International Islamic University Chittagong

Department of Electrical and Electronic Engineering
B. Sc. Engineering in EEE
Final Exam, Spring 2022

Course Code: **EEE 3607** Course Title: **Solid State Devices**
Time: **2 hours 30 minutes** Full Marks: **50**

(i) The figures in the right-hand margin indicate full marks
(ii) Course Outcomes and Bloom's Levels are mentioned in additional Columns

Course Outcomes (COs) of the Questions *Upon the successful completion of the course, students will be able to*	
CO1	Understand the physics of semiconductor devices regarding carriers, the energy band and their behavior in solid.
CO2	Develop the designing skill from the idea of carrier transportation in solid and their behavior in various junctions.
CO3	Understanding the working principle of different devices like FET, BJT, Solar Cell and gain necessary knowledge for device design, fabrication and characterization.

Bloom's Levels of the Questions						
Letter Symbols	**R**	**U**	**Ap**	**An**	**E**	**C**
Meaning	Remember	Understand	Apply	Analyze	Evaluate	Create

Part A

[Answer the questions from the followings]

1.	a)	Draw and explain the energy band diagram of a p-n junction at (i) equilibrium and (ii) reverse biased condition.	CO1	R	5
1.	b)	An abrupt Si PN junction has Na=10^{18} cm^{-3} on one side and Nd=5×10^{15} cm^{-3} on other side. (i) Calculate the Fermi level positions at 300 K in the p and n regions. (ii) Draw an equilibrium band diagram for the junction and determine the contact potential V0 from the diagram.	CO3	Ap	5
2.	a)	Explain the coupled-diode properties of Eber-Moll's equations of BJT.	CO3	E	5
2.	b)	How is amplification done with BJT? Show the relationship between the current transfer ratio and the base-to-collector current amplification factor. Also, show, schematically, how electrons and holes flow in a p-n-p transistor.	CO3	An	3+2

Or,

2.	a)	Evaluate the terminal current by using proper boundary conditions in the diffusion equation (only emitter current evaluation is sufficient).	CO3	E	5
2.	b)	Why there must be some base current in a BJT? Also, determine the base current and collector current from the following network in **Fig.1** below. The average hole lifetime in the base is 10×10^{-6} sec and transit time for hole from emitter to collector is 1×10^{-7} sec.	CO3	An	2+3

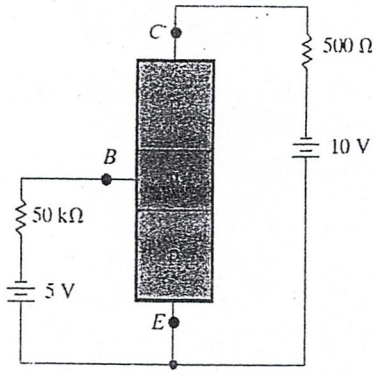

Fig. 1: For Question **2(b)**

Part B

[Answer the questions from the followings]

3.	a)	Develop a relationship between the pinch-off voltage and the metallurgical half width of a JFET.	CO3	An	4
3.	b)	i. What purpose do MESFET and HEMT serve in comparison to JFET?	CO3	An	3
		ii. Explain the operation of a JFET showing the current-voltage characteristics.		An	3
4.	a)	Explain the operation of an enhancement type n-MOSFET and from it draw the drain characteristics of the device.	CO3	An	5
4.	b)	i. How does an electron get "*hot*" in MOSFET? What is the effect of it?	CO3	An	3
		ii. Draw the equivalent circuit of a MOSFET		R	2
5.	a)	Explain the principle of a photovoltaic solar cell. Why n-type material is generally thinner side compared to the p-type of a solar cell?	CO3	Ap	5
5.	b)	Why direct band gap semiconductor is used in LASER? Describe the fabrication process of a simple junction LASER.	CO3	An	5

Or,

5.	a)	Explain the operating principle of a solar cell. Also draw the I-V and P-V characteristics curve of solar cell.	CO3	Ap	5
5.	b)	What do you mean by direct band gap of LASER? Describe the fabrication process of LASER.	CO3	An	5