Sub Code: RME504

Paper Id: 140509 Roll No: | | | | | | | | | | | | | |

B TECH

(SEM V) THEORY EXAMINATION 2019-20

DESIGN OF MACHINE ELEMENT

Time: 3 Hours *Total Marks: 70*

Notes:

- *Attempt all Sections.*
- *Assume any missing data. Use of design data book is allowed.*

SECTION -A

1. Attempt any seven questions in brief. **[2x7=14]**

a) What is the difference between modulus of elasticity and modulus of rigidity?

b) Write short note on maximum shear stress theory verses maximum strain energy theory.

c) What are flexible couplings and what are their applications? Illustrate your answer with suitable examples.

d) Discuss the various types of power threads.

e) Define the following:
(i) Poisson's ratio, (ii) Volumetric strain

f) Explain the following terms in connection with design of machine members subjected to variable Loads:
(i)Endurance limit, (ii) Notch sensitivity.

g) What is a herringbone gear? Where they are used?

h) Explain the following terms used in helical gears:

(*a*) Helix angle; (*b*) normal pitch;

SECTION-B

2. Attempt any three part of the following: **[7X3=21]**

a) A screw jack is to lift a load of 80 kN through a height of 400 mm. The elastic strength of screw material in tension and compression is 200 MPa and in shear 120 MPa. The material for nut is phosphor-bronze for which the elastic limit may be taken as 100 MPa in tension, 90 MPa in compression and 80 MPa in shear. The bearing pressure between the nut and the screw is not to exceed 18 N/mm2. Design and draw the screw jack. The design should include the design of 1. Screw, 2. Nut, 3. Handle and cup, and 4. Body.

b) A horizontal nickel steel shaft rests on two bearings, A at the left and B at the right end and carries two gears C and D located at distances of 250 mm and 400 mm respectively from the centre line of the left and right bearings. The pitch diameter of the gear C is 600 mm and that of gear D is 200 mm. The distance between the centre lines of the bearings is 2400 mm. The shaft transmits 20 kW at 120 r.p.m. The power is delivered to the shaft at gear C and is taken out at gear D in such a manner that the tooth pressure FtC of the gear C and F_{tD} of the gear D act vertically downwards. Find the diameter of the shaft, if the working stress is 100 MPa in tension and 56 MPa in shear. The gear C and D weighs 950 N and 350 N respectively. The combined shock and fatigue factors for bending and torsion may be taken as 1.5 and 1.2 respectively

c) A pair of helical gears is to transmit 15 kW. The teeth are 20° stub in diametral plane and have a helix angle of 45°. The pinion runs at 10 000 r.p.m. and has 80 mm pitch diameter. The gear has 320 mm pitch diameter. If the gears are made of cast steel having allowable static strength of 100 MPa; determine a suitable module and face width from static strength considerations and check the gears for wear, given σes = 618 MPa.

d) For the axially loaded member shown in Fig.1 determine the nodal displacements and reaction at fixed end.

Given: Area of Aluminum rod $= 32\times10^{-4}$ m^2
Area of Brass rod $= 12\times10^{-4}$ m^2
Modulus of Elasticity E_{Al} = 70 GPa
Modulus of Elasticity E_{Brass} = 100 GPa
Axial load P_2 = 250 kN
Axial load P_3 = 80 kN

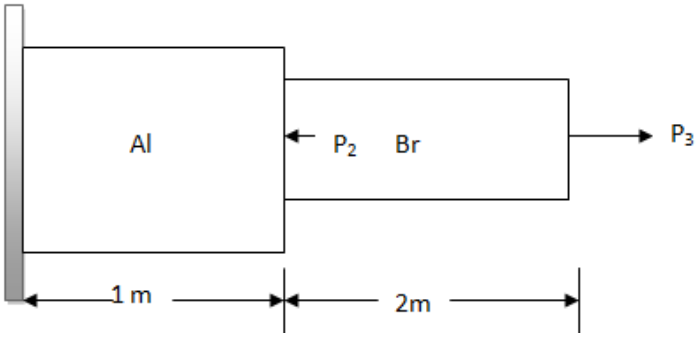

Fig.1

SECTION-C

3. Attempt any one part of the following: [7x1=7]

a) Design a close coiled helical compression spring for a service load ranging from 2250 N to 2750 N. The axial deflection of the spring for the load range is 6 mm. Assume a spring index of 5. The permissible shear stress intensity is 420 MPa and modulus of rigidity, G = 84 kN/mm^2. Neglect the effect of stress concentration. Draw a fully dimensioned sketch of the spring, showing details of the finish of the end coils.

b) Design a muff coupling to connect two shafts transmitting 40 kW at 120 r.p.m. The permissible shear and crushing stress for the shaft and key material (mild steel) are 30 MPa and 80 MPa respectively. The material of muff is cast iron with permissible shear stress of 15 MPa. Assume that the maximum torque transmitted is 25 per cent greater than the mean torque.

4. Attempt any one part of the following: [7x1=7]

a) Explain general methodology of solving a design problem using finite element method. Also write the advantages of FEM.

b) A simply supported beam has a concentrated load at the centre which fluctuates from a value of P to 4 P. The span of the beam is 500 mm and its cross-section is circular with a diameter of 60 mm. Taking for the beam material an ultimate stress of 700 MPa, a yield stress of 500 MPa, endurance limit of 330 MPa for reversed bending, and a factor of safety of 1.3, calculate the maximum value of P. Take a size factor of 0.85 and a surface finish factor of 0.9.

5. Attempt any one part of the following: [7x1=7]

a) A bar of circular cross-section is subjected to alternating tensile forces varying from a minimum of 200 kN to a maximum of 500 kN. It is to be manufactured of a material with an ultimate tensile strength of 900 MPa and an endurance limit of 700 MPa. Determine the diameter of bar using safety factors of 3.5 related to ultimate tensile strength and 4 related to endurance limit and a stress concentration factor of 1.65 for fatigue load. Use Goodman straight line as basis for design.

b) Design a helical compression spring for a maximum load of 1000N for a deflection of 25mm using Value of spring index as 5. Maximum permissible shear stress for spring wire is 420MPa & modulus of Rigidity is 84KN/mm^2. Take Wahl's factor: K= [{(4C-1) / (4C-4)} + {(0.615)/C}] where C = spring index.

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6. Attempt any one part of the following: [7x1=7]

a) 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 2.25 kN. 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.

b) Design a shaft and flange for a Diesel engine in which protected type of flange coupling is to be adopted for power transmission. The following data is available for design: Power of engine = 75 kW; speed of engine = 200 r.p.m.; maximum permissible stress in shaft = 40 MPa; maximum permissible twist in shaft = 1° in length of shaft equal to 30 times the diameter of shaft; maximum torque = 1.25 × mean torque; pitch circle diameter of bolts = 3 × diameter of shaft; maximum permissible stress in bolts = 20 MPa

7. Attempt any two part of the following: [3.5x2=7]

a) A steel shaft 35 mm in diameter and 1.2 m long held rigidly at one end has a hand wheel 500nmm in diameter keyed to the other end. The modulus of rigidity of steel is 80 GPa.

(i). what load applied to tangent to the rim of the wheel produce a torsional shear of 60 MPa?

(ii). How many degrees will the wheel turn when this load is applied?

b) What are the factors to be considered for the selection of materials for the design of machine elements? Discuss.

c) Explain the following terms of the spring:

(i) Solid height;

(iii) Spring rate; (iv) Active and inactive coils;