Wednesday, 18th October 2017

Duration: 60 minutes
Answer all questions: Total marks: **50**

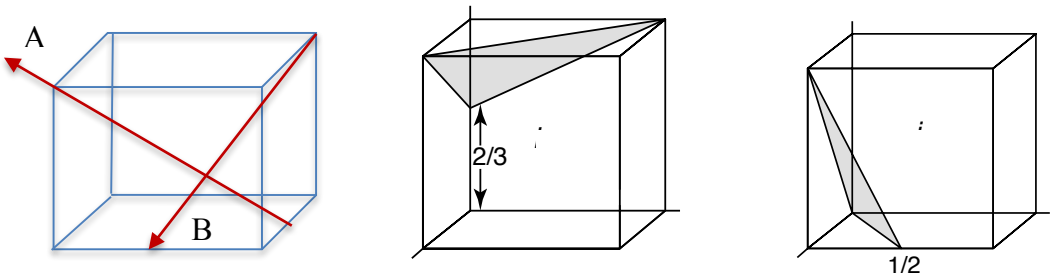
---

1. Sketch the following planes and directions within a cubic unit cell: **(6 marks)**

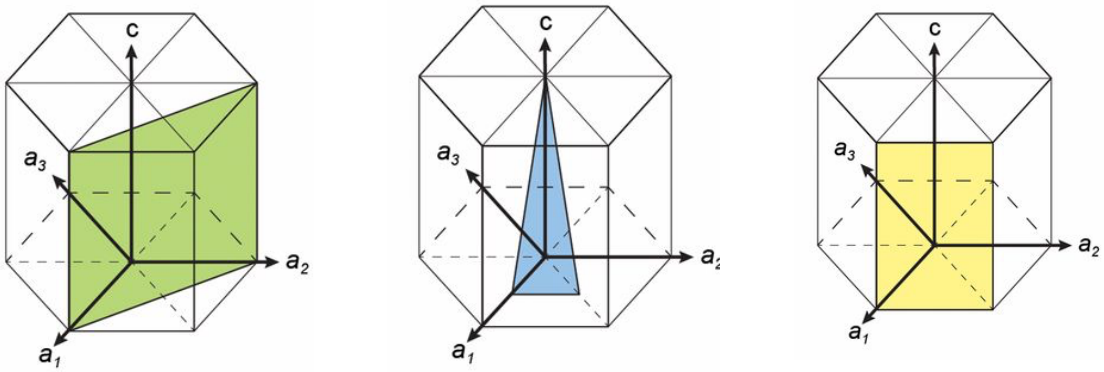
$$[1\bar{2}\bar{2}], [\bar{1}\bar{1}1], [10\bar{2}]$$

$$(\bar{2}01), (1\bar{3}1), (\bar{1}21)$$

2. Determine the indices for the directions and planes in the cubic unit cell shown below: **(4 marks)**



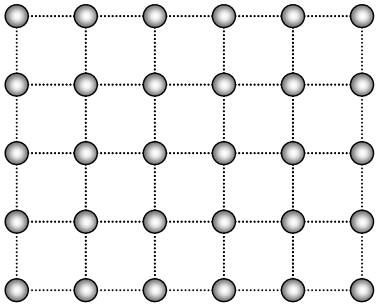
3. Determine the indices for the planes in the hexagonal lattice as shown. (you can use 3-axis or 4-axis) **(6 marks)**



4. What are the indices of the four directions of the form <111> that lie in the (101) plane of a BCC unit cell. **(4 marks)**

5. The figure below shows a perfect crystal with no defects.

   a) Reproduce the drawing after introducing a positive line dislocation within the crystal. **(2 marks)**
   b) Identify (and label) the dislocation line, Burgers vector and slip plane and describe the relationship between them. **(5 marks)**



6. A single crystal of silver (Ag) metal (FCC) is oriented so that the [001] direction is parallel to an applied stress of 30 MPa. If slip occurs on the $(1\bar{1}1)$ plane:

   a) Identify the active slip directions. **(4 marks)**
   b) Calculate the critical resolved shear stress if the normal to the slip plane makes an angle of 45° with the stress direction, and the angles between the active slip directions and stress direction are 90°, 45° and 45°. **(2 marks)**
   c) Which slip system will become active first? **(2 marks)**

   Given: $a_{Ag} = 4.079 \times 10^{-10}$ m, $\tau_{cr} = \sigma \cos\phi \cos\lambda$

   a) List three different types of crystal defects that play a significant role in the strengthening of metals. **(3 marks)**

   b) Briefly (2-3 sentences) describe, in terms of the role played by the crystal defects listed above, three strengthening mechanisms responsible for increasing the strength of metals. **(6 marks)**

7. Use the impact energy-temperature curve shown below to explain why FCC metals, such as copper, are recommended for use at low temperatures compared to steels. **(6 marks)**