# International Islamic University Chittagong

Department of Electrical and Electronic Engineering

B. Sc. Engineering in EEE

Final Exam, Autumn 2021

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** | |
|---|---|
| **CO1** | **Understand** the physics of semiconductor devices regarding carriers, the energy band and their behavior in solid. |
| CO-2 | **Develop** the designing skill from the idea of carrier transportation in solid and their behavior in various junctions. |
| CO-3 | **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** | **App** | **An** | **E** | **C** |
| **Meaning** | Remember | Understand | Apply | Analyze | Evaluate | Create |

## Part A

[Answer the questions from the followings]

| | | | | | |
|---|---|---|---|---|---|
| 1. | a) | What are the two types of capacitances associated with a p-n junction? Show that, $C_j = \frac{\epsilon A}{W}$ | CO2 | R, An | 5 |
| 1. | b) | i. What is Avalanche breakdown? Why it is called so? | CO2 | R, An | 2 |
| | | ii. Show the effects of a bias in a p-n junction by using proper diagrams to show the particle flow and current directions within the depletion region for (a) equilibrium, (b) forward bias, and (c) reverse bias. | | E | 3 |
| 2. | a) | Show that, $\frac{\alpha}{1-\alpha} = \beta$, where $\beta$ base transport factor and emitter junction efficiency $\gamma$ . | **CO2** | **An** | **5** |
| 2. | b) | Sketch the summary of charge carrier flow in a p-n-p transistor with proper biasing. | **CO2** | **E** | **5** |
| | | Or, | | | |
| 2. | a) | With neat sketch draw the cross-sectional view of bipolar n-p-n transistor. Why collector region made so large? | **CO2** | **E** | **5** |
| 2. | b) | Derive the Ebers- Moll equations. | **CO2** | **An** | **5** |

## Part B

[Answer the questions from the followings]

| | | | | | |
|---|---|---|---|---|---|
| 3. | a) | Explain the I-V characteristics of JFET. | CO1 | An | 5 |

| | | | | | |
|---|---|---|---|---|---|
| 3. | b) | Write down short notes on following topics<br>(a) MESFET (b) HEMT | CO2 | U | 5 |
| 4. | a) | Define MOSFET scaling and hot electron effects. | CO2 | U | 5 |
| 4. | b) | With neat sketch explain the basic construction and principle of operation of a p- channel depletion type MOSFET. | CO2 | E | 5 |
| 5. | a) | Explain the principle of a photovoltaic solar cell. | **CO3** | **Ap** | 4 |
| 5. | b) | I. Why n-type material is generally thinner side compared to the p-type of a solar cell? | **CO3** | **An, E** | 6 |

II. Consider the following I-V curve in the **Fig.02** below of a solar cell driving a load of 3 Ω. The cell has an area of 3 cm × 3 cm and is illuminated with light of intensity 700 W $m^{-2}$. Find the current and voltage in the circuit. Find the power delivered to the load, the efficiency of the solar cell in this circuit, and the fill factor of the solar cell.

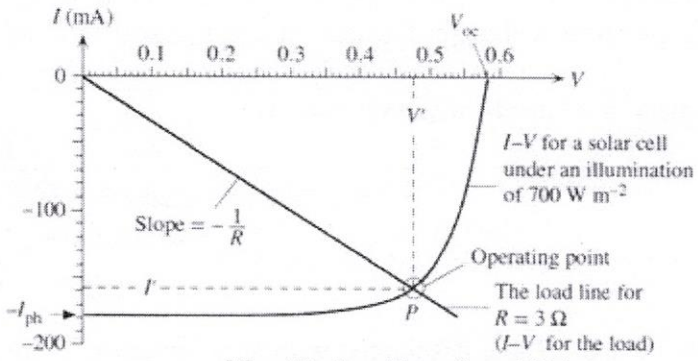


**Fig. 02: for Question 5(b)**

Or,

| | | | | | |
|---|---|---|---|---|---|
| 5. | a) | Briefly explain the working principle of LASER. Why direct band gap semiconductor is used in LASER? | **CO3** | **Ap, An** | 5 |
| 5. | b) | i. Describe the fabrication process of a simple junction LASER. | **CO3** | **Ap, An** | 5 |
| | | ii. How amorphous solar cells are made? What are their advantages? | | | |