1. A piping system used to transport a corrosive liquid is fabricated from 304 stainless steel. Welding of the pipes is required to assemble the system. Unfortunately, corrosion occurs and the corrosive liquid leaks from the pipes near the weld. Identify the problem and design a system to prevent corrosion in the future. (Hint: the 304 stainless steel contains 0.08% C, causing the steel to be sensitized if it is improperly treated during welding.) (10%)

2. Consider a dislocation in an FCC crystal with the following characteristics: \( \tau_{cm} = 0.5 \text{ MPa}, \quad t = \frac{1}{\sqrt{6}} [\overline{1}2], \quad b = \frac{a_0}{2} [\overline{1}0] \).

(a) Determine the slip plane for this dislocation (5%)
(b) Calculate the magnitude of the applied normal stress in the [010] direction necessary to cause the motion of this dislocation. (10%)

3. There are two typical stress-strain curves, as shown as following. Please explain why some materials display a double yield point and give examples. (10%)

4. A 0.2 mm thick wafer of silicon is treated so that a uniform concentration gradient of antimony (Sb) is produced. One surface contains 1 Sb atom per \( 10^8 \) Si atoms and the other surface contains 500 Sb atoms per \( 10^8 \) Si atoms. The lattice parameter for Si is 5.407 Å. Calculate the concentration gradient in Sb atoms/cm\(^3\)-cm. (10%)
5. Briefly describe the simplest continuous cooling heat treatment procedure that would be used in converting a 4340 steel from one microstructure to another. The CCT curve for 4340 is as shown as following. (5% for each, 15% in total)
   (a) (Martensite + ferrite + bainite) to (martensite + ferrite + pearlite + bainite)
   (b) (Martensite + ferrite + bainite) to spheroidite
   (c) (Martensite + bainite + ferrite) to tempered martensite

   ![CCT Curve for 4340 Steel](image)

6. Briefly define or explain the items as follows. (5% for each, 25% in total)
   (a) Martensite transformation
   (b) Burgers vector
   (c) Liquid crystals
   (d) Allotropy
   (e) Thermoelectric effect

7. What is the principle of aging hardening? (5%) Suppose that age hardening is possible in Mg-8%Al alloy, please design a heat treatment for this alloy. (10%)

   ![Age Hardening Curve for Mg-8%Al Alloy](image)