(T) Roll No. .....

PAPER ID—16003

B. Tech. EXAMINATION, 2024

(First Semester)

COMPUTER SCIENCE AND ENGINEERING

(CYBER SECURITY)

Basics of Electrical and Electronics Engineering

Time : 3 *Hours* *Maximum Marks :* 70

Before answering the question-paper candidates should ensure that they have been supplied to correct and complete question-paper. No complaint, in this regard, will be entertained after the examination.

Note : Attempt *Five* questions in all, selecting *one* question from each Unit. Q. No. 1 is compulsory. All questions carry equal marks.

1. (a) Define the terms 'current', 'voltage' and 'charge' in the context of an electrical circuit and explain their interrelationships.

(b) Describe the difference between ideal and controlled voltage/current sources. How do these sources behave in a circuit ?

(c) What is the difference between peak value, average value and RMS value of a sinusoidal waveform ? Provide formulas for each.

(d) Explain the concept of phasor representation of a sinusoidal waveform and how is it used to analyse AC circuits. How does it simplify the analysis compared to time-domain analysis ?

(e) Define a *p-n* junction diode and describe its basic operation. What are the primary applications of a *p-n* junction diode in electronic circuits ?

(f) Explain the difference between a half-wave rectifier and a full-wave rectifier. How do their output waveforms differ and which one is more efficient ?

(g) Explain the concept of pinch-off voltage in a FET. How does the channel's conductivity change as the drain-to-source voltage increases beyond the pinch-off voltage ? 7×2=14

Unit I

2. (a) Apply Thevenin's Theorem to a circuit with a voltage source and resistors to simplify the circuit. Evaluate the Thevenin equivalent voltage and resistance and explain its significance in practical circuit analysis. 6

(b) In a series circuit, a 10 Ω resistor, a 2 H inductor and a 5 μF capacitor are connected across a 100 V AC supply at 50 Hz : 8

(i) Calculate the total impedance of the circuit.

(ii) Determine the current flowing through the circuit.

(iii) Explain, how the impedance changes when the frequency is increased.

(iv) Discuss the significance of each circuit element (R, L, C) on the impedance of the circuit.

3. (a) A circuit consists of a 100 Ω resistor, a 20 μF capacitor and a 10 H inductor connected in series with an AC voltage source of 50 V at 60 Hz : 7

(i) Calculate the total impedance of the circuit and determine the phase angle.

(ii) Calculate the current flowing through the circuit.

(iii) Discuss the effects of increasing the frequency on the impedance and the phase angle of the circuit.

(b) Explain the role and importance of electrical circuits in engineering. Discuss the relationship between charges, current, voltage and energy in an electrical circuit. 7

Unit II

4. (a) In a three-phase AC system, compare the power delivered by a balanced system of 3-phase loads in both star and delta configurations. Discuss, how the power factor and energy efficiency might differ in each configuration. 7

   (b) Explain the basic concepts of sinusoidal waveforms. Describe the mathematical representation of a sinusoidal waveform and the significance of its parameters such as peak value, average value and RMS value. How do these parameters relate to each other in the context of AC circuits ? 7

5. (a) Explain the concepts of complex power, real power, reactive power, apparent power, and power factor in AC circuits : 7

   (i) Define each type of power and provide the formulas for their calculation.

(ii) Evaluate the significance of power factor in the efficiency of AC circuits and its impact on real-world applications such as power distribution and energy consumption.

(iii) Apply these concepts to a simple AC circuit with a resistor, inductor, and capacitor to calculate the total power and analyse the circuit's efficiency.

(b) In a series RLC circuit, a 120 V, 60 Hz AC supply is connected to a resistor ($R = 10\ \Omega$), inductor ($L = 50$ mH), and capacitor ($C = 10\ \mu F$) : 7

(i) Calculate the total impedance of the circuit using the complex representation of impedance.

(ii) Compute the current flowing through the circuit using phasor analysis.

(iii) Find the phase angle between the voltage and current.

(iv) Calculate the power factor of the circuit.

(v) If the supply voltage is sinusoidal, determine the real power, reactive power and apparent power delivered by the circuit.

Unit III

6. (a) Describe the operation of clipping and clamping circuits. How do they differ from each other in terms of their functionality and applications in signal processing ? 7

(b) Analyse the working of a Bipolar Junction Transistor (BJT) in a Common Emitter (CE) configuration. Compare the input and output characteristics of the CE configuration to those of the Common Base (CB) and Common Collector (CC) configurations. 7

7. (a) Give a circuit with a varactor diode and a varistor, explain how each component works and its application in voltage regulation and surge protection. Provide a practical example for both. 7

(b) Evaluate the significance of thermal stability in BJT circuits. Compare the advantages and disadvantages of different biasing techniques such as base bias, emitter feedback bias, and voltage divider bias in terms of thermal stability and performance. 7

Unit IV

8. (a) Explain the basic operation of a Junction Field Effect Transistor (JFET). Describe its structure and how the gate, source and drain are involved in the device's operation. What are the key characteristics of the JFET and how do they affect its behavior in electronic circuits ? 7

(b) For an N-channel MOSFET, the oxide capacitance per unit area is $C_{ox} = 10\ \mu F/m^2$ and the gate length is 1 μm : 7

(i) Calculate the total oxide capacitance if the gate width is 10 μm.

(ii) Explain, how the MOS capacitor contributes to the behavior of the MOSFET, particularly in terms of threshold voltage and channel formation.

9. (a) Describe the basic operation of a Metal-Oxide-Semiconductor Field Effect Transistor (MOSFET). Explain the role of the gate, source, and drain in the operation of the device. What are the differences between an enhancement-mode and a depletion-mode MOSFET ? 7

(b) A Junction Field Effect Transistor (JFET) has a drain current of 10 mA when the gate-source voltage V_{GS} is 0 V and the pinch-off voltage is $V_P = -4V$: 7

(i) Calculate the drain current when $V_{GS} = -2V$.

(ii) Explain, how the drain current varies with V_{GS} for this JFET.