1. State in detail Divergence theorem and Stoke's theorem. How are they correlated with Gauss' law and Ampere's law? (10%)

2. In electromagnetics, what do the symbols E,D,H,B,σ,μ,and ϵ represent? What are their units?(For example: I represents current, its unit is Ampere.) (14%)

3. The curl of $\vec{E}$ is proportional to the time rate of change of $\vec{B}$. Express this relation by an equation. How do you determine the constant in this equation? What does this constant really mean? (10%)

4. What is contact resistance? A conducting sphere is half buried in the ground which has conductivity b. Find the contact resistance of the sphere to the ground. (Refer to Fig.1) (10%)

5. A conducting ring is so placed that it can move vertically along the iron core as shown in Fig 2. At the moment K is closed, will the ring be attracted or repelled by the coil? Give your explanation in detail. (6%)

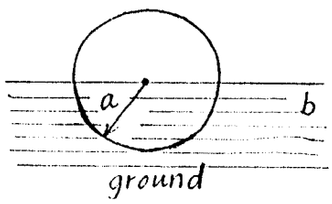

Fig.1

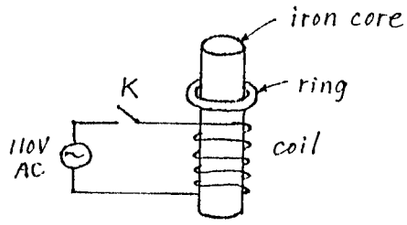

Fig.2

(15%) 6. For a p^+-n-p (emitter-base-collector) homojunction bipolar transistor. Please draw an energy band diagram
(1) at thermal eqilibrium
(2) under active mode
(3) under cut-off mode
Note: E_c, E_v, E_i and E_F must be shown.

(15%) 7. For a p-n junction with $N_A = 10^{17}cm^{-3}$, $N_D = 3 \times 10^{16}\ cm^{-2}$ at room temperature (assume complete ionization). Give the electron density $n = N_c \exp(-(E_c-E_F)/kT)$ and the intrinsic concentration $n_i = 1.45 \times 10^{10}\ cm^{-2}$.
(8%) (1) Derive and calculate the built-in voltage.
(7%) (2) Prove that the Fermi-level is constant throughout the p and n regions at thermal equilibrium.

(10%) 8. Describe that how the inversion layers are formed in a heterojunction MESFET and a MOSFET (using n-type semiconductor). Indicate the position of inversion layer in the energy band diagram.

(10%) 9. For a p-n junction, under what conditions the following phenomena will occur
(1) equilibrium and steay-state
(2) non-equilibrium but steady-state
(3) non-equilibrium and non-stedy-state.