Roll No. | | | | | | | | | | |

ANNA UNIVERSITY (UNIVERSITY DEPARTMENTS)

B.E. (Full Time) - END SEMESTER EXAMINATIONS, APR / MAY 2024

ELECTRONICS AND COMMUNICATION ENGINEERING

Semester II

PH3204 PHYSICS OF SEMICONDUCTORS AND DEVICES

(Regulation 2023)

Time: 3hrs | Max. Marks: 100

CO1	Understand the basics of electronic states and energy band structure formation
CO2	Recognize the importance of carrier concentration and doping in semiconductors
CO3	Understand the operation and characteristics of PN junction and BJTs
CO4	Comprehend the characteristics of the field effect transistors
CO5	Realize the physics of special semiconductor devices

BL – Bloom's Taxonomy Levels

(L1-Remembering, L2-Understanding, L3-Applying, L4-Analysing, L5-Evaluating, L6-Creating)

PART- A (10x2=20Marks)

(Answer all Questions)

Q. No.	Questions	Marks	CO	BL
1	Define Fermi function and Fermi energy.	2	1	L1
2	What is meant by negative effective mass?	2	1	L2
3	Why no hole is generated by the electron excitation involving a donor impurity atom?	2	2	L4
4	Illustrate the acceptor energy level and Fermi level on the energy band diagram of a degenerately doped p-type semiconductor.	2	2	L3
5	In a transistor, β=45, the voltage across 1kΩ connected to the collector is 1volt. Find the base current.	2	3	L5
6	Sketch an I–V curve that shows the base width modulation effect.	2	3	L3
7	Define transconductance.	2	4	L1
8	How does the reduction of channel length and channel width affect the threshold voltage of a MOSFET?	2	4	L2
9	What is an opto coupler?	2	5	L1
10	How is a laser diode different from an LED?	2	5	L2

PART- B (5x13=65Marks)

Q. No.	Questions	Marks	CO	BL
11 (a)	What is the meaning of the density of states function? With a neat diagram, derive an expression for density of energy states. Obtain an expression for Fermi energy in metals at T=0 K.	13	1	L4
	OR			
11 (b)	What is the effect of periodic potential on the energy of electrons in a metal? Explain it on the basis of Kronig-Penney model and explain the formation of energy bands.	13	1	L4
12 (a)	(i) With necessary theory, obtain an expression for the hole concentration in an intrinsic semiconductor.	9	2	L2
	(ii) Determine the number (#/cm^3) of quantum states in silicon between E_c and E_c + kT at T=300 K.	4	2	L5
	OR			
12 (b)	(i) Derive an expression for the carrier concentration in an n-type semiconductor. What would be the position of Fermi level? Explain.	9	2	L2

	(ii) For a given semiconductor with Eg=1.12 eV, determine the position of the Fermi level at 300 K, if $m_e^*=0.12m_o$ and $m_h^*=0.28m_o$.	4	2	L5
13 (a)	With appropriate theory, derive the ideal current–voltage relationship in a pn junction diode. Sketch the energy bands in a zero-biased, reverse-biased and forward-biased pn junction.	13	3	L4
	OR			
13 (b)	Discuss with necessary diagrams, the minority carrier concentrations throughout bipolar junction transistor under the forward active mode.	13	3	L4
14 (a)	With suitable figures, explain the C–V characteristics of a MOS capacitor with p-type semiconductor substrate under low-frequency conditions.	13	4	L4
	OR			
14 (b)	Discuss the experimental characteristics of MOSFETs that cause deviations from the assumptions used in the ideal derivations.	13	4	L4
15 (a)	(i) Describe the basic operation and characteristics of an SCR.	9	5	L2
	(ii) Briefly explain the I-V characteristics of a tunnel diode.	4	5	L4
	OR			
15 (b)	(i) Explain the construction and working of a Schottky diode.	9	5	L2
	(ii) Write a note on the working principle of LDR.	4	5	L4

PART- C (1x15=15Marks)

(Q.No.16 is compulsory)

Q. No.	Questions	Marks	CO	BL
16.	(i) Discuss the electronic states in quantum well structures with an emphasis on the optoelectronic properties of quantum wells and superlattices.	5	2	L2
	(ii) Explain the Ebers–Moll model for an npn bipolar transistor and evaluate the applicability of the equivalent circuit in any of the transistor operating modes.	10	3	L5