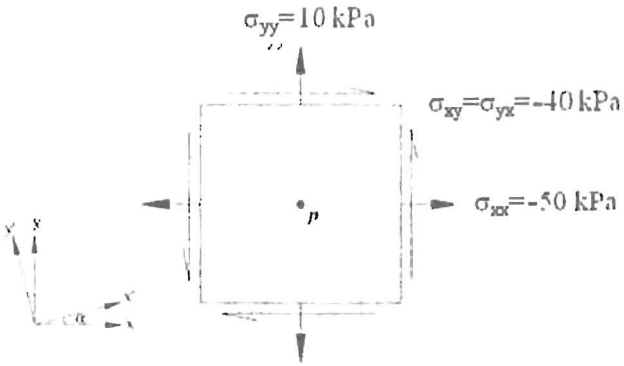
※ 考生請注意：本試題 □可 ☑不可 使用計算機

1. Define the following terms:
   (a) Yield strength and ultimate strength. (5%)
   (b) Ductile materials and brittle materials. (5%)
   (c) Engineering stress and true stress. (5%)
   (d) Draw a typical stress-strain diagram of a ductile material and mark yield strength, ultimate strength, and fracture point in the diagram. (5%)

2. Consider the 2-D state of stress shown to the right. Using Mohr's circle, determine the following quantities: (a) the values of stresses α'_{xx}, α'_{yy}, α'_{xy} for $\alpha = 45^\circ$ (10%), and (b) the principal stresses and the maximum shearing stress (10%).



3. Like stress, strain can have different components at each point depending on the coordinate system to which it is referred. It can be shown that strain transforms in the following fashion:

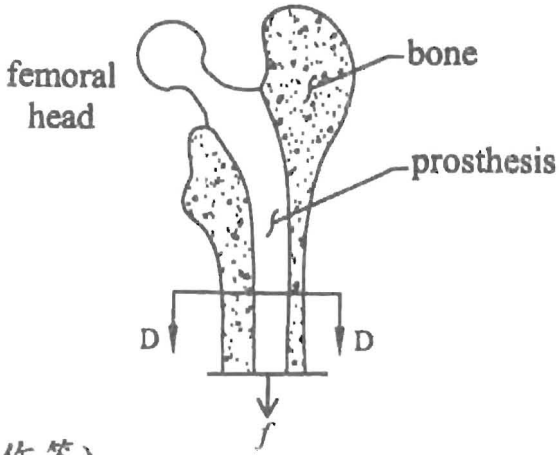
$$\varepsilon'_{xx} = \varepsilon_{xx}\cos^2\alpha + \varepsilon_{yy}\sin^2\alpha + \gamma_{xy}\sin\alpha\cos\alpha,$$

$$\varepsilon'_{yy} = \varepsilon_{xx}\sin^2\alpha + \varepsilon_{yy}\cos^2\alpha - \gamma_{xy}\sin\alpha\cos\alpha,$$

$$\frac{\gamma'_{xy}}{2} = (\varepsilon_{yy} - \varepsilon_{xx})\sin\alpha\cos\alpha + (\cos^2\alpha - \sin^2\alpha)\frac{\gamma_{xy}}{2}.$$

Design an experimental set-up using strain gauges whereby one can measure a complete 2-D strain in a small region (i.e., averaged over a small region even though strain is, strictly speaking, defined at a point). (10%)

4. One of the most common causes of femoral damage is fracture associated with osteoporosis (骨質疏鬆). Artificial hips are designed to be implanted surgically to relieve pain and restore ambulatory motion. Focus on the region near section D-D in the figure and consider the action of an axial load only. How does the applied load f in the figure distribute between the metal implant and the remaining bone? Assume that



(背面仍有題目,請繼續作答)

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the bone and the prosthesis each exhibit linearly elastic, homogeneous, and isotropic behaviors. The elastic moduli for the bone and the prosthesis are E_b and E_p, respectively, and cross-sectional areas for the bone and the prosthesis are A_b and A_p, respectively. Begin the analysis by drawing a free body diagram that relates the axial stresses in each component to the applied load f and geometry. (20%) Propose a hypothesis that causes bone resorption after implantation of the metal prosthesis. (5%)

5. Modeling a saccular aneurysm (囊狀動脈瘤) as a thin-walled sphere, assume that it has an inner radius of a and a thickness of h at a mean blood pressure of P. Draw a free body diagram and show that $\sigma_{\theta\theta} = \sigma_{\phi\phi} = \dfrac{Pa}{2h}$. (10%)

6. The rigid bar DEF is welded at point D to the steel beam AB. For the loading shown, determine the equations defining the shear and bending moment at any point of the beam (15%).