HALDIA INSTITUTE OF TECHNOLOGY

(AN AUTONOMOUS INSTITUTION UNDER MAULANA ABUL KAILAM AZAD UNIVERSITY OF TECHNOLOGY, WEST BENGAL)

Paper Code: ES-EE 101
Paper Name: Basic Electrical & Electronics Engineering

Practice Set (Module 5 - Module 8)

Module 5: Basics of Diode and its Applications

Q1: How does a PN-junction diode work? Explain in simple terms.

Q2: What is the difference between forward bias and reverse bias in a diode? Draw neat diagrams for both.

Q3: Draw the V-I (voltage–current) characteristics of a PN-junction diode and explain the curve.

Q4: What is a Half-Wave Rectifier? Explain how it works.

Q5: Write the advantages and disadvantages of Half-Wave and Full-Wave Rectifiers.

Q6: A silicon bar has a cross-section of 4 cm^2 and a length of 0.4 cm. It is intrinsic silicon at 300 K. A field of 20 V/cm is applied across it.Calculate the following: (a) Electron current density (b) Hole current density (c) Total current flowing through the bar (d) Resistivity of the silicon bar

Q7: Write the differences between a conductor, a semiconductor, and an insulator with a band diagram.

Q8: Explain how the depletion region is formed in a PN junction and describe what happens when the diode is forward biased and reverse biased.

Q9: a)Draw the circuit of a Half-Wave Rectifier and explain how its output waveform is obtained.
b) Derive its efficiency and ripple factor.

Q10: Draw the V–I characteristics of a Zener diode.

Q11: What is Zener breakdown voltage?Write two applications of a Zener diode.

Q12: How is a Zener diode used as a voltage regulator?

Q13: Difference Between Intrinsic and Extrinsic Semiconductor with examples.

Q14: Write the working Principle of a Full-Wave Bridge Rectifier.

Q15: What is the origin of the reverse saturation current in a p-n junction diode? Does the reverse saturation current change with the applied reverse bias and the diode temperature? Explain.

Q16: What is the difference between avalanche and Zener breakdown of a p-n junction diode? Explain in detail.

Q17: Define the cut-in voltage of a p-n junction diode. What are its typical values for Ge and Si diodes? Draw an I-V characteristics and compare the characteristics of Ge and Si diodes.

Q18: How is the width of the space-charge region affected when a p-n junction diode is (a) forward biased, (b) reverse biased? Explain in detail with a proper diagram.

Q19: Derive expressions for (i) the efficiency and (ii) the ripple factor of a rectifier. Are the same expressions applicable to half-wave, full wave and bridge rectifiers? If so, wherein lie the differences?

Q20: Draw I-V characteristics of PN junction diode for temperature T1 and T2 where T2 > T1.

Module 6: Basic Operating Principle of Bipolar Junction Transistor and Field Effect Transistor

Q1: MOSFET is a voltage controlled device. Justify the statement.

Q2: BJT is a current controlled device. Justify the statement.

Q3: What is the difference between MOSFET and BJT?

Q4: Draw and explain the IV characteristics of CC configuration in BJT?

Q5: Explain in detail how BJT can work as a switch with a suitable circuit diagram?

Q6: Draw and explain the drain characteristics of a JFET?

Q7: Define the current gains in all connections of BJT. Derive the relation between them.

Q8: Discuss the importance of biasing in transistor operation and list the factors affecting stability.

Q9: Discuss the transfer characteristics of p-channel and n-channel JFET?

Q10: What is meant by transconductance with respect to MOSFET?

Q11: What do you understand by pinch off voltage?

Q12: What are the disadvantages of JFET?

Q13: Compare the features of BJT and FET.

Q14: Explain the concept of the Load Line in a transistor circuit and describe how the Q-point (Operating Point) is determined.

Q15: Why CE is preferred over CB and CC configuration of BJT. What are the applications of CB configuration?

Q16: Define current amplification factor for CC, CE, and CB configuration of BJT?

Q17: a) Derive the equations for collector current (I_C) and stability factor (S) in a Fixed-Bias transistor circuit. b) Explain how changes in β affect the stability of the operating point.

Q18: Explain the Self-Bias or voltage-divider bias with the help of a neat circuit diagram.

Q19: Draw the common-base input characteristics of a BJT transistor. What is the Early effect? How can it account for the CB characteristics?

Q20: (a) Give a sketch of the basic structure of an n-channel enhancement-type MOSFET, and define source, drain, gate and channel. Explain the operation and sketch the drain characteristics of the MOSFET, (b)What is the difference between an enhancement-type and a depletion-type MOSFET?

Module 7: Digital Electronics

Q1: Determine the binary equivalent of (i) 17, (ii) 13.875, (iii) 26.25, (iv) 13.65625

Q2: Find the binary equivalent of (i) 10011, (ii) 101.1101

Q3: Determine the decimal and binary equivalents of the hexadecimal numbers (i) A5B and (ii) 643.

Q4: Find the hexadecimal equivalent for the decimal numbers (i) 581, (ii) 12735.4.

Q5: Convert $(1557)_8$ to HEX.

Q6: Give the logic symbols, Boolean expressions and the truth tables of a two-input NOR, NAND, XOR and XNOR gates.

Q7: Simplify the function $X = A'B'C + AB'C + A'BC'$ and draw a simplified logic circuit.

Q8: (a) How can a NOT gate be obtained from a NAND gate? (b) Show that an AND gate can be built with NAND gates, (c) How can the NAND gates be combined to perform the OR operation?

Q9: Explain De Morgan's first and second theorem. Prove each of them by considering two boolean variables.

