八十五學年度國立台灣工業技術學院研究所碩士班招生考試

所別：電子工程技術研究所　　組別：元件與材料組　　科目：電磁學與固態電子學

1. (16%) A 0.5 m long coaxial cable consists of an inner wire of radius a=2 mm and an outer conductor in the form of a hollow cylinder of radius c=12 mm. A cylindrical shell of material have dielectric constant ε_m and outer radius b=6mm surrounds the wire. Outside of the material there is air. As shown in Fig. 1. Charges +Q and -Q are placed on the wire and outer conductor. (a) Find $\vec{E}$, $\vec{D}$ in the material and in the air. (b) Find the voltage V between the conductors, and the capacitor C.

2. (16%) In Fig. 1, the material has permiability $\mu=100\mu_0$. Now, the wire and the outer conductor carry currents I in the opposite directions. (a) Find $\vec{B}$, $\vec{H}$ in the material and in the air. (b) Find the magnetic flux Φ linking the wires, and the inductance L.

3. (6%) Determine the potential functon for the region inside the rectangular trough of infinite length whose cross section is shown in Fig. 2.

4. (12%) Answer the following questions:
   (1) Write the integral form of Maxwell's equations as well as their significance.
   (2) What is skin effect? Name one phenomenum (or device) that may illustrate the use of this effect.
   (3) What do we mean by diamagnetic material? Name one material that is diamagnetic material.
   (4) A rectangular waveguide having interior dimensions a=1.5 cm, b=0.6 cm. What are the first 5 modes (from the lowest to the highest mode)?

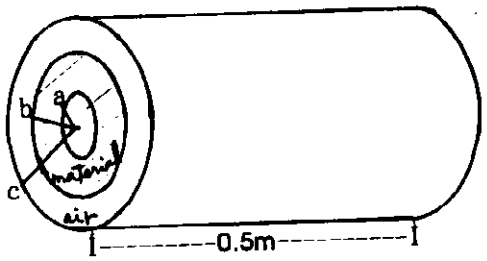

Fig. 1

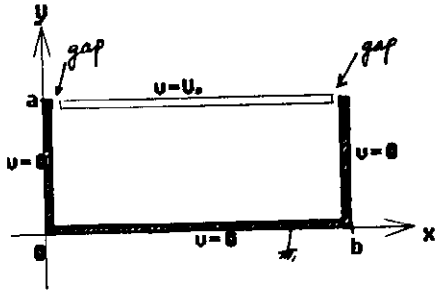

Fig. 2

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5.(15%) Answer the following questions:

(1). What do we mean by diamond lattice structure? Name one material that has this lattice structure.

(2). What do we mean by direct band gap? Name one semiconductor that has direct band gap.

(3). What do we mean by homogeneous medium, and isotropic medium?

(4). what do we mean by electroluminescence phenomenum? Name one device that may illustrate its application.

(5). What does the word L A S E R stand for? What is the property of laser light.

6.(20%) For a silicon one-sided abrupt junction with $N_A=10^{19}$ cm^{-3}, $N_D=10^{16}$ cm^{-3}. (a) Calculate the depletion layer width, (b) the maximum field at zero bias (T=300 K). (c) Calculate the minority-carrier concentrations at the depletion-layer edges when the junction is forward biased, $V_f=0.52$ V. (d) Draw qualitatively the potential distribution in equilibrium condition and when $V_f=0.52$ V.

7.(15%) Find the electron and hole concentrations, mobilities, and resistivities of silicon samples at 300 K, for each of the following impurity concentration: (a) $5x10^{15}$ Boron atoms/cm^3, (b) $5x10^{15}$ Boron atoms/cm^3, 10^{17} arsenic atoms/cm^3, and 10^{17} gallium atoms/cm^3, (c) The sample in (a) is illuminated with light so that there are 10^{14}electron-hole pairs/cm^3 created in steady-state.

(arsenic 砷 , gallium 鎵 , Boron 硼)

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The Boltzman's constant=1.38×10^{-23} J/K
The elementary charge=1.6×10^{-19} C
The properties of silicon
band gap=1.12 ev
dielectric constant=$11.8\times8.854\times10^{-14}$ F/cm
the intrinsic carrier density at 300K=1.45×10^{10} cm^{-3}

Mobilities and diffusivities in Si and GaAs at 300 K as a function of impurity concentration are shown in the following figure