**Questions from Electrical and Electronic Engineering course**

## I. True or False Questions:

1. Inductive reactance is proportional to frequency, while capacitive reactance is inversely proportional to frequency. ( T )
2. The current phase of an inductor leads its voltage by 90°, while the voltage phase of a capacitor leads its current by 90°. ( F )
3. A semiconductor doped with trivalent elements (e.g., boron) is called an N-type semiconductor. ( F )
4. For a component with voltage and current in associated reference directions, a positive calculated power indicates the component delivers power. ( F )
5. The equivalent capacitance of two parallel capacitors ( C\_1 ) and ( C\_2 ) is ( C\_1 + C\_2 ). ( T )
6. The switching law states that capacitor voltage and inductor current cannot abruptly change during switching. ( T )
7. Multiplying a phasor by ( j ) rotates it clockwise by 90°. ( F )
8. A common-collector amplifier circuit is also called an emitter follower. ( T )
9. A D/A converter converts analog signals to digital signals. ( F )
10. The logical relationship where "an event occurs only when all conditions are met" is called OR logiC.( F )
11. A D/A converter converts digital signals to analog signals. ( T )
12. The output state of a sequential logic circuit depends only on the current input variables. ( F )
13. In digital circuits, "1" and "0" represent two states with numerical magnitude. ( F )
14. A counter where all flip-flops are controlled by the same clock pulse is called an asynchronous counter. ( F )
15. When a binary decoder is disabled, all outputs are at a high logic level. ( T )
16. Not all active single-port networks have Thévenin or Norton equivalents. ( T )
17. When writing nodal or mesh equations for circuits with dependent sources, treat dependent sources as independent sources. ( F )
18. For Thévenin/Norton equivalent resistance, replace independent voltage sources with short circuits and current sources with open circuits. ( T )
19. Inductors and capacitors are dynamic, energy-storage, and active elements. ( F )
20. The actual direction of current is defined as the movement of free electrons. ( F )
21. In DC steady state, an inductor behaves as an open circuit. ( F )
22. Kirchhoff’s Current Law (KCL) applies to both nodes and closed surfaces. ( T )
23. An emitter follower can amplify both voltage and current. ( F )
24. Transistors and FETs conduct using both electrons and holes. ( F )
25. In a FET with the substrate pre-connected to the source, the drain and source cannot be interchanged. ( T )
26. In an active transistor, the emitter current arises from majority carrier diffusion. ( T )
27. In an active transistor, the collector current arises from minority carrier drift. ( T )
28. Amplifier analysis follows the principle of "AC first, DC second." ( F )
29. The 74LS20 is a dual 4-input NAND gate IC.( T )
30. The 74LS151 is a dual 4-to-1 multiplexer IC.( F )
31. The 74LS153 is an 8-to-1 multiplexer IC.( F )
32. The 74LS138 is a 3-to-8 line decoder IC.( T )

## II. Fill-in-the-blank questions:

1. The three essential elements of a sinusoidal quantity are \_\_\_\_\_\_, \_\_\_\_\_\_, and \_\_\_\_\_\_. **Answer**: Amplitude (or peak value), Frequency (or angular frequency), Initial phase.
2. Based on circuit structure, flip-flops can be categorized into \_\_\_\_\_\_, \_\_\_\_\_\_, and \_\_\_\_\_\_. **Answer**: Basic (level-triggered) flip-flops, Synchronous (clock-controlled) flip-flops, Edge-triggered flip-flops.
3. A semiconductor has two types of charge carriers: \_\_\_\_\_\_ and \_\_\_\_\_\_. Their ordered movements are \_\_\_\_\_\_ and \_\_\_\_\_\_. **Answer**: Free electrons, Holes; Diffusion, Drift.
4. Negative feedback can be classified into four types based on input/output connections with the amplifier: \_\_\_\_\_\_, \_\_\_\_\_\_, \_\_\_\_\_\_, and \_\_\_\_\_\_. **Answer**: Voltage-series negative feedback, Voltage-shunt negative feedback, Current-series negative feedback, Current-shunt negative feedback.
5. An integrated operational amplifier consists of four parts: \_\_\_\_\_\_, \_\_\_\_\_\_, \_\_\_\_\_\_, and \_\_\_\_\_\_. **Answer**: Input stage, Intermediate stage, Output stage, Bias circuit.
6. When a PN junction is reverse-biased, the space charge region \_\_\_\_\_\_, and the junction enters the \_\_\_\_\_\_ state. **Answer**: Widens, Cutoff.
7. For associated reference directions: If power ( p ) is positive, the component \_\_\_\_\_\_ power; if ( p ) is negative, it \_\_\_\_\_\_ power. For non-associated directions: If ( p ) is positive, the component \_\_\_\_\_\_ power; if ( p ) is negative, it \_\_\_\_\_\_ power. **Answer**: Absorbs, Delivers; Delivers, Absorbs.
8. After equivalent transformation in a circuit, the \_\_\_\_\_\_ and \_\_\_\_\_\_ of the untransformed part remain unchanged, meaning the transformation is \_\_\_\_\_\_ equivalent. **Answer**: Voltage, Current; Externally.
9. The two fundamental dynamic elements are \_\_\_\_\_\_ and \_\_\_\_\_\_. **Answer**: Inductor, Capacitor.
10. The complete response of a first-order circuit equals the superposition of the \_\_\_\_\_\_ response and the \_\_\_\_\_\_ response. **Answer**: Zero-input, Zero-state.
11. A planar circuit with ( n ) nodes and ( b ) branches can have \_\_\_\_\_\_ independent KCL equations and \_\_\_\_\_\_ independent KVL equations. **Answer**: ( n - 1 ), ( b - n + 1 ).

