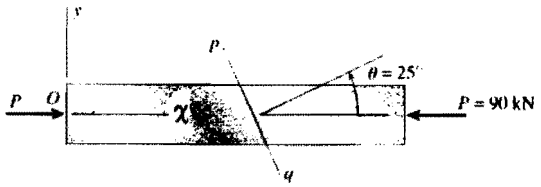
1. Define the following terms:
   (a) Poisson's ratio. (5%)
   (b) Shear stress (5%)
   (c) Shear strain (5%)
   (d) Engineering stress (5%)
   (e) Strain-energy density (5%)
   (f) Draw a typical stress-strain diagram of a **ductile** material and mark yield strength, ultimate strength, and fracture point in the diagram. (5%)

2. A prismatic bar having cross-sectional area $A$ =1200 mm$^2$ is compressed by an axial load $P$ =90 kN. (a) Determine the stresses acting on an inclined section $pq$ cut through the bar at an angle $\theta = 25^\circ$. (7%) (b) Determine the complete state of stress for $\theta = 25^\circ$ and show the stresses on a properly oriented stress element. (8%). Note that $\cos 25^\circ = 0.906$ and $\sin 25^\circ = 0.423$.



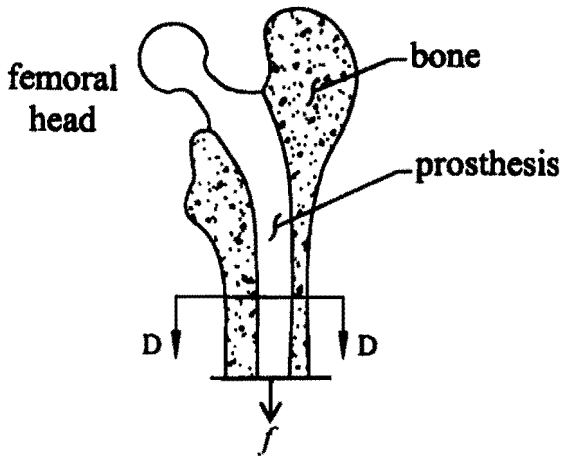

3. Like stress, strain can have different components at each point depending on the coordinate system to which it is referred. Show that strain can be transformed in the following fashion (20%):

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

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

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

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 the bone and the prosthesis each exhibit linearly




(背面仍有題目,請繼續作答)

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 (10%).

5. Modeling a blood vessel as a thin-walled cylinder, 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 (5%) and determine the circumferential stress in the vessel wall (5%).

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%).