1. Under thermal equilibrium, which of the following approache(s) can create a built-in electric field in a semiconductor?(A)p-n junction(B) spatial variation of doping concentration(C)hetrojunction(D)Schottky contacts.(3%)
2. (a)As shown in Fig.1, the five forward I-V curves correspond to five p-n junction diodes made from different semiconductors with corresponding energy band gap E_{g1},E_{g2}, E_{g3},E_{g4} and E_{g5}. Please identify which of the following item(s) is(are) true.(A) $E_{g3}>E_{g4}$(B) $E_{g5}>E_{g4}$(C) $E_{g3}<E_{g4}$ (D) $E_{g3}>E_{g2}>E_{g1}$ (E) $E_{g1}>E_{g2}>E_{g3}$(3%)

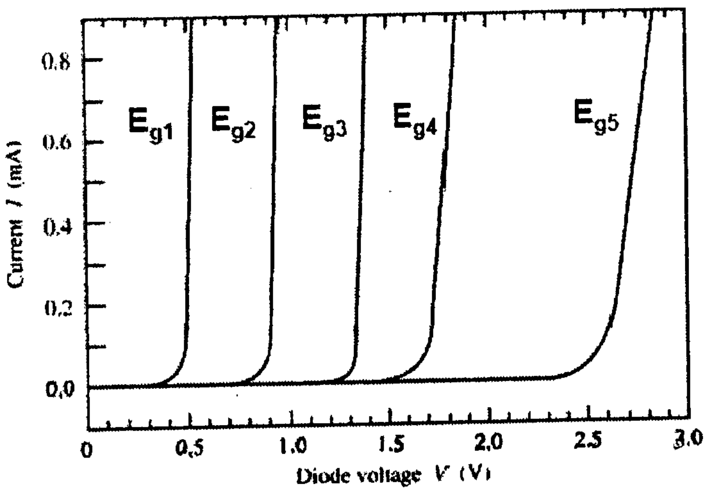

Fig.1

(b) As shown in Fig.2, if the five forward I-V curves correspond to a GaAs junction diode operated at different temperatures, please identify which of the following item(s) is(are) true.(A)$T_1>T_2$(B)$T_3>T_4$(C)$T_2>T_5$(D)$T_3>T_2$(E)$T_5>T_4$(3%)

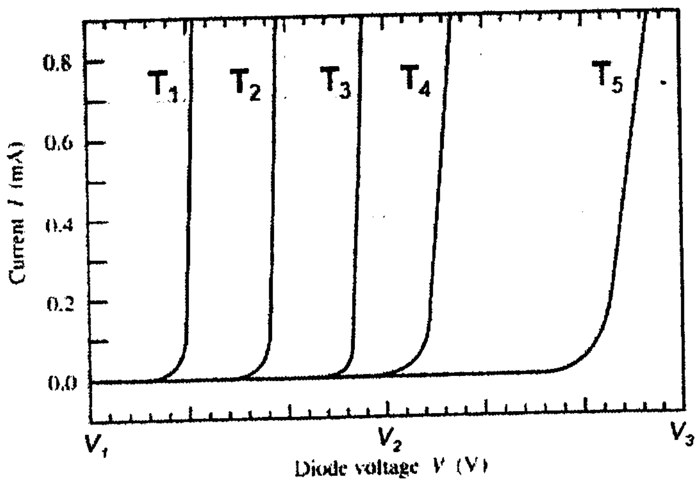

Fig.2

(c) As shown in Fig.3, if the five light output power-current (L-I) curves correspond to a GaAs LED operated at different pulsed injection currents, i.e., different duty cycles, which is defined in the inset of Fig.3. Please identify which of the following items is(are) true.(A)duty1> duty 2(B) duty 3> duty 4(C) duty 2> duty 5(D) duty 3> duty 2(E) duty 5> duty 4(3%)

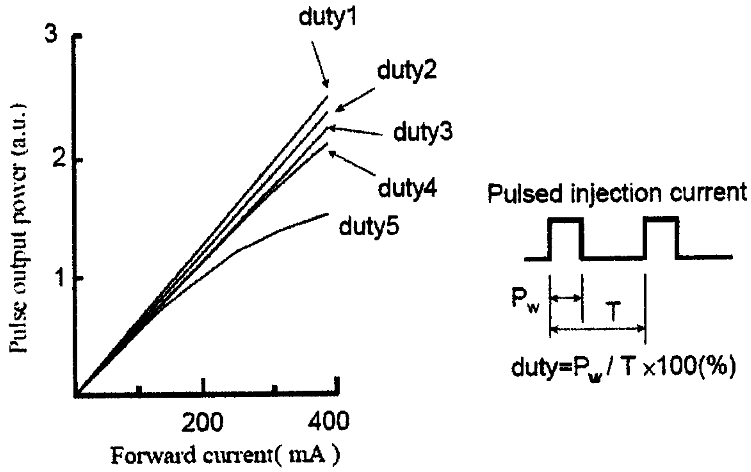

Fig.3

3. For a pn junction with $N_A=10^{17}/cm^3$ and $N_D=10^{16}/cm^3$, please find, at T=300K, the built-in voltage(V_0), the width depletion region (W), and the distance it extends in the p side(X_p) and in the n side(X_n) of the junction. Use $n_i=10^{16}/cm^3$ and $\varepsilon_s = 1.04\times10^{-12}\,F/cm$. (a)$V_0$=__V(b) W=__μm(c) X_p=___ μm(d) X_n=___ μm(8%)

