2024

ELECTRONICS — HONOURS

Paper : DSE-B-1 and DSE-B-2

The figures in the margin indicate full marks.

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

Paper : DSE-B-1

(Semiconductor Fabrication and Characterization)

Full Marks : 50

Answer ***question no.* 1** and ***any four*** questions from the rest.

1. Answer ***any ten*** questions : 1×10

(a) The common p-type dopant(s) for Si is/are

(i) Gallium (ii) Phosphorus

(iii) Boron (iv) Nitrogen.

(b) Metal has typical band gap value of

(i) 0 eV (ii) 0.5 eV

(iii) 6 eV (iv) 2 eV.

(c) Point defects in crystal

(i) produce unintentional doping (ii) originate color centre

(iii) increase mechanical strength (iv) All of these.

(d) Diffusion pump is a

(i) primary pump (ii) secondary pump

(iii) mechanical pump (iv) None of these.

(e) Penning gauge is a

(i) thermal conductivity gauge (ii) cold cathode type ionization gauge

(iii) optical gauge (iv) None of these.

(f) Pulsed Laser Deposition (PLD) is a

(i) physical vapor deposition technique (ii) chemical vapor deposition technique

(iii) ion implantation technique (iv) None of these.

6. (a) What is TEM?

(b) Compare AFM and SEM.

(c) Why thick samples cannot be characterized by TEM?

(d) Compare Dry and Wet oxidations. 2+3+2+3

7. (a) What is Reactive Ion Etching (RIE)?

(b) Design a CMOS inverter circuit and explain its operation briefly.

(c) What are the basic components of a photoresist?

(d) What are the physical properties of a photoresist? 2+4+2+2

8. (a) What is a clean room and why is it used in the fabrication of the IC process?

(b) What is pattern transfer in photolithography? Describe the process with suitable figures.

(c) Write a short note on ion beam lithography. 2+(2+2)+4

(h) The controlled parameter in IGBT is the

(i) I_G (ii) V_{GE}

(iii) I_C (iv) V_{CE}.

(i) Which terminal does not belong to the SCR?

(i) Anode (ii) Gate

(iii) Base (iv) Cathode.

(j) Choose the false statement.

(i) SCR is a bidirectional device

(ii) SCR is a controlled device

(iii) In SCR the gate is the controlling terminal

(iv) SCR are used for high-power applications.

(k) If the cathode of an SCR is made positive with respect to the anode and no gate current is applied, then

(i) all the junctions are reversed biased

(ii) all the junctions are forward biased

(iii) only the middle junction is forward biased

(iv) only the middle junction is reversed biased.

(l) di/dt protection is provided to the thyristor by

(i) connecting an inductor in parallel across the load

(ii) connecting an inductor in series with the load

(iii) connecting an inductor in parallel across the gate terminal

(iv) connecting an inductor in series with the gate.

2. Draw and highlight different regions of the I-V characteristics of a power diode. Explain the reverse recovery characteristics of a power diode with the help of necessary characteristics curve. What are the differences between General propose diodes and Fast-recovery and Schottky diodes? 2+5+3

3. What do you mean by Current rating and Voltage rating of SCR? Explain different SCR triggering mechanisms. What is thyristor protection? Explain any two protection circuits. 2+4+1+3

4. Draw the basic structure of triac and explain its operation. Explain how Diac can act as a triggering device for Triac. 2+4+4

5. Draw the block diagram of an IGBT and highlight different regions of the device. Explain the working principle of an IGBT. Explain Turn on delay time and rise time of an IGBT. 3+4+3

Please Turn Over

6. Draw the device structure and explain the characteristics of a power MOSFET. Discuss the switching characteristics of a power MOSFET with the help of necessary circuit diagram. What do you mean by forward-biased and reverse-biased safe operating area of a power BJT? 4+3+3

7. Explain how SCR can be used as a snubber circuit. Explain with necessary diagram, the operation of parallel inverters with reactive feedback. Mention the limitations of series inverter circuits. 2+4+4

8. Write short notes on ***any two*** of the following : 5+5

   (a) Buck-Boost regulator

   (b) DC Motor

   (c) Morgan Chopper

   (d) Secondary Breakdown in Power MOSFET.

Paper : DSE-B-2

(Power Electronics)

Full Marks : 50

Answer ***question no.* 1** and ***any four*** questions from the rest.

1. Answer ***any ten*** questions : 1×10

(a) Which of the following diodes uses a metal-semiconductor junction?

(i) General purpose diodes (ii) Fast recovery diodes

(iii) Schottky diode (iv) None of the mentioned.

(b) The power loss in which of the following cases would be the maximum?

(i) When both V and I are minimum (ii) When both V and I are maximum

(iii) When only V is maximum (iv) When only I is maximum.

(c) Which of the following devices does not belong to the transistor family?

(i) IGBT (ii) MOSFET

(iii) GTO (iv) BJT.

(d) A power transistor is a

(i) three-layer, three junction device (ii) three-layer, two junction device

(iii) two-layer, one junction device (iv) four-layer, three junction device.

(e) In a power transistor, _____ is the controlled parameter.

(i) V_{BE} (ii) V_{CE}

(iii) I_B (iv) I_C.

(f) IGBT and BJT both posses _____.

(i) low on-state power losses (ii) high on-state power losses

(iii) low switching losses (iv) high input impedance.

(g) In IGBT, the p+ layer connected to the collector terminal is called as the

(i) drift layer (ii) injection layer

(iii) body layer (iv) collector layer.

(g) For the deposition of epitaxial thin film which deposition technique would you prefer?

(i) e-beam evaporation (ii) Sputtering

(iii) MBE (iv) None of these.

(h) SEM produces

(i) surface morphology imaging (ii) crystallographic imaging

(iii) volume defect imaging (iv) All of these.

(i) True surface imaging of thin film can be done by

(i) SEM (ii) XRD

(iii) TEM (iv) UV-VIS spectroscopy.

(j) Band gap of a transparent thin film material can be determined by UV-VIS-NIR spectroscopy using

(i) Bode plot (ii) Arrhenious plot

(iii) Tauc plot (iv) Scherrer equation.

(k) Crystalline size of polycrystalline material can be determines from XRD pattern using

(i) Bragg's equation (ii) Laue's equation

(iii) Debye-Scherrer equation (iv) Tauc's equation.

(l) Main advantage of e-beam lithography over photo-lithography is

(i) higher resolution (ii) low cost

(iii) less complexity (iv) All of these.

2. (a) Explain why conductivity of semiconducting material increases with temperature.

(b) Compare metal, semiconductor and insulator in term of their band gap.

(c) Sketch and explain Czochralski growth system for single crystalline Si ingot preparation. 2+3+5

3. (a) How polycrystalline materials are different from single crystalline and amorphous materials?

(b) What do you mean by Si (100) wafer?

(c) What are primary flat and secondary flat in Si wafer? 4+2+(2+2)

4. (a) What is epitaxy? What are homo and hetero epitaxial thin films?

(b) Explain briefly with diagram a MBE system. (2+2+2)+4

5. (a) What is Bragg's law?

(b) Why visible light is not used for crystallographic study of solids?

(c) Compare lattice constant and *d*-spacing.

(d) What are the disadvantages of x-ray diffraction over electron diffraction? 2+3+2+3