1) Using the Biot Savart Law compute the magnitude and direction of the magnetic field “B” at the center of a square loop with each side length “a” and carrying a current “I” clockwise.

2) Consider a wire with the shape shown in the figure below. The length of the wire on each side of the semicircle is “a” and the radius of the semicircle is also “a”. The wire carries a current “I” from left to right. Calculate the magnitude and direction of the magnetic field “B” at the center of the semicircle given by the point “O” in the figure.

3) Consider a material with magnetic permeability $\mu$ in which a free current density $J_f$ is flowing. Show that the effective bound current density “$J_e$” is given by:

$$J_e = (\mu - 1)J_f$$
(4) Consider the boundary between two materials with magnetic permeability \( \mu_1 \), \( \mu_2 \) as shown in the figure below. Derive a relation between \( \theta_1, \theta_2, \mu_1, \mu_2 \).

(5) Consider a sphere of radius \( a \) with a magnetic moment/unit volume \( M \) in the z direction. Calculate the contribution to the vector potential \( A \) from the \( r^{-3} \) terms in the expansion; namely after the dipole \( r^{-2} \) term.