the diameter 'd' and radius 'r', so that the maximum stress will be limited to a value corresponding to a factor of safety of 2. Notch sensitivity index = 1.

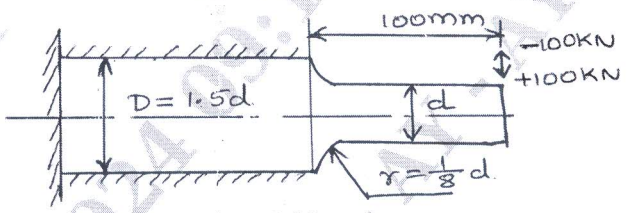

Fig.Q8(b) **(10 Marks)**

Module-5

9 Design pair of spur gears to transmit a power of 18 KW from a shaft running at 1000 rpm to a parallel shaft to be run at 250 rpm maintaining a distance of 160 mm between the shaft centers. Suggest suitable surface hardness for the gear pair. **(20 Marks)**

OR

10 The following data refer to a helical gear:
(i) Power transmitted 34 kW at 2800 rpm of pinion
(ii) Speed reduction ratio 4.5
(iii) Helix angle 25°
(iv) Material for both pinion and gear is medium carbon steel whose allowable bending stress may be taken as 230 MPa, BHN = 275.
(v) Pinion diameter is limited to 125 mm. Determine module and face width. Check the design for wear strength against dynamic loading. Determine also the axial thrust on the shaft. **(20 Marks)**