## III. Multiple Choice Question:

1. AC voltmeters typically measure: (C)  
   A. Instantaneous value   
   B. Peak value   
   C. RMS value   
   D. Peak-to-peak value
2. Combinational logic circuits are built using: (B)  
   A. Flip-flops   
   B. Logic gates   
   C. Counters   
   D. Registers
3. For an amplifier circuit, "open-loop" means: (B)  
   A. No signal source   
   B. No feedback path   
   C. No power supply   
   D. No load
4. An N-type semiconductor is formed by doping an intrinsic semiconductor with: (A)  
   A. Pentavalent elements   
   B. Tetravalent elements   
   C. Trivalent elements   
   D. Divalent elements
5. A P-type semiconductor is formed by doping an intrinsic semiconductor with: (C)  
   A. Pentavalent elements   
   B. Tetravalent elements   
   C. Trivalent elements   
   D. Divalent elements
6. In the saturation region, a transistor’s emitter and collector junctions are biased as: (A)  
   A. Both forward-biased   
   B. Emitter forward, collector reverse  
   C. Emitter reverse, collector forward   
   D. Both reverse-biased
7. In the cutoff region, a transistor’s emitter and collector junctions are biased as: (D)  
   A.Both forward-biased   
   B.Emitter forward, collector reverse  
   C.Emitter reverse, collector forward   
   D.Both reverse-biased
8. In the active region, a transistor’s emitter and collector junctions are biased as: (B)  
   A.Both forward-biased   
   B.Emitter forward, collector reverse  
   C.Emitter reverse, collector forward   
   D.Both reverse-biased
9. When a PN junction is forward-biased, the depletion layer: (D)  
   A.First widens then narrows   
   B.First narrows then widens   
   C.Widens   
   D.Narrows
10. When a PN junction is reverse-biased, the depletion layer: (A)  
    A.Widens   
    B.Narrows
11. The Zener region of a diode corresponds to: (C)  
    A.Forward conduction   
    B.Reverse cutoff   
    C.Reverse breakdown   
    D.Forward cutoff
12. Which of the following Boolean logic expressions is incorrect? (C)  
    A.  
    B.  
    C.  
    D.
13. An example of a non-weighted code is: (A)  
    A.Gray code   
    B.8421BCD code   
    C.5421BCD code   
    D.2421BCD code
14. Which circuit is NOT a sequential logic circuit? (C)  
    A.Synchronous counter   
    B.Data register   
    C.Decoder   
    D.Asynchronous counter
15. In Boolean algebra, ( A + A = ) \_\_\_\_\_\_. (C)  
    A. 2A    
    B. 1    
    C. A    
    D. 0
16. The decimal number 25 in 8421BCD code is: (D)  
    A.10101  
    B.100111   
    C.11001   
    D.00100101
17. A NAND gate outputs logic 0 when: (D)  
    A.All inputs are 0   
    B.Any input is 0   
    C.Only one input is 0   
    D.All inputs are 1
18. The XOR result of 24 "1"s is: (B)  
    A. -1   
    B. 0    
    C. 1   
    D. 24
19. A 16-to-1 multiplexer has \_\_\_\_\_\_ address input lines. (C)  
    A.2   
    B.3   
    C.4   
    D.8
20. A maxterm expression is also called: (B)  
    A.Standard sum-of-products   
    B.Standard product-of-sums  
    C.Standard XOR form   
    D.Standard XNOR form
21. Encoding 100 objects requires \_\_\_\_\_\_ binary bits. (C)  
    A.5   
    B.6   
    C.7   
    D.8
22. Addition that ignores carry from lower bits is called: (B)  
    A.Full adder   
    B.Half adder   
    C.Full subtractor   
    D.Half subtractor
23. A valid Boolean identity is: (D)  
    A. C\*C = C^2    
    B. 1 + 1 = 10   
    C. 0 < 1    
    D. A + 1 = 1

## IV. Short Answer Questions:

#### 1. What is a combinational logic circuit?

A combinational logic circuit is one where the output at any moment depends only on the current input values and not on the circuit’s prior state.

#### 2. What is a sequential logic circuit?

A sequential logic circuit’s output depends not only on the current input values but also on the circuit’s previous state (i.e., it incorporates memory elements like flip-flops).

#### 3. What is an electric circuit?

An electric circuit is a system composed of interconnected electrical components (e.g., resistors, capacitors, sources) designed to achieve a specific function.

#### 4. What is P-type semiconductor?

A P-type semiconductor is formed by doping an intrinsic semiconductor (e.g., silicon) with trivalent impurities (e.g., boron, aluminum, or gallium), creating an excess of holes (positive charge carriers).

