D 23452 (Pages : 3) Name.....

Reg. No.....

JYOTHI ENGG. COLLEGE LIBRARY THRISSUR EDUCATIONAL TRUST LEAD KINDLY LIGHT CHERUTHURUTHY

THIRD SEMESTER B.TECH. (ENGINEERING) DEGREE EXAMINATION, JANUARY 2003

EC2K 303. SOLID-STATE DEVICES

(New Scheme)

Time : Three Hours Maximum : 100 Marks

Answer **all** *questions.*

Assume suitable data that are not given.

1. (a) Explain the concept of effective mass of charge carriers in a semiconductor.

   (b) Name the *two* types of reverse breakdowns which can occur in a *pn* junction diode and explain.

   (c) With necessary diagrams, explain the variation of minority carrier concentration in a *p-n-p* transistor biased in the active region.

   (d) Draw the equivalent circuit of UJT and explain its characteristics.

   (e) Comment on AC loadlines of a BJT.

   (f) Write brief note on transit time effect and kirk effect.

   (g) How does the substrate bias affect the performance of an enhancement mode MOSFET ?

   (h) Explain accumulation, depletion and inversion with reference to charges at the interface of the semiconductor and insulator in a MOSFET.

   (8 × 5 = 40 marks)

2. (a) (i) Show that the probability an energy state δE above the Fermi level is filled equals the probability a state δE below the Fermi level is empty.

   (9 marks)

   (ii) A semi infinite silicon bar has a steady-state excess hole concentration at the plane $x = 0$ as $10^{16}/cm.^3$ The cross-sectional area is 0·001 $cm.^2$ Hole diffusion length is 0·001 cm. and the hole life time is 1×10^{-6} sec. What is the hole current feeding this steady-state distribution ?

   (6 marks)

   Or

   (b) (i) Explain how the injected minority carrier concentration vary with distance in a forward biased *p-n* diode.

   (6 marks)

   (ii) What is meant by transition-capacitance of a *p-n* diode. Derive the expression for it.

   (9 marks)

3. (a) (i) Plot the volt ampere characteristics for p-n diode and explain the nature of this curve. (8 marks)

(ii) If the reverse saturation current of a p-n diode is 100×10^{-9} amp., determine the value of its forward current for a voltage of 0·6 volt at a temperature of 27° C. (7 marks)

Or

(b) (i) An abrupt p-n junction has the same dopant concentration on both sides and equal to $4 \times 10^{18}/cm.^3$ Assuming that Zener breakdown occurs where the electric field reaches 10^6 V/cm. What is the reverse voltage required for Zener breakdown occur ? (8 marks)

(ii) Explain the origin of negative region in the V-I characteristics of a Tunnel diode. (7 marks)

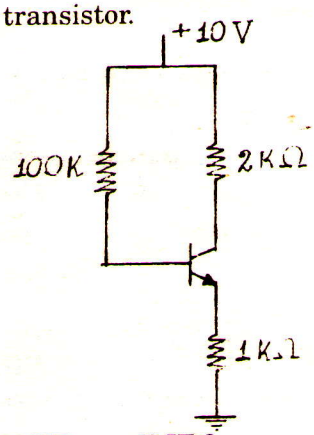
4. (a) (i) A p-n-p silicon transistor has a uniform area of 2×10^{-4} cm.^{2} and base width of 1×10^{-6} m. The emitter doping is $10^{18}/cm.^3$ and the base doping is $10^{16}/cm.^3$ The hole life time in the base is 1 micro sec. and the mobility is 200 cm.^{2}/V-sec. Determine the base emitter and collector currents for a base-emitter forward bias of 0·6 volts. (8 marks)

(ii) What is the transit time effect in a BJT ? What are its implications ? Suggest one method to reduce transit time ? (7 marks)

Or

(b) (i) Explain the significance of Eber-Moll diagrams. Write down the important equations connected with the diagrams. (8 marks)

(ii) The circuit shown employs a silicon transistor with a $h_{FE} = 100$. Determine the operating point (V_{CE}, I_C) of the transistor.



(7 marks)

5. (a) (i) What are the merits of FET over BJT ? (4 marks)

(ii) Sketch the important static characteristics for a JFET. Indicate its important regions of working. (5 marks)

(iii) What is a pinch off voltage ? (3 marks)

(iv) Explain Floating gate MOSFETs. (3 marks)

Or

(b) (i) What are the parameters that determine the threshold of a MOSFET ? How do they affect the threshold voltage ?

(8 marks)

(ii) A silicon JFET has *p* regions doped with 10^{18} acceptors/cm.^{3} and a channel with 10^{16} donors/cm.^{3} If the metallurgical width of the channel is 2×10^{-6} m., what is the pinch off voltage ? With a gate bias of – 3 volts at what value of the drain bias does the current saturate ? (with the source grounded).

(7 marks)

[4 × 15 = 60 marks]