Unit III

5. (a) A transmission shaft of cold drawn steel 27Mn^2 (s_{ut} = 500 MPa and S_{yt} = 300 MPa) is subjected to fluctuating torque which varies from –100 N-m to + 400 N-m.

(i) Draw the modified Goodman's line diagram assuming surface factor equal to 0.8, size factor equal to 0.85 and reliability factor equal to 0.897. Neglect stress concentration.

(ii) Determine the diameter of the shaft using Maximum shear stress theory.

(b) Define theoretical stress concentration factor K_t, fatigue stress concentration factor K_f, and notch sensitivity q. Derive relation among them and explain why we do not have data for fatigue stress concentration factor K_t in design data book rather we have that for K_t and q.

10+5=15

AA-84

M. Tech. EXAMINATION, May 2017

(First Semester)

(B. Scheme) (Re-appear Only)

(ME)

MEM-507-B

ADVANCED DESIGN OF MECHANICAL SYSTEMS

Time : 3 *Hours*] [*Maximum Marks :* 75

Before answering the question-paper candidates should ensure that they have been supplied to correct and complete question-paper. No complaint, in this regard, will be entertained after the examination.

Note : Attempt *Five* questions in all, selecting at least *one* question from each Unit. Assume any missing data suitably. All questions carry equal marks.

Unit I

1. (a) From a given Displacement Field $\{u\ v\ w\}^T$, derive Stress field $\{\sigma_{xx}\ \sigma_{yy}\ \sigma_{zz}\ \tau_{xy}\ \tau_{xz}\ \tau_{zx}\}^T$.

   (b) Considering the equilibrium of elementary tetrahedron, derive general formula for stress on an arbitrary plane. **7+8=15**

2. (a) Derive stress equilibrium equations from force equilibrium consideration. Take body forces also into account.

   (b) From moment equilibrium consideration prove that complementary shear stresses are equal. **8+7=15**

Unit II

3. (a) Write the mathematical statement of Max Shear Stress and Von Mises/Maximum Distortion Energy theories in terms of principal stresses and their corresponding design equations.

   (b) A circular shaft is subjected to a combined load consisting of a bending moment M = 20 kN-m and a constant torque T = 30 kN-m. Assume that the bar is made of C 15 steel with yield strength equal to 420 MPa. Determine the principal stresses at the section of the shaft. And assuming a factor of safety of 2 determine the diameter of the shaft using maximum Shear Stress Theory and Von-Mises Theory and comment on the results. **8+7=15**

4. (a) Write constitutive relation between stress field and strain field.

   (b) Derive the governing equation for fix-fix column made of steel with yield strength of 220 MPa using free body diagram and determine the expression for critical load. Determine the minimum value of slenderness ratio for which the formula so derived is valid. **5+(7+3)=15**

Unit IV

7. Explain engineering design. Discuss various phases of engineering design with special emphasis on feasibility phase but explain phase with suitable illustrative examples to bring the point home. **5+10=15**

8. Explain any *three* with suitable illustrative examples : **5×3=15**

(a) Open-ended and close-ended engineering design problem.

(b) Gaussian Normal distribution and its significance in engineering design.

(c) Design for ergonomics and aesthetics.

(d) Material considerations in design.

6. The work cycle of a mechanical component subjected to completely reversed bending stresses comprising of the following three components :

(i) $\pm$ 350 N/mm^2 for 60% of time.

(ii) $\pm$ 400 N/mm^2 for 20% of time.

(iii) $\pm$ 450 N/mm^2 for 20% of time.

The material of the component is 50 C8 (Sut = 650 MPa). It is machined and cold drawn with a surface factor of 0.70 and size factor of 0.75.

(a) Draw the S-N diagram for the component for high cycle fatigue.

(b) Construct Relation between fatigue strength S and Fatigue life N for this mechanical component.

(c) Determine the life of the component.

5×3=15