4. In the circuit of Fig.4, transistor Q1 and Q2 have threshold voltage Vt=1 V, and the process transconductance parameter $k_n' = 100\mu A/V^2$. Assuming $\lambda = \frac{1}{V_A} = 0$ and $(W/L)_1=(W/L)_2=20$, please find (a)V_1=___V (b)V_2 = ___V (c) V_3 =___V (12%)

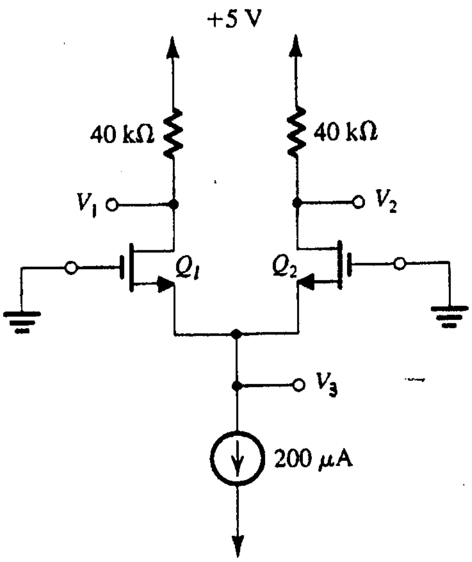

Fig.4

5.The OP amplifier in the circuit of Fig.5 is ideal with output saturation levels of $\pm 12\text{V}$. The diodes exhibit a constant 0.7 V drop when conducting. Please find $v_- =$ ____ V, $v_A =$ ____ V and $v_o =$ ____ V for $v_I = -1$ V .(12%)

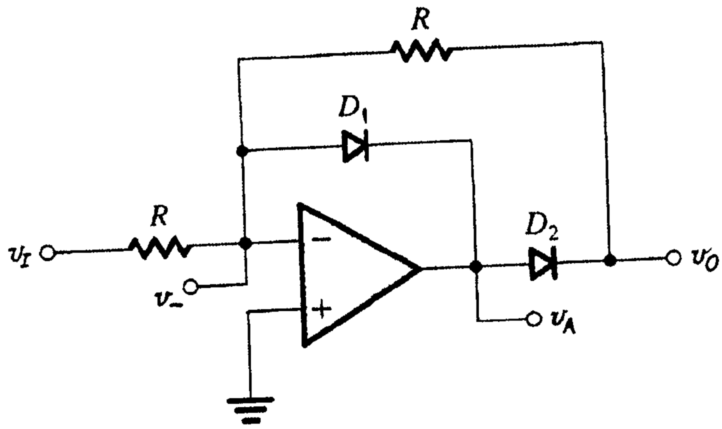

Fig.5

6. At room temperature, it is required to find the incremental (i.e., small-signal) resistance of each of the diode-connected transistors shown in the Fig.6. assume that the dc bias current I=0.1mA. For the MOSFET, let $\mu_n C_{ox}$=200 $\mu A/V^2$ and W/L=10.
(a) r=____Ω(b) r=____Ω(8%)

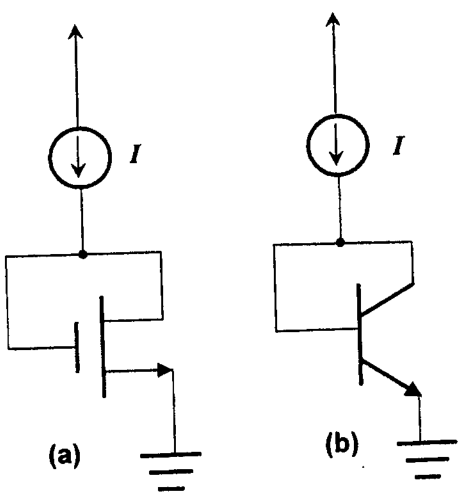

Fig.6

7. As shown in Fig.7, assume that the p-n and Zener diodes are ideal, and Vz =5V, Find V_2=____V and V_3 =____Vwhen the voltage of V_1 is 16 V. (8%)

