Total number of printed pages: 2

Programme: UG/3rd/UECE301

DEC 2023

ELECTRONIC DEVICES

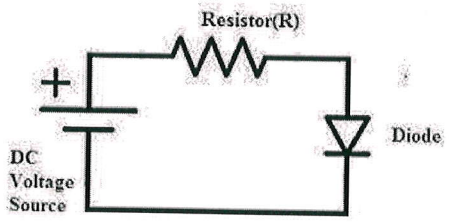
Full Marks : 100

Time : Three hours

The figures in the margin indicate full marks for the questions.

Answer any five questions.

1.	a)	Determine the surface density of atoms on (100), (110) and (111) planes of single crystalline Silicon.	6
	b)	Using schematic diagrams, explain how photolithography, followed by dry etching, can be employed to transfer patterns onto a SiO_2 layer over a Si-substrate.	8
	c)	Discuss the process of ion implantation and its advantages over thermal diffusion.	6
2.	a)	Solve the Schrodinger equation and show that energy for particle in a 1-D box with infinite wall potential is quantized.	8
	b)	State Bloch's theorem. Write the boundary conditions for a simplified Kronig-Penney model and obtain the necessary condition for the allowed energies of a particle in this potential.	2+10
3.	a)	Derive the expression for density of states for electrons in a 3D box and plot it as a function of energy.	6
	b)	Starting with reduced bandstructure, determine the value of the number of holes in a semiconductor in terms of the effective density of states in the valence band.	8
	c)	Show that the donor impurity level in an n-type Si crystal is mostly ionized at room temperature.	6
4.	a)	Determine the value of the width of the depletion region in terms of the applied voltage across the p-n junction.	6
	b)	Derive and solve the continuity equation for holes on the n-side of a forward biased p-n junction under low-level injection approximation.	8
	c)	Determine the current through the Si-diode in the following circuit if the DC voltage is 5V, reverse saturation current, $I_0=1x10^{-12}A$ and $R=1K\Omega$.	6



5. a) Define 'emitter injection efficiency' and 'base transport factor' for a BJT. Explain how and why these parameters are optimized for obtaining a better device operation. 5

b) Derive the expression for collector current in ACTIVE mode assuming linear variation of minority carrier concentration in the base region. 6

c) Draw the energy band diagram for a p-n-p transistor in ACTIVE mode of operation. 4

d) Draw the output characteristics of a BJT in common-emitter configuration and mark different regions to specify different modes of operation. 5

6. a) Using a neat schematic diagram, explain the output characteristics of a p-channel JFET. Using its transfer characteristics, explain how amplification of weak signals is possible using a JFET device. 6+2

b) Using energy-band diagram, explain the I-V characteristics of a tunnel diode. 6

c) Derive the expression for drain current in an n-channel MOSFET as a function of its terminal voltages. 6
