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SUB CODE: NME501 SEM: 5TH

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B TECH
(SEM V) THEORYEXAMINATION 2017-18
MACHINE DESIGN - I

Time: 3 Hours ***Total Marks: 100***

Note: 1. Attempt all Sections. If require any missing data; then choose suitably.
2. Standard design data book is allowed

SECTION A

1. Attempt *all* questions in brief. 2 x10 = 20

a. Explain the BIS method of specifying cast iron and its major types.
b. What is the standardization in design, Discuss with suitable example
c. Enumerate advantages and disadvantages of plastic materials over metals.
d. What are the various factors that reduce fatigue strength of materials?
e. What is meant by stress concentration? How it can be mitigated?
f. Define the term Caulking and Filleting.
g. Define the end connections of compression and tension helical springs with suitable sketch.
h. What is an eccentric riveted joint? Explain the method adopted for designing such a joint?
i. Describe the distortion energy theory.
j. A manufacturer is interested in manufacturing 4 different models of generating sets ranging from 5 kw to 50 kw capacities. Using R5 series, specify the capacities of the models. If the further wisher wants to expand 8 models within the same range, what will be the capacities of the additional models?

SECTION B

2. Attempt any *three* of the following: 10 x 3 = 30

a. An overhang crank with pin and shaft is shown in Fig. 1, tangential load of 15 kN acts on the crank pin. Determine the maximum principal stress and the maximum shear stress at the center of the crankshaft bearing.

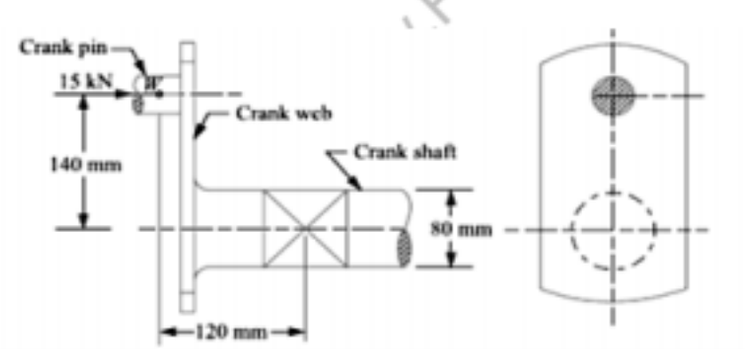

Figure 1

b. 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.

c. A double riveted lap joint is made between 15 mm thick plates. The rivet diameter and pitch are 25 mm and 75 mm respectively. If the ultimate stresses are 400 MPa in tension, 320 MPa in shear and 640 MPa in crushing, find the minimum force per pitch which will rupture the joint. If the above joint is subjected to a load such that the factor of safety is 4, find out the actual stresses developed in the plates and the rivets.

d. Design and draw a protective type of cast iron flange coupling for a steel shaft transmitting 15 kW at 200 r.p.m. and having an allowable shear stress of 40 MPa. The working stress in the bolts should not exceed 30 MPa. Assume that the same material is used for shaft and key and that the crushing stress is twice the value of its shear stress. The maximum torque is 25% greater than the full load torque. The shear stress for cast iron is 14 MPa.

e. The cutter of a broaching machine is pulled by square threaded screw of 55 mm external diameter and 10 mm pitch. The operating nut takes the axial load of 400 N on a flat surface of 60 mm and 90 mm internal and external diameters respectively. If the coefficient of friction is 0.15 for all contact surfaces on the nut, determine the power required to rotate the operating nut when the cutting speed is 6 m/min. Also find the efficiency of the screw.

SECTION C

3. Attempt any *one*part of the following: 10 x 1 = 10

(a) Write the procedure to design the (i) Longitudinal butt joint of a boiler shell and (ii) bush pin type flexible coupling.

(b) A steel connecting rod is subjected to a completely reversed axial load of 160 kN. Suggest the suitable diameter of the rod using a factor of safety 2. The ultimate tensile strength of the material is 1100 MPa, and yield strength 930 MPa. Neglect column action and the effect of stress concentration.

