7.16 (a) This part of the problem asks, for a BCC metal, that we compute the resolved shear stress in the $[1\bar{1}1]$ direction on each of the (110), (011), and $(10\bar{1})$ planes. In order to solve this problem it is necessary to employ Equation 7.2, which means that we first need to solve for the for angles λ and φ for the three slip systems.

For each of these three slip systems, the λ will be the same—i.e., the angle between the direction of the applied stress, [100] and the slip direction, $[1\bar{1}1]$. This angle λ may be determined using Equation 7.6

$$\lambda = \cos^{-1}\left[\frac{u_1u_2 + v_1v_2 + w_1w_2}{\sqrt{\left(u_1^2 + v_1^2 + w_1^2\right)\left(u_2^2 + v_2^2 + w_2^2\right)}}\right]$$

where (for [100]) $u_1 = 1$, $v_1 = 0$, $w_1 = 0$, and (for $[1\bar{1}1]$) $u_2 = 1$, $v_2 = -1$, $w_2 = 1$. Therefore, λ is determined as

$$\lambda = \cos^{-1}\left[\frac{(1)(1) + (0)(-1) + (0)(1)}{\sqrt{\left[(1)^2 + (0)^2 + (0)^2\right]\left[(1)^2 + (-1)^2 + (1)^2\right]}}\right]$$

$$= \cos^{-1}\left(\frac{1}{\sqrt{3}}\right) = 54.7°$$

Let us now determine φ for the angle between the direction of the applied tensile stress—i.e., the [100] direction—and the normal to the (110) slip plane—i.e., the [110] direction. Again, using Equation 7.6 where $u_1 = 1$, $v_1 = 0$, $w_1 = 0$ (for [100]), and $u_2 = 1$, $v_2 = 1$, $w_2 = 0$ (for [110]), φ is equal to

$$\phi_{[100]-[110]} = \cos^{-1}\left[\frac{(1)(1) + (0)(1) + (0)(0)}{\sqrt{\left[(1)^2 + (0)^2 + (0)^2\right]\left[(1)^2 + (1)^2 + (0)^2\right]}}\right]$$

$$= \cos^{-1}\left(\frac{1}{\sqrt{2}}\right) = 45°$$

Now, using Equation 7.2

$$\tau_R = \sigma \cos\phi \cos\lambda$$

we solve for the resolved shear stress for this slip system as