近代物理（75%）

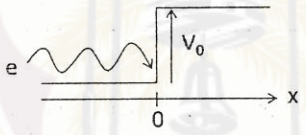
Plank's constant : $h=6.62\times10^{-34}$ J-s

1. (15%) The total energy density in a blackbody cavity is proportional to T^a in accordance with the Stefan-Boltzmann law, where T is temperature. Please find "a" (You need to write down the detailed calculation). You might need to use the energy density distribution function :

$$u(\lambda)=\frac{8\pi hc\lambda^{-5}}{\varepsilon^{hc/\lambda kT}-1}$$

2. (5%) Please explain the correspondence principle in quantum mechanics.
3. (10%) Please use uncertainty principle to estimate the size of hydrogen atom.
4. (5%) In a system with 2 electrons which follows the Pauli Exclusion Principle, is the total wavefunction symmetric or antisymmetric? Why?

5. For a beam of electrons, each with 0.2eV is incident on a potential step with V_0=4eV. Please "derive" the relative probability $|\psi(x)|^2$ of particles penetrating the step potential at function of penetration depth x. What is the probability of finding the electron at penetration depth 0.5nm? (10 points) (The electron mass $m_0=9.11\times10^{-31}$Kg, $\hbar=1.05\times10^{-34}$ joul · s)



6. For the infinite barrier quantum well problem with quantum well length L (From x=0 to x=L) . The electron energy will split into n states where the energy and wave function can be expressed as

$$E_n=\frac{n^2\pi^2\hbar^2}{2mL^2}\qquad \psi_n(x)=\sqrt{\frac{2}{L}}\sin\frac{n\pi x}{L},\ n=1,2,3\ldots$$

For the electron to transit from n_1 state to n_2 state by absorbing a photon, the selection rule requires to successfully transit is

$$\int_{-\infty}^{\infty}\psi^*(x)\left(-i\hbar\frac{\partial}{\partial x}\right)\psi(x)dx\neq 0$$

In what condition that the transition is allowed? (10 points)

7. If the Phosphor is used to dope into Si to form an n-type semiconductor, what is the ionized energy of the levels? What is the radius of the electron orbit? (The effective mass for electrons in Si is about 0.26 m_0. The dielectric constant of Si is 12.0, $\epsilon_0=8.852\times10^{-12}$F/m, $m_0=9.11\times10^{-31}$Kg, , $\hbar=1.05\times10^{-34}$ joul · s) (10 points)

8. As we know, photons are Bosons and the occupation needs to follow Boise Einstein distribution.
   (1) Please derive the "photon" density of states in a volume V?
   (2) For a blackbody with temperature T, please derive the formula for total photons number density (i.e. total photons number per unit volume V, or $\frac{N}{V}$)? (10 points)

見背面

電子學 (25%)

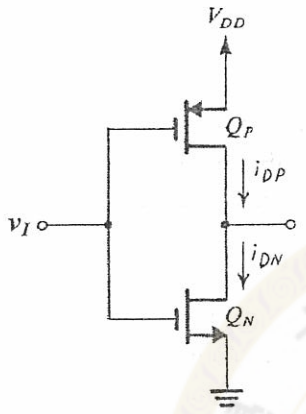


Fig (a)

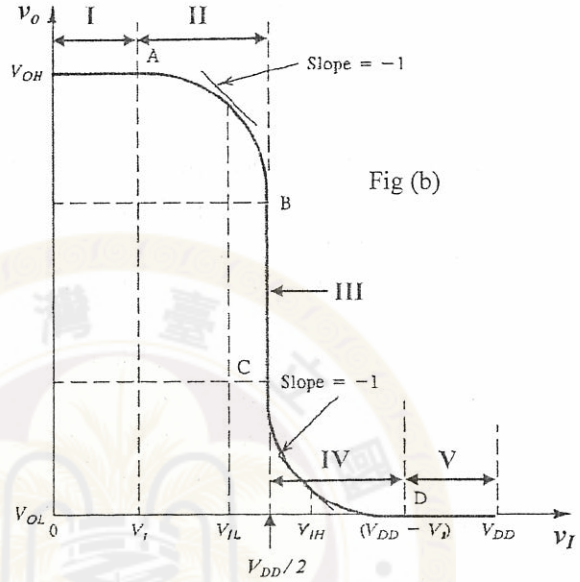


Fig (b)

The basic CMOS inverter and the corresponding voltage transfer characteristic are shown in Figure (a) and (b), respectively. The CMOS technology utilized is a generic 1.2-μm technology and the inverter has the following parameters: channel length $L_n = L_p = 1.2$ μm; $W_n = 1.8$μm (i.e. channel width of Q_N); threshold voltage $V_{tn} = |V_{tp}| \equiv V_t = 1$ V; process transconductance parameters $k_n' = 81$ μA/V^2 and $k_p' = 27$ μA/V^2; and $V_{DD} = 5$ V.

(5%) (a) Write down the combinations of modes of operation (off, triode, or saturation) of Q_N and Q_P in regions I, II, III, IV, V, respectively.

(2%) (b) If W_n (i.e. channel width of Q_N) is 1.8μm, find the value of W_p (i.e. channel width of Q_P) that would result in Q_N and Q_P being matched.

(6%) (c) Derive the expressions of V_{IH} and V_{IL}, and calculate the values of V_{IH} and V_{IL} in Figure (b).

(6%) (d) Derive the expressions of noise margins NM_H and NM_L, and calculate the values of NM_H and NM_L.

(6%) (e) Calculate the values of the output resistance of the inverter when $v_O = V_{OL}$ and $v_O = V_{OH}$, respectively.

試題隨卷繳回