1903080103030001
Examination March - 2024
MASTER OF SCIENCE (PHYSICS) (THIRD SEMESTER)
PHYSICS OF SEMICONDUCTOR DEVICES

[Time: Three Hours] **[Max. Marks: 70]**

Instructions:
1. Fill up strictly the following details on your answer book
   a. Name of the Examination: **MASTER OF SCIENCE (PHYSICS) (THIRD SEMESTER)**
   b. Name of the Subject: **PHYSICS OF SEMICONDUCTOR DEVICES**
   c. Subject Code No: **1903080103030001**
2. Sketch neat and labelled diagram wherever necessary.
3. Figures to the right indicate full marks of the question.
4. All questions are compulsory.
5. Symbols used have their usual meaning.

Seat No:

Student's Signature

Q.1 Attempt any two out of the (a), (b) and (c) below.

a) Discuss free carrier mobility and its dependence on temperature and effective mass in semiconductors. Draws drift mobility versus impurity concentration for n and p type silicon at room temperature. **6**

b) i) Write down equations Einstein's relation and discussed diffusion coefficient in details. **4**
ii) Determine the diffusion coefficient of n-type GaAs having carrier mobility 8500 cm^2/ V-s at temperature 300K. **2**

c) i) What is recombination? With reference to the direct and indirect transitions, explain briefly the optical properties of semiconductors. **3**
ii) Write down basic equation for semiconductor device operation and discuss the current density equation. **3**

Q.2 Attempt any two out of the (a), (b) and (c) below.

a) Using necessary energy band diagram, of semiconductor- 6 semiconductor heterojunctions. Using EAM model discuss optical window used in solar cell and LED. **6**

b) i) Draw current-voltage characteristics across p-n junction diode and give the reasons its departure from the ideal condition details. **4**

ii) The current flowing in a p-n junction at temperature 303K is 0.5 μA, when a large reverse bias voltage is applied. Calculate the current flowing for forward bias 0.1 volt. **2**

c) i) Discuss various breaks down mechanism across p-n junction. **3**

ii) Distinguish between tunnelling and avalanche mechanism. **3**

Q.3 Attempt any two out of the (a), (b) and (c) below.

a) Explain static characteristics in n-p-n transistor and shows collector current as function of emitter base voltages with four regions due various properties. **6**

b) i) How current gain increases in transistor discuss factor current gain dependence emitter efficiency. **3**

ii) Define cutoff frequency. Show that emitter to collector delay time depend upon represents the sum of four delays. **3**

c) i) Describe a bipolar transistor working as ideal transistor switch on and off condition. **4**

ii) Determine $h_{FE(min)}$ for common emitter transistor saturation circuit has $V_{cc} = 20\ volt, R_L = 2.2\ K\Omega$. **2**

Q.4 Attempt any two out of the (a), (b) and (c) below.

a) Draw the general current - voltage characteristics of a SCR and explain the terms break over voltage, holding current and forward current rating as used in SCR analysis. **5**

b) i) Explain the construction and working of a Diac. **3**

ii) What are advantages of a Triac over SCR. **2**

c) i) Write short notes on unijunction relaxation oscillator. **3**

ii) A unijunction transistor has 10 volt between the bases. If intrinsic stand-off ratio is 0.65. What will be the peak-point voltage if the forward voltage drop in the p-n junction is 0.7 Volt. **2**

Q.5 Attempt any two out of the (a), (b) and (c) below.

a) Draw energy-band diagrams of metal-semiconductor contacts and explain the relation between barrier height and energy bandgap in ideal condition. **6**

b) i) Discuss four basic current transport mechanisms in metal- semiconductor contacts. **4**

ii) What is image force lowering effect? **2**

c) i) Discuss surface states play to characterization of barrier height with two different limiting cases in metal-semiconductor contacts. **4**

ii) Explain the difference between p-n junction and Schottky junction. **2**

Q.6 Attempt any two out of the (a), (b) and (c) below.

a) Derive absorption coefficient and explain dependence of optical absorption coefficient for semiconductor on the wavelength of incident light. **6**

b) i) Draw and explain I-V characteristics of a solar cell, explain it using derive the efficiency and fill factor using of short circuit current and open circuit voltage. **4**

ii) Discuss optical cavity role in LASER diode. **2**

c) i) Describe the operation of an LED and semiconducting materials using in LED. **4**

ii) Calculate the critical angle at a semiconductor-air interface, the interface between GaAs semiconductor and air, refractive index for GaAs semiconductor n_2=3.66 and refractive index for GaAs air n_1 =1.00. **2**

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