

International Islamic University Chittagong
Department of Electrical and Electronic Engineering
B. Sc. Engineering in EEE

Special Semester End Exam, Autumn 22

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), Program Outcomes (POs) and Bloom's Levels (BL) of the Questions			
CO	CO Statements	PO	BL
CO1	Understand the physics of semiconductor devices regarding carriers, the energy band and their behavior in solid.	PO1	C2
CO2	Develop the designing skill from the idea of carrier transportation in solid and their behavior in various junctions.	PO3	C4
CO3	Understanding the working principle of different devices like FET, BJT, Solar Cell and gain necessary knowledge for device design, fabrication and characterization.	PO4	C4

Bloom's Levels (BL) of the Questions						
Letter Symbols	C1	C2	C3	C4	C5	C6
Meaning	Remember	Understand	Apply	Analyze	Evaluate	Create

Part A

[Answer the questions from the followings]

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|---|-----|-----|---|
| 1. a) What is 'carrier injection'? Evaluate the total current through a p-n diode for bias condition. | CO2 | C4 | 5 |
| 1. b) i. What is Avalanche breakdown? Why it is name so? | CO2 | C4 | 2 |
| ii. What are the two capacitances associated with PN junction? "The drift current of a biased PN junction is limited not by how fast carriers are swept down the barrier, but rather how often"- explain. | | C5 | 3 |
| 2. a) Explain the couple-diode model of BJT. | CO3 | C5 | 5 |
| 2. b) i. Show the relationship between current transfer ratio, α and base-to-collector current amplification factor, β . | CO3 | C4 | 3 |
| ii. Mention the three dominant physical mechanisms to account for the base current in BJT. | | C4 | 2 |
| Or, | | | |
| 2. a) Evaluate the solution of the diffusion equation in the base region of BJT. | CO3 | C5 | 5 |
| 2. b) i. Explain the concept of a "hole injection" device for the development of BJT. | CO3 | C4, | 3 |
| ii. Explain how BJT is a current-controlled device. | | C4 | 2 |

Part B

[Answer the questions from the followings]

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|--|-----|----|---|
| 3. a) Calculate the pinch-off voltage of a JFET. | CO3 | C4 | 4 |
| 3. b) i. The channel conductivity of a MESFET can be increased by increasing the doping in the channel, which results increased scattering by the ionized impurities. What can be a clever solution of | CO3 | C4 | 3 |
| | | C4 | |

- the problem?
- ii. Explain the operation of a n-channel JFET and show the output characteristics curve. 3
4. a) What do you understand by *work function*? Draw the energy band diagram for ideal MOS structure when we apply, i) negative voltage, ii) positive voltage between metal and semiconductor. CO3 C4 5
4. b) i. What are the problems associated with MOSFET scaling? CO3 C4 3
 ii. Draw the equivalent circuit of a MOSFET. C1 2
5. a) A solar cell under an illumination of 500 Wm^{-2} has a short circuit current I_{sc} of 150 mA and an open circuit output voltage V_{oc} of 0.530 V. What are the short circuit current and open circuit voltage when the light intensity is doubled? Assume $\eta = 1.5$, a typical value for various Si *pn* junctions. CO3 C3 4
5. b) i. Why a solar cell cannot use most of the available sunlight? CO3 C4, 3
 ii. What are the advantages of amorphous solar cells? What are the advantages of heterojunction solar cells? C3 3
- Or,
5. a) Explain the working principle of LASER. CO3 C3 4
5. b) i. Why n-type semiconductor is usually placed in the illuminating side of a solar cell? CO3 C4, 3
 ii. Why direct bandgap semiconductor materials are used in LASER? C3 3