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 **PRESIDENCY UNIVERSITY**

  **Bengaluru**

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| **End - Term Examinations – JANUARY 2025** |
| **Date:** 11 – 01- 2025 **Time:** 01:00 pm – 04:00 pm |

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| **School:** SOE | **Program:** B Tech-VLSI |
| **Course Code :** ECE2012 | **Course Name :** Solid State Electronics |
| **Semester**: III | **Max Marks**: 100 | **Weightage**: 50% |

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| **CO - Levels** | **CO1** | **CO2** | **CO3** | **CO4** | **CO5** |
| **Marks** | **10** | **10** | **20** | **30** | **30** |

**Instructions:**

1. *Read all questions carefully and answer accordingly.*
2. *Do not write anything on the question paper other than roll number.*

**Part A**

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| **Answer ALL the Questions. Each question carries 2marks. 10Q x 2M=20M** |
| **1** | The law of mass action is important in semiconductor physics and electronics because it establishes the relationship between the concentrations of free electrons and electron holes in a semiconductor when it is in thermal equilibrium. Represent mass action law mathematically. | **2 Marks** | **L1** | **CO2** |
| **2** | Identify the quantum mechanical phenomenon in which an object such as an electron or atom passes through a potential energy barrier that, according to classical mechanics, should not be passable due to the object not having sufficient energy to pass or surmount the barrier. | **2 Marks** | **L1** | **CO2** |
| **3** | The way the atoms are bonded, in a NaCl is different from that of a Carbon. Name the type of bonding in NaCl and Carbon.  | **2 Marks** | **L1** | **CO2** |
| **4** | John observed that if same electric field is applied to an electron in vacuum and in a crystal, it accelerates with different velocities. Why? | **2 Marks** | **L1** | **CO2** |
| **5** | In any material, the Pauli’s exclusion principle plays an important role in bandgap formation. State Pauli’s exclusion principle. | **2 Marks** | **L1** | **CO2** |
| **6** | Trans-conductance is the ratio of change in output current to change in input voltage at any constant output voltage for any solid state electronic device. Find the mathematical equation for trans-conductance for a JFET. | **2 Marks** | **L1** | **CO5** |
| **7** | Billions of MOS transistors are used, together in semiconductor memory devices and microprocessors. List any two features of Field Effect Transistor that enable them for above application. | **2 Marks** | **L1** | **CO5** |
| **8** | In any FETs, the width of the channel can be controlled, by applying a voltage to the gate, which in turn controls the current flowing from the source to the drain. Identify the gate voltage at which the drain current reaches the saturation value. | **2 Marks** | **L1** | **CO5** |
| **9** | The parasitic capacitances and resistances play a crucial role in high-frequency behavior and switching characteristics of the MOSFET. A small signal model or an equivalent model effectively model the inherent capacitances and resistances across its terminals. Draw the equivalent model of a MOSFET. | **2 Marks** | **L1** | **CO5** |
| **10** | 2DEG(2 Dimensional Electron Gas) is formed at the interface of the materials due to differences in their band gaps. This 2DEG acts as a high-mobility electron channel for current flow. In which type of transistor 2DEG is commonly seen? | **2 Marks** | **L1** | **CO5** |

**Part B**

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| **Answer the Questions Total 80 Marks** |
| **11.** | **a.** | By varying the alloy composition, a direct semiconductor GaAs can become indirect semiconductor AlAs. Is the above statement true? Explain with necessary diagrams, how the bandgap varies with alloy composition. | **10****Marks** | **L2** | **CO1** |
| **Or** |
| **12.** | **a.** | In solids, the formation of a bandgap is directly linked to the Pauli exclusion principle. Explain the formation of bandgap in Carbon with the help of a neat diagram. | **10****Marks** | **L2** | **CO1** |
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| **13.** | **a.** | Drift and Diffusion are two mobility techniques of charge carriers in semiconductors. Explain with necessary equations and diagrams. | **10****Marks** | **L2** | **CO3** |
| **Or** |
| **14.** | **a.** | Consider a Silicon pn junction at room temperature doped at Na=1x1016/cm3 in the p region and Nd =1x1017/cm3 in the n region. Intrinsic carrier density is 1.5x1010/cm3 at room temperature. Find the barrier potential and width of the depletion region. For Si the permittivity is given as 1.04x10-12 F/cm, Charge of an electron 1.6x10-19C. | **10****Marks** | **L2** | **CO3** |

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| **15.** | **a.** | According to Quantum mechanics, there is a finite probability that carriers can penetrate through the barrier of thin width. Explain the diode working on above phenomenon. | **10****Marks** | **L2** | **CO3** |
| **Or** |
| **16.** | **a.** | A metal-semiconductor junction is formed when a metal comes into contact with a semiconductor material. Explain the various types with necessary diagrams. | **10****Marks** | **L2** | **CO3** |

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| **17.** | **a.** | Unlike conventional Bipolar Junction Transistors (BJTs), HBTs use different semiconductor materials for the emitter and base regions, which gives them unique advantages. Explain about Heterojunction Bipolar transistors. | **15****Marks** | **L2** | **CO4** |
| **Or** |
| **18.** | **a.** | The current gain of a BJT decreases at high collector current. Is the above statement true? Justify your answer with necessary explanations and diagrams. | **15****Marks** | **L2** | **CO4** |

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| **19.** | **a.** | The Early effect is a phenomenon that occurs in bipolar junction transistors (BJTs) when the effective width of the base changes due to a variation in the base-to-collector voltage. Discuss how the base width variation affects the normal working of a BJT. | **15****Marks** | **L2** | **CO4** |
| **Or** |
| **20.** | **a.** | A transistor is an important solid state electronic device used in amplification and switching applications. Explain the operation of BJT with the help of p-n-p transistor and derive the amplification factor β. | **15****Marks** | **L2** | **CO4** |

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| **21.** | **a.** | Junction Field Effect Transistor (JFET) is a unipolar device as it works with majority carrier movement. Explain the working of JFET with necessary diagrams and equations. | **20****Marks** | **L2** | **CO5** |
| **Or** |
| **22.** | **a.** | CMOS is based on metal-oxide semiconductor field-effect transistor (MOSFET) technology, which uses switches or amplifiers to control the amount of electricity flowing between terminals. Explain the various processes involved in CMOS fabrication with necessary diagrams and the working of a CMOS technology based inverter. | **20****Marks** | **L2** | **CO5** |

**\*\*\*\*\* BEST WISHES \*\*\*\*\***