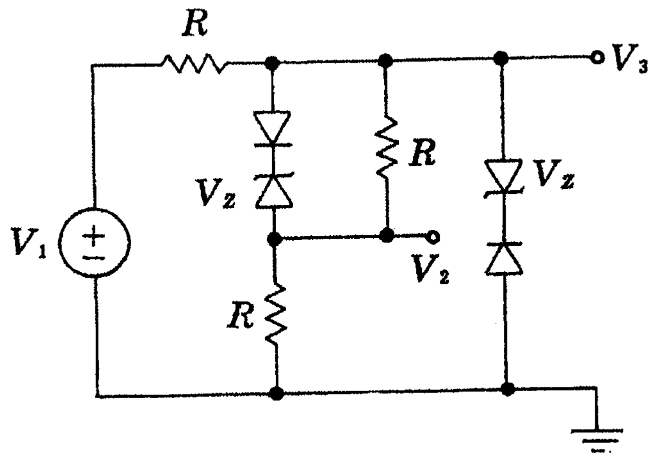

Fig.7

8. For the common-emitter amplifier shown in Fig.8, let V_{CC}=9V, R_1=27 kΩ R_2=15 kΩ, R_E=1.2kΩ and R_C=2.2kΩ. The transistor has β=100 and V_A=100V. (a)Calculate the dc bias current I_E (b)if the amplifier operates between a source for which R_{sig}=10kW and a load of 2 kΩ, find the values of R_{in}, the voltage gain $A_V = v_o / v_{sig}$ and the current gain $A_i = i_o / i_i$ (20%)

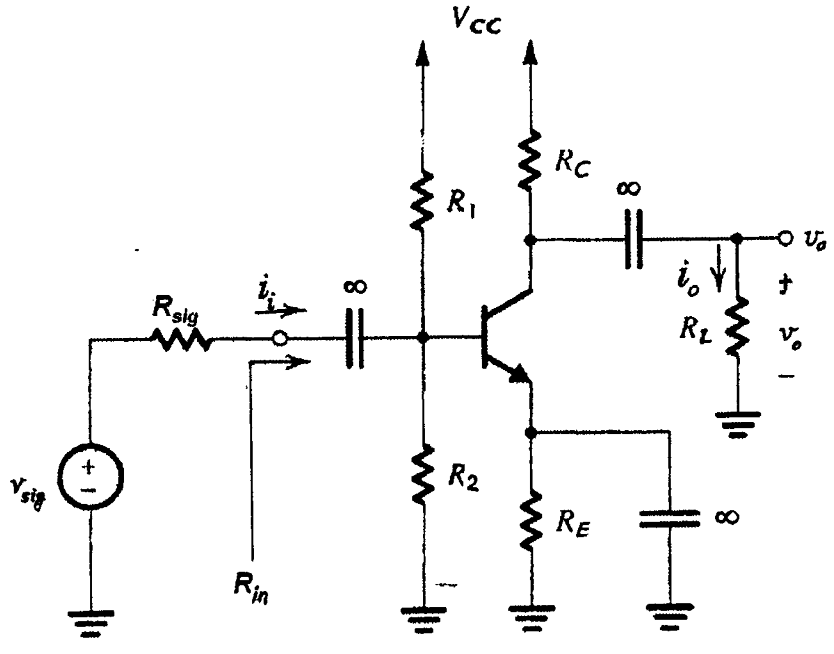

Fig.8

9. The circuit in Fig. 9 utilizes an ideal OP amplifier.
   (a)Find I_1, I_2, I_3 *and* V_x.
   (b)If V_o is not to be lower than -13 V, find the maximum allowed value for R_L.
   (c)If R_L is varied in the range 100Ω to 1kΩ, what is the corresponding change in I_L and V_o? (20%)

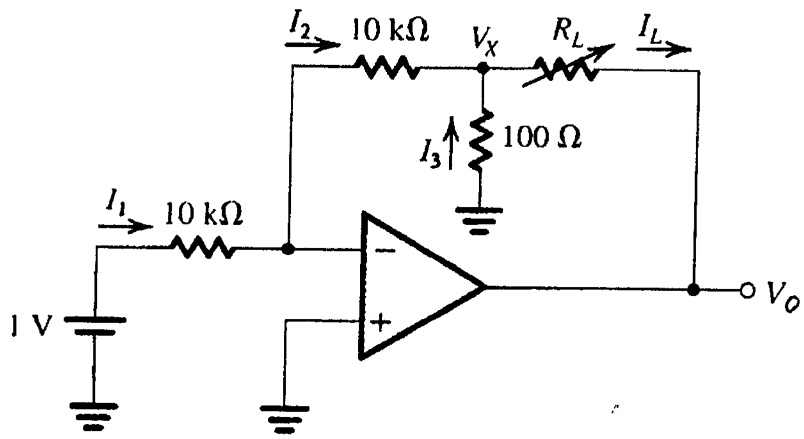

Fig. 9