VIT Vellore Institute of Technology

Reg. No. :

Final Assessment Test (FAT) – November/December 2022

Programme	**B.Tech.**	Semester	**Fall Semester 2022-23**
Course Title	**ELECTRONIC MATERIALS AND DEVICES**	Course Code	**BECE201L**
Faculty Name	**Prof. Sheena Christabel Pravin**	Slot	**C1+TC1**
		Class Nbr	**CH2022231002262**
Time	**3 Hours**	Max. Marks	**100**

Section A (4 X 15 Marks)
Answer All questions

1. A PN junction has acceptor impurity concentration of 10^{20} per cm^3 and donor impurity of 10^{17} per cm^3. **[15]**
   (i)Derive an expression for contact difference potential in the PN junction [**9 marks**]
   (ii)Compute the built-in potential [**3 marks**]
   (iii)Calculate the width of the depletion region [**3 marks**]
2. With relevant equations, illustrate the equivalent circuit model of a bipolar transistor. [**5 marks**] **[15]**
   Verify the model construction by applying Kirchoff's Voltage and Current law at the input and output loops respectively for
   (i)Common Emitter Configuration [**5 marks**]
   (ii)Common Base Configuration [**5 marks**]
3. (i)With a detailed comparison of JFET with MOSFET, illustrate the use of JFET as a variable resistor [**9 marks**] **[15]**
   (ii)Determine the pinch-off voltage for an N-channel silicon FET with a channel width of 5.6 x 10^{-4} cm and a donor concentration of $10^{15}/cm^3$. Assume that the dielectric constant of Si is 12.[**3 marks**]
   (iii)With relevant graphs, illustrate the Transfer characteristics of JFET and MOSFET. [**3 marks**]
4. (i)List the dielectrics that can be used for various capacitance values, indicating their frequency ranges. [**6 marks**] **[15]**
   (ii)What is electrical double-layer capacitance? Illustrate the basis for high capacitance in supercapacitor with relevant equations, along with a simplified structure of a supercapacitor [**9 marks**]

Section B (3 X 10 Marks)
Answer All questions

5. Arrive at the expression for current density and drift velocity of electrons under the influence of an electric field, taking into consideration the velocity gained by electrons in a particular direction. **[10]**
6. An n-type Si wafer was doped uniformly with 10^{16} Antimony (Sb) atoms per cm^3. **[10]**
   (i)Calculate and sketch the position of the Fermi Energy with respect to the Fermi Energy level (E_{Fi}) in Intrinsic Si. [**5 marks**]
   (ii)The same n-type Si sample was further doped with 2 x 10^{17} Boron atoms per cm^3. Recalculate and sketch the position of the Fermi Energy with respect to the Fermi Energy level (E_{Fi}) in Intrinsic Si with the following assumptions: T=300K and KT=0.0259 eV. [**5 marks**]

7. (i)State the rule that combines the effects of various scattering mechanisms into a single measure of mobility and gives the probability of carrier scattering. [**2 marks**] [**10**]

(ii)Using the rule, find the net mobility of carriers due to ionized impurity scattering and phonon scattering. [**4 marks**]

(iii)Does Electron mobility depend on temperature? If yes, graphically represent the change in electron mobility w.r.t. temperature of Silicon doped at different concentrations. [**4 marks**]

Section C (2 X 5 Marks)

Answer All questions

8. (i) What is the applied electric field that will impose a drift velocity equal to 0.1 percent of the mean speed '*u*'(approximately 10^6 m s^{-1}) of conduction electrons in copper? [**3 marks**] [**5**]

(ii)What is the corresponding current density and current through a Cu wire of diameter 1 mm? Assume that the drift mobility of copper is 43.4 cm^2 V^{-1} s^{-1} and conductivity is 5.9×10^7 Ω^{-1} m^{-1}. [**2 marks**]

9. Which diode is used to detect the presence of light along with its colour and intensity? Explain its principle of working with its modes of operation. [**5**]