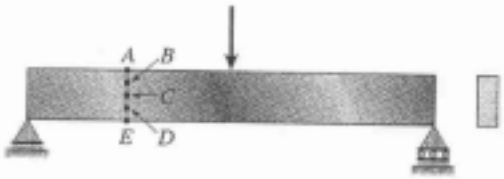
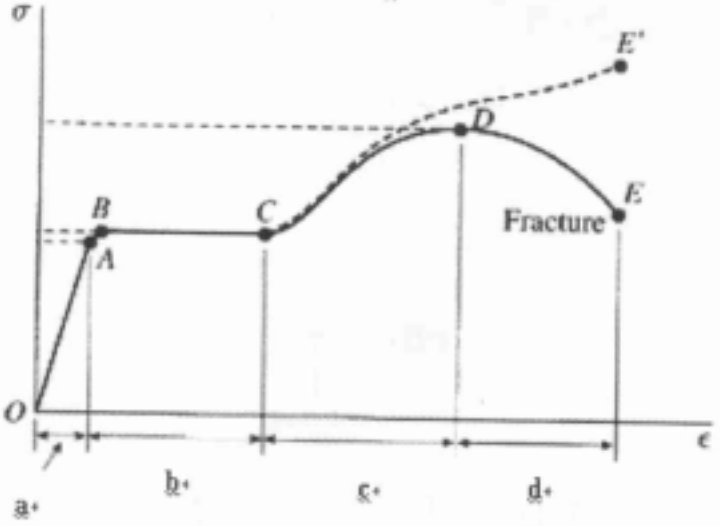
Mechanics of Materials

I 、 Explain the following terms:

1. Principal Stress
2. Statically indeterminate structure
3. Buckling
4. For a beam of rectangular cross section as shown in the figure, please draw the normal and shear stresses acting on stress element at points A, B, C, D, and E. Where points A and E are at the top and bottom of the beam respectively, point C is at the mid-height of the beam, and points B and D are in between.



5. Please explain all the points on the stress-strain curve and the meanings of the corresponding horizontal region.



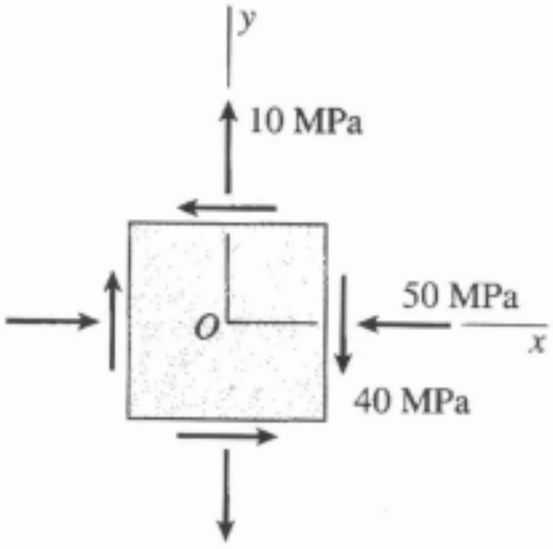
Ⅱ、At a point on the surface of a generator shaft the stress are σ_x=-50 MPa, σ_y=10 MPa, and τ_{xy}=-40 MPa, as shown in Figure. Using Mohr's circle, determine the following quantities：(a) the stress acting on an element inclined at an angle θ=45°, (b) the principal stresses, and (c) the maximum shear stresses.（Consider only the in-plane stresses, and show all results on sketches of properly oriented elements.）

$$\sigma_{x_1} - \frac{\sigma_x + \sigma_y}{2} = \frac{\sigma_x - \sigma_y}{2}\cos 2\theta + \tau_{xy}\sin 2\theta$$

$$\tau_{x_1y_1} = -\frac{\sigma_x - \sigma_y}{2}\sin 2\theta + \tau_{xy}\cos 2\theta$$

$$(\sigma_{x_1} - \frac{\sigma_x + \sigma_y}{2})^2 + \tau_{x_1y_1}^2 = (\frac{\sigma_x - \sigma_y}{2})^2 + \tau_{xy}^2$$

$$\sigma_{aver} = \frac{\sigma_x + \sigma_y}{2} \qquad R = \sqrt{(\frac{\sigma_x - \sigma_y}{2})^2 + \tau_{xy}^2}$$



Vibration Theory and Practice

1. Explain Convolution Integral (or called Duhamel;s Integral) and its physical meanings (10%)

2. What are Modal Coordinates (or called Natural Coordinates, Principal Coordinates, or Normal Coordinates) and explain their physical meanings (10%)

3. What is Expansion Theorem (or called Modal Expansion Theorem, or Mode Summation Method)? What is the difference between the Expansion theorem and assumed mode method ? (10%)

4. What is the physical meanings of complex eigenvectors. (10%) in vibration

5. Why a gyroscopic system as below is conservative? (10%)
   $\mathbf{M}\ddot{\mathbf{q}} + \mathbf{G}\dot{\mathbf{q}} + \mathbf{K}\mathbf{q} = 0$
   where $\mathbf{q}$ is the generalized coordinate vector, $\mathbf{M}$ is a real symmetric positive definite mass matrix, $\mathbf{G}$ is a real skew symmetric gyroscopic matrix, and $\mathbf{K}$ is a real symmetric positive definite or positive semidefinite stiffness matrix.