Q10: Design a two-input XOR gate exclusively with the help of (i) NAND gates (ii) NOR gates.

Q11: List the truth table of the function: (a) $F = XY + XY' + Y'Z$, (b) $F = X'Z' + YZ$.

Q12: Implement the Boolean function $X = AB + A'C$ with NAND gates only and show the circuit diagram.

Q13: Which of the following is not true?

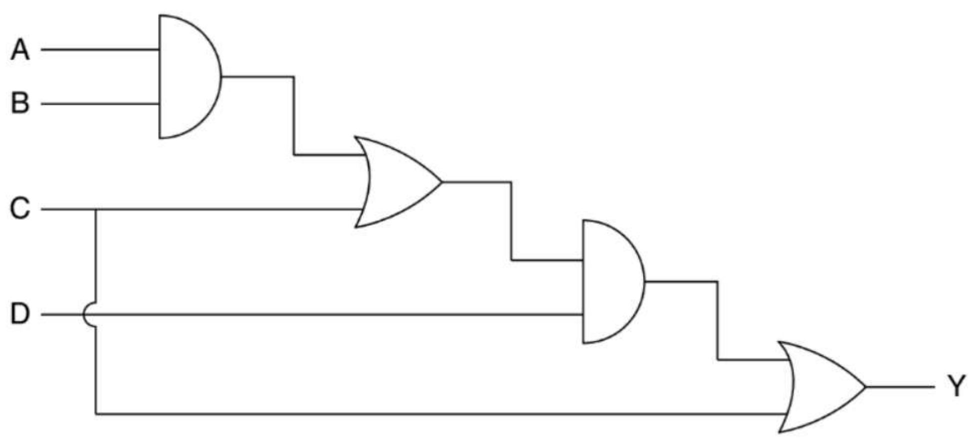
(a) $A.A = A$ (b) $A.A' = 0$ (c) $A + 1 = 1$ (d) $A + A' = 0$

Q14: $X + X'Y$ is reduced to

(a) X (b) $X+Y'$ (c) $X+Y$ (d) $X'+Y$

Q15: What is a universal gate? Give examples. Realize the basic gates with universal NOR gates.

Q16: Deduce the output of the following logic diagram:



Q17: Which of the following logical operations has '+' as its symbol?

(a) AND (b) NAND (c) OR (d) NOT

Q18: Simplify the following Boolean expression and implement using minimum number of gates:

(a) $Y = A'BC'D' + ABC' + BCD' + A'CD + AB'D$
(b) $Y = A'B + BC' + A'$
(c) $Y = ABC + A'BC + AB'C + ABC' + A'B'C'$

Q19: Describe the following laws of Boolean Algebra and verify it using truth table:

(a) Distributive Laws
(b) Commutative Laws
(c) Associative Laws

Q20: Verify the following Boolean identities using Boolean properties and truth tables:

(a) $(A+B)(B+C)(C+A) = AB + BC + CA$
(b) $((AB)' + A' + AB)' = 0$
(c) $(AB + C'D)' = (A' + B')(C + D')$

Module 8: Oscillators

Q1: What is an oscillator? Explain the difference between positive and negative feedback.

Q2: List the characteristics of an ideal and practical op-amp. Define common-mode rejection ratio (CMRR) and explain the significance of a relatively large value of CMRR.

Q3: Name the IC number of OPAMP. Draw the PIN diagram and explain the significance of each PIN.

Q4: Classify the different types of oscillators. State and explain the Barkhausen Criterion for sustained oscillations.

Q5: Explain the operation of OPAMP as a differential amplifier circuit.

Q6: Explain the concept of virtual ground in an Op-Amp. An input of 3V is fed to a non-inverting terminal of an Op-Amp. The amplifier has R_i = 10kΩ and R_f = 10kΩ. Find the output voltage.

Q7: Explain voltage follower circuit in detail with circuit diagram and derivations. Explain the importance of voltage follower circuit.

Q8: Explain the operation of the integrator and differentiator of an OPAMP.

Q9: Does the CMRR of an op-amp have any practical significance?

Q10: What is virtual ground related to an op-amp circuit? How is it different from the actual ground?

Q11: What is CMRR of an op-amp? How is it related to the CMRR of a differential amplifier circuit made of op-amp?

Q12: Draw the circuit diagram of a Hartley oscillator and derive an expression for its frequency of oscillation. Compare its feedback network with that of Colpitts oscillator.

Q13: Explain the working principle of a feedback amplifier and deduce an expression for the gain with feedback in terms of the transfer gain of the basic amplifier and the feedback ratio.

Q14: Show that negative feedback improves the input and output resistances of a voltage amplifier.

Q15: The two input terminals of an OP-AMP are connected to voltage signals of strength 745 μV and 740 μV respectively. The gain of the OP-AMP in differential mode is 5×10^5 and its CMRR is 80 dB. Calculate the common mode gain, output voltage of differential mode gain and output voltage of common mode gain.

Q16: Define the following terms for an op-amp: Slew rate, Input bias current, Input offset voltage and output offset voltage.

Q17: Draw the circuit of the astable multivibrator using 555 timer and explain its working. Derive the expression for its frequency and duty cycle. Draw the waveforms.

Q18: What are the basic building blocks of an op-amp? Why is a dc-level shifter used in an op-amp?

Q19: In an op-amp, if I_{B1}= 600 nA and I_{B2}= 400 nA, then determine the bias current and the off-set current.

Q20: The output voltage of an op-amp circuit changes by 20 V in 4 μs. What is the slew rate?