#### 5. What is N-type semiconductor?

An N-type semiconductor is formed by doping an intrinsic semiconductor with pentavalent impurities (e.g., phosphorus, arsenic, or antimony), creating an excess of free electrons (negative charge carriers).

#### 6. Explain the unidirectional conductivity of a PN junction.

A PN junction conducts current only in forward bias (when the P-side is connected to the positive terminal and the N-side to the negative terminal). In reverse bias, it blocks current, exhibiting high resistance.

#### 7. Describe the structure of a bipolar junction transistor (BJT).

A BJT consists of:

**•** Three doped regions: Emitter, base, and collector.

**•** Two PN junctions: Emitter-base junction and base-collector junction.

**•** Three electrodes: Emitter (E), base (B), and collector (C).

#### 8. What are the three regions of a BJT’s output characteristic curve?

**•** Cutoff region: Both junctions are reverse-biased; no current flows.

**•** Saturation region: Both junctions are forward-biased; acts as a closed switch.

**•** Active region: Emitter-base junction is forward-biased, collector-base junction is reverse-biased; amplifies signals.

#### 9. Classify independent and dependent power sources.

**•** Independent sources: Voltage sources (fixed voltage) and current sources (fixed current).

**•** Dependent (controlled) sources: Voltage-controlled voltage/current sources (VCVS/VCCS) and current-controlled voltage/current sources (CCVS/CCCS).

#### 10. What is a node?

A node is a connection point in a circuit where three or more components are joined.

#### 11. What is a branch?

A branch is a single path in a circuit connecting two nodes, containing one or more components.

#### 12. What is a loop?

A loop is any closed path in a circuit where no component or node is encountered more than once.

#### 13. What is the Branch Current Method?

A circuit analysis technique where branch currents are treated as variables, and Kirchhoff’s laws are applied to write equations for solving these currents.

#### 14. State the Superposition Theorem.

The total response (voltage or current) in a linear circuit with multiple sources is the sum of the responses caused by each source acting alone, with all other sources turned off (voltage sources shorted, current sources opened).

#### 15. What is Thévenin’s Theorem?

Any linear two-terminal network can be replaced by an equivalent circuit with a voltage source ((V\_{Th})) in series with a resistor ((R\_{Th})), where:

**•** (V\_{Th}) = Open-circuit voltage at the terminals.

**•** (R\_{Th}) = Equivalent resistance with all sources turned off.

#### 16. What is Norton’s Theorem?

Any linear two-terminal network can be replaced by an equivalent circuit with a current source ((I\_N)) in parallel with a resistor ((R\_N)), where:

**•** (I\_N) = Short-circuit current through the terminals.

**•** (R\_N) = Equivalent resistance with all sources turned off.

#### 17. What are the three essential parameters of a sinusoidal AC signal?

**•** Amplitude (maximum value).

**•** Frequency (or angular frequency, (\omega = 2\pi f)).

**•** Initial phase angle (starting phase at (t=0)).

#### 18. Define "switching" in circuits.

Switching refers to any event that changes a circuit’s configuration, such as turning a power source on/off or altering component values.

#### 19. What is zero-input response?

The zero-input response is the voltage/current generated solely by the initial stored energy (e.g., in capacitors/inductors) in a circuit after switching, with no external input.

#### 20. What is zero-state response?

The zero-state response is the voltage/current generated by an external input in a circuit with no initial stored energy (e.g., capacitors discharged, inductors uncharged).

#### 21. What are the three configurations of transistor amplifiers?

**•** Common Emitter (input at base, output at collector).

**•** Common Collector (emitter follower).

**•** Common Base.

#### 22. What is AND logic?

AND logic requires all conditions to be true for the outcome to be true. Symbolically: (Y = A \cdot B).

#### 23. What is OR logic?

OR logic requires at least one condition to be true for the outcome to be true. Symbolically: (Y = A + B).

#### 24. Name the basic logic operations.

**•** AND (multiplication).

**•** OR (addition).

**•** NOT (inversion).

#### 25. Classify flip-flops by structure.

**•** Basic (asynchronous) flip-flops.

**•** Synchronous (clocked) flip-flops.

**•** Edge-triggered flip-flops.

#### 26. What are the sections of an operational amplifier (op-amp)?

**•** Input stage (differential amplifier).

**•** Intermediate stage (gain stage).

**•** Output stage (power amplifier).

**•** Bias circuitry.

#### 27. Explain positive/negative feedback and list types of negative feedback.

**•** Positive feedback: Feedback reinforces the input signal (e.g., oscillators).

**•** Negative feedback: Feedback opposes the input signal, improving stability and linearity.

**•** Types of negative feedback:

**•** Voltage-series feedback.

**•** Voltage-shunt feedback.

**•** Current-series feedback.

**•** Current-shunt feedback.

#### 28. What determines closed-loop gain in deep negative feedback?

In deep negative feedback, the closed-loop gain depends only on the feedback network’s parameters (e.g., feedback ratio) and is independent of the amplifier’s intrinsic gain.