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Your Roll No. .....

B.Tech. (M) / IV **J**

Paper EME–401— MACHINE DESIGN

Time : 3 hours *Maximum Marks* : 70

(Write your Roll No. on the top immediately on receipt of this question paper.)

Note : - (i) Question No. 1 is compulsory.
(ii) Answer any four from the remaining.
(iii) Use of Design Data Handbook is allowed.
(iv) Assume missing data, if any.
(v) Use of non programmable scientific calculator allowed

1. (a) List the important factors that influence the magnitude of factor of safety.
(b) What is meant by eccentric loading and eccentricity?
(c) What is meant by stress concentration, how it can be reduced in components?
(d) Write Soderberg's equation and state its application to different type of loadings.
$3_{1/2} \times 4 = 4$

2. Design the longitudinal and circumferential joint for a boiler whose diameter is 2.4 meters and subjected to a pressure of 1 N/mm^2 . The longitudinal joint is a triple riveted butt joint with an efficiency of 85% and circumferential joint is a double riveted lap joint with an efficiency of 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 + 5 +4 = 14)

3. (a) Determine the length of weld run for a plate of size 120 mm wide and 15 mm thick to be welded to another plate by means of a single transverse weld and double parallel fillet welds when the joint is subjected to variable loads. (2 + 8)
(b) Define the terms used in screws : Double start, Major diameter, Pitch and Lead (4)

4. Design and draw a cotter joint to support a load varying from 30,000N in compression to 30,000 N in tension. The material used is carbon steel for which the following allowable stresses may be used. The load is applied statically. $\sigma_t = \sigma_c$ = 50 MPa , τ = 35 MPa and crushing stress = 90 MPa. (14)

Turn over

5. (a) A line shaft rotating at 200 rpm is to transmit 20 kW. The allowable shear stress for the material of the shaft is 42 MPa. If the shaft carries a central load of 900 N and is simply supported between bearing 3 meter apart, determine the diameter of the shaft. The maximum tensile or compressive stress not to exceed 56 MPa. (10)

(a) Define equivalent twisting moment and equivalent bending moment. State when these two terms are used in design of shafts. (1+1+2=4)

6. (a) Design a helical compression spring for a maximum load of 2000 N for a deflection of 25 mm using the value of spring index as 5. The maximum permissible shear stress for spring wire is 420 MPa and Modulus of rigidity is 84 kN/mm^2 .

Take Wahl's factor, $k=\frac{4C-1}{4C-4}+\frac{0.615}{C}$ where C is

spring index. Find : 1. Size of spring wire 2 . Diameters of the spring, 3. Number of turns of the spring, and 4. Free length of the spring. (5 + 2 +2+1 = 10)

(b) Explain the following terms used in helical gears :

(i) Module (ii) Backlash

(iii) Pressure angle (iv) Circular pitch (1+1+1+1 = 4)

7. A pair of straight teeth spur gears is to transmit 20 kW when the pinion rotates at 300 rpm. The velocity ratio is 1 : 3. The allowable static stresses for the pinion and gear materials are 120 MPa and 100 MPa respectively. The pinion has 15 teeth and its face width is 14 times the module. Determine : (a) Module, (b) Face width and (c) Pitch circle diameter of both the pinion and the gear from the stand point of strength only, taking into consideration the effect of the dynamic loading. The tooth form factor y can be taken as

$$y = 0.154 - \frac{0{\cdot}912}{No.\ of\ teeth}$$

and the velocity factor

C_V as $C_v=\frac{3}{3+v}$,

where v is pitch line velocity expressed in m/s. (5 + 5 + 4)

8. Write short notes on the following :

(i) Buckling in spring.

(ii) Causes of gear tooth failures

(iii) Notch sensitivity

(iv) Modes of failures of riveted joints

(v) Assumption made in deriving a bending formula

(vi) Design Procedure

(vii) Forms of screw threads (2 x 7 = 14)