4. Attempt any *one* part of the following: 10 x 1 = 10

(a) A triple riveted lap joint with zig-zag riveting is to be designed to connect two plates of 6 mm thickness. Determine the dia. of rivet, pitch of rivets and distance between the rows of rivet. Indicate how the joint will fail. Assume: σ_t= 120 MPa; τ = 100 MPa and σ_c= 150 MPa.

(b) Design the longitudinal and circumferential joint for a boiler whose diameter is 2.4 meters and is subjected to a pressure of 1 N/mm2. The longitudinal joint is a triple riveted butt joint with an efficiency of about 85% and the circumferential joint is a double riveted lap joint with an efficiency of about 70%. The pitch in the outer rows of the rivets is to be double than in the inner rows and the width of the cover plates is unequal. The allowable stresses are: σ_t = 77 MPa; τ = 56 MPa and σ_c = 120 MPa Assume that the resistance of rivets in double shear is 1.875 times that of single shear. Draw the complete joint.

5. Attempt any *one* part of the following: 10 x 1 = 10

(a) It is required to design a square key for fixing a pulley on the shaft, which is 50 mm in diameter. The pulley transmits 10 kW power at 200 rpm to the shaft. The key is made of steel 45C8 ($\sigma_{yt} = \sigma_{yc}$= 380 N/mm^2) and the factor of safety is 3. Determine the dimensions of the key. Assume ($\sigma_{sy} = 0.577\ \sigma_{yt}$).

(b) Design a cast iron protective flange coupling to connect two shafts in order to transmit 7.5 kW at 720 r.p.m. The following permissible stresses may be used: Permissible shear stress for shaft, bolt and key material = 33 MPa Permissible crushing stress for bolt and key material = 60 MPa, Permissible shear stress for the cast iron = 15 MPa.

6. Attempt any *one* part of the following: 10 x 1 = 10

(a) A shaft is supported on bearings A and B, 800 mm between centers. A 20° straight tooth spur gear having 600 mm pitch diameter, is located 200 mm to the right of the

left hand bearing A, and a 700 mm diameter pulley is mounted 250 mm towards the left of bearing B. The gear is driven by a pinion with a downward tangential force while the pulley drives a horizontal belt having 180° angle of wrap. The pulley also serves as a flywheel and weighs 2000 N. The maximum belt tension is 3000 N and the tension ratio is 3:1. Determine the maximum bending moment and the necessary shaft diameter if the allowable shear stress of the material is 40 MPa.

(b) Design a screw jack for lifting a load of 50 kN through a height of 0.4 m. The screw is made of steel and nut of bronze. The following allowable stresses may be assumed For steel: Compressive stress = 80 MPa; Shear stress = 45 MPa; For bronze: Tensile stress = 40 MPa, Bearing stress = 15, MPa Shear stress = 25 MPa. The coefficient of friction between the steel and bronze pair is 0.12. The dimensions of the swivel base may be assumed proportionately. The screw should have square threads. Design the screw, nut and handle. The handle is made of steel having bending stress 150 MPa (allowable).

7. Attempt any *one* part of the following: 10 x 1 = 10

(a) Design a helical spring for a spring loaded safety valve (Ramsbottom safety valve) for the following conditions: Diameter of valve seat = 65 mm; Operating pressure = 0.7 N/mm^2; Maximum pressure when the valve blows off freely = 0.75 N/mm^2; Maximum lift of the valve when the pressure rises from 0.7 to 0.75 N/mm^2 = 3.5 mm; Maximum allowable stress = 550 MPa; Modulus of rigidity = 84 kN/mm^2; Spring index = 6. Draw a neat sketch of the free spring showing the main dimensions.

(b) Explain the following terms in connection with design of machine members subjected to variable loads:

(a) Endurance limit, *(c)* Size factor,
(b) Surface finish factor, and *(d)* Notch sensitivity.