B.Tech/ECE/4th Sem/ECEN-2204/2016

2016

SOLID STATE DEVICES

(ECEN 2204)

Time Alloted : 3 Hours *Full Marks : 70*

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable

GROUP - A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following : **[10×1=10]**

   i) Varactor diodes are commonly used

   (a) as voltage controlled capacitance

   (b) as a constant current source

   (c) as voltage multiplier

   (d) as a constant voltage source

   ii) The lowest current gain can be obtained using _____ configuration.

   (a) Common base (b) Common emitter

   (c) Common collector (d) Emitter-follower

   iii) Lifetime is the amount of time between the creation and disappearance of a/an

   (a) free electron (b) proton

   (c) ion (d) neutron

   iv) What is the input control parameter of a FET?

   (a) Source Voltage (b) Drain Voltage

   (c) Gate Current (d) Gate Voltage

   v) The k vector in free electron theory is related to

   (a) electron momentum (b) electron wave vector

   (c) angular momentum (d) orbital momentum

   vi) Density of states g(E) varies with energy (E) as :

   (a) E^2 (b) $E^{1\backslash 2}$

   (c) E (d) It is independent of E

   vii) A p-n junction behaves as a closed switch when it

   (a) is reversed biased

   (b) cannot overcome barrier voltage

   (c) has a low junction resistance

   (d) has a wide depletion region

   viii) What is associated with random motion due to thermal agitation in the movement of holes and electrons in a silicon crystal?

   (a) drift (b) diffusion

   (c) doping (d) recombination

ix) The barrier potential of Germanium at 25°C

(a) 0.3V (b) 0.7V

(c) 0.5V (d) 0.4V

x) What is Fermi energy?

(a) average kinetic energy per electron

(b) total energy of all electrons

(c) energy of highest occupied state at zero temperature

(d) forbidden energy band in a crystal

GROUP - B

2. (a) Describe the phenomena of energy level splitting in case of N-number of Silicon atoms.

(b) Explain how the probability of finding an electron in a particular energy level changes with the increase in temperature.

Determine the position of Fermi level with respect to the valence band energy in p-type GaAs at T = 300K. The doping concentrations are $N_a = 5x10^{18}$ cm^{-3} and $N_d = 4x10^{15}$ cm^{-3}.

(c) Show that the polarity of effective mass is different in valence and conduction bands.

4+(3+2)+3 = 12

3. (a) Derive an expression for the current density of holes diffusing in a semiconductor under concentration gradient.

(b) Explain the free carrier drift under the effect of high electric field.

Two scattering events are present in a semiconductor. If only the first mechanism were present, mobility would

be 250 cm^2/V-s. If only the second mechanism were present, mobility would be 50cm^2/V-s.

Determine the mobility when both scattering mechanisms exist at the same time.

(c) Discuss quasi Fermi energy.

5+(3+2)+2 = 12

GROUP - C

4. (a) Derive the current equation of a forward biased diode. Mention function of tunnel diode.

(b) What do you mean by breakdown voltage of a PN junction? What are the various breakdown mechanisms, a PN junction can exhibit? What are the applications of a reference diode? Expalin in details.

(4+2)+(1+3+2) = 12

5. (a) Explain the formation of built in electric field in the depletion region of an unbiased p-n junction diode. Derive its expressions in p side and n side depletion region. Plot the nature of electric field with proper justification.

(b) What is the maximum power rectangle in a solar cell characteristics? **(2+4+3)+3= 12**

Group - D

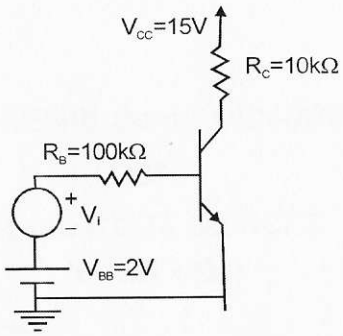
6. (a) Draw the band structure of a pnp transistor under (i) unbiased condition, (ii) forward active mode.

(b) Describe the saturation condition of a BJT and explain thermal runaway.

(c) Draw the minority carrier concentration curve in the emitter-base-collector region of a pnp transistor.

(2+2)+(2+2)+4 = 12

7. (a)



Determine the values of r_e, g_m and r_π considering a hybrid-model for the n–p–n BJT shown above, assuming $\beta = 100$.

(b) Neatly draw and discuss about the different current components of a pnp transistor clearly. **6+6 = 12**

GROUP - E

8. (a) Explain the different regions of output characteristics of an n-channel JFET. Write down the drain current equation and from it arrive at the equation of transconductance, g_m.

(b) Explain the working principle of a depletion type MOSFET and draw its static characteristics.

(4+3)+5 = 12

9. Write short notes on any three of the following :

(a) Piezo electric effect

(b) LASER

(c) UJT

(d) SCR

(v) Early effect **3x4 = 12**