PAPER ID-310034

Subject Code: RME501

Roll No: | | | | | | | | | | | | | |

BTECH
(SEM V) THEORY EXAMINATION 2023-24
MACHINE DESIGN-I

TIME: 3 HRS **M.MARKS: 70**

Note: 1. Attempt all Sections. If require any missing data; then choose suitably.

SECTION A

1. Attempt *all* questions in brief. 2 x 7 = 14

a.	Define fatigue and endurance limit in design.
b.	What do you understand by preferred numbers?
c.	When a shaft is subjected to a bending moment M and a twisting moment T, what will be the equivalent twisting moment?
d.	Differentiate between rigid and flexible coupling.
e.	Define spring index.
f.	Differentiate between chaukling and Fullering.
g.	Define self-locking screw.

SECTION B

2. Attempt any *three* of the following: 7 x 3 = 21

a.	A machine element is subjected to the following stresses σx=40MPa, σy=35MPa, τxy=15 MP. find the factor of safety, if it is made up of C45 steel having yield stress as 350MPa, using the following theory of failure (i) Rankine Theory (ii) Guest Theory (iii) Von- Mises -Hencky Theory
b.	Discuss the Soderberg, Goodman and modified Goodman criteria in detail.
c.	A cylindrical shaft made of steel having yield strength 800 mpa is subjected to static load consisting of bending moment 10 kN-m and a torsional moment of 30 kN-m. Assuming F.O.S of 2. Find the required diameter of shaft using max. shear stress theory. Take E =210 GPa and Poisson ratio is 0.25.
d.	A helical spring is made of a wire 6mm diameter and has outside diameter of 75 mm if the permissible shear stress is 350 N/mm2 and modulus of rigidly is 84 KN/mm2, find the axial load which the spring can carry and deflection per active turn. Neglect the effect of curvature.
e.	Derive the expression for efficiency of power screw.

SECTION C

3. Attempt any *one* part of the following: 7 x 1 = 7

(a)	Discuss all theories of failure in brief with their graphical representation.
(b)	Define Design. Explain the Complete design process in detail. Discuss the important design considerations.

4. Attempt any *one* part of the following: 7 x 1 = 7

(a)	A pulley is keyed to a shaft midway between two bearings. The shaft is made of cold drawn steel for which the ultimate strength is 550 MPa and the yield strength is 400 MPa. The bending moment at the pulley varies from – 150 N-m to + 400 N-m as the torque on the shaft varies from – 50 N-m to + 150 N-m. Obtain the diameter of the shaft for an indefinite life. The stress concentration factors for the keyway at the pulley in bending and in torsion are 1.6 and 1.3

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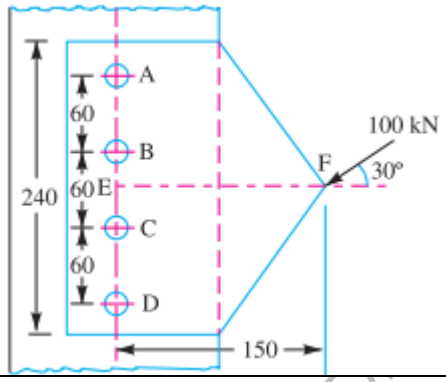
	respectively. Take the following values: Factor of safety = 1.5 Load correction factors = 1.0 in bending, and 0.6 in torsion Size effect factor = 0.85 Surface effect factor = 0.88
(b)	A bracket in the form of a plate is fitted to a column by means of four rivets A, B, C and D in the same vertical line, as shown in Fig. 9.33. AB = BC = CD = 60 mm. E is the mid-point of BC. A load of 100 kN is applied to the bracket at a point F which is at a horizontal distance of 150 m from E. The load acts at an angle of 30° to the horizontal. Determine the diameter of the rivets which are made of steel having a yield stress in shear of 240 MPa. Take a factor of safety of 1.5. 

5. Attempt any *one* part of the following: 7 x 1 = 7

(a)	Design a shaft to transmit power from an electric motor to a lathe head stock through a pulley by means of a belt drive. The pulley weighs 200 N and is located at 300 mm from the centre of the bearing. The diameter of the pulley is 200 mm and the maximum power transmitted is 1 kW at 120 r.p.m. The angle of lap of the belt is 180° and coefficient of friction between the belt and the pulley is 0.3. The shock and fatigue factors for bending and twisting are 1.5 and 2.0 respectively. The allowable shear stress in the shaft may be taken as 35 MPa.
(b)	A shaft is supported by two bearings placed 1 m apart. A 600 mm diameter pulley is mounted at a distance of 300 mm to the right of left hand bearing and this drives a pulley directly below it with the help of belt having maximum tension of 2.25KN. Another pulley 400 mm diameter is placed 200 mm to the left of right hand bearing and is driven with the help of electric motor and belt, which is placed horizontally to the right. The angle of contact for both the pulleys is 180° and μ = 0.24. Determine the suitable diameter for a solid shaft, allowing working stress of 63 MPa in tension and 42 MPa in shear for the material of shaft. Assume that the torque on one pulley is equal to that on the other pulley.

6. Attempt any *one* part of the following: 7 x 1 = 7

(a)	Design a helical spring for a spring loaded safety valve for the following conditions: Diameter of valve seat = 70 mm; Operating pressure = 0.75 N/mm^2; Maximum pressure when the valve blows off freely = 0.8 N/mm^2; Maximum lift of the valve when the pressure rises from 0.75 to 0.8 N/mm^2 = 3.5 mm ; Maximum allowable stress = 650 MPa ; Modulus of rigidity = 84 kN/mm^2; Spring index = 6.
(b)	A helical compression spring made of oil tempered carbon steel, is subjected to a load which varies from 400 N to 1200 N. The spring index is 6 and the design factor of safety is 1.5. If the yield stress in shear is 770 MPa and endurance stress in shear is 350 MPa, Find: (i) Size of the spring wire, (ii) Diameters of the spring, (iii)

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	Number of turns of the spring, and (iv)Free length of the spring. The compression of the spring at the maximum load is 30 mm. The modulus of rigidity for the spring material may be taken as 80 kN/mm^2.

7. Attempt any *one* part of the following: 7 x 1 = 7

(a)	A vertical two start square threaded screw of 100 mm mean diameter and 20 mm pitch supports a vertical load of 18 kN. The nut of the screw is fitted in the hub of a gear wheel having 80 teeth which meshes with a pinion of 20 teeth. The mechanical efficiency of the pinion and gear wheel drive is 90 percent. The axial thrust on the screw is taken by a collar bearing 250 mm outside diameter and 100 mm inside diameter. Assuming uniform pressure conditions, find, minimum diameter of pinion shaft and height of nut, when coefficient of friction for the vertical screw and nut is 0.15 and that for the collar bearing is 0.20. The permissible shear stress in the shaft material is 56 MPa and allowable bearing pressure is 1.4 N/mm2.
(b)	An electric motor driven power screw moves a nut in a horizontal plane against a force of 75 kN at a speed of 300 mm / min. The screw has a single square thread of 6 mm pitch on a major diameter of 40 mm. The coefficient of friction at screw threads is 0.1. Estimate power of the motor