(1) Two conducting media with conductivity σ_1 and σ_2 are separated by an interface, as shown in Fig 1. The steady current density in medium 1 at point P has a magnitude J_1 and makes an angle α_1 with the normal. Determine the magnitude and direction of the current density at point P in medium 2. (15%)

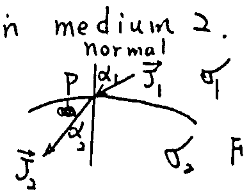

Fig 1.

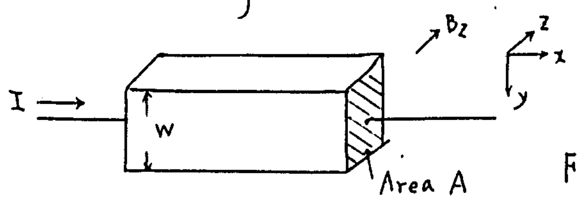

Fig 2.

(2) A y-polarized uniform plane wave ($\vec{E}_i, \vec{H}_i$) with a frequency 8.0 MHz propagates in air and impinges normally on a perfectly conducting Plane at x=0. Assume the amplitude of $\vec{E}_i$ to be 8 mV/m. (a) Write $\vec{E}_1$ and $\vec{H}_1$ of the total wave in air. (b) Determine the location nearest to the conducting plane where E_1 is zero. ($\epsilon_0 = 8.85 \times 10^{-12}$ F/m, $\mu_0 = 4\pi \times 10^{-7}$ H/m) (15%)

(3) (a) State Poynting's theorem. (10%)

(b) Define magnetization vector.

(4) (a) Find the maximum width of the depletion region for an ideal MOS capacitor on p-type GaAs with $Na = 10^{15}\ cm^{-3}$. ($\epsilon_r = 10.9$, $n_i = 1.79 \times 10^{6}\ cm^{-3}$)

(b) If the thickness of SiO_2 layer is 0.10 μm, calculate threshold voltage V_T and minimum capacitance C_{min}. (20%)

(5) (a) Compare homojunction transistor and heterojunction bipolar transistor (HBT). (25%)

(b) Draw tunnel diode band diagrams and I-V characteristics for various biasing conditions.

(c) Define population inversion and carrier, optical confinement in semiconductor laser

(d) Draw the depletion region, energy band diagram, and carrier distribution in forward bias and reverse bias of p-n junction.

(e) Draw the band diagram to explain ohmic contact and Schottky contact.

(6) (a) What information will be obtained from Hall effect measurement.

(b) A sample of GaAs is doped with doped with sulfur (S) 10^{17} atoms/cm³. Find the Hall coefficient R_H and Hall voltage V_H in a sample with W = 500 μm, A = $2.5 \times 10^{-3}\ cm^2$, I = 1 mA and $B_z = 10^{-4}$ wb/cm² as shown in Fig. 2 (15%)