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Basic Concepts

Q1. What is resistance and its unit?

Answer: Resistance is the opposition offered by a material to the flow of electric current; its unit is ohm (Ω).

Memory Tip: More resistance means less current, like a thin pipe blocking water.

Q2. Define inductance and its unit.

Answer: Inductance is the property of a coil by which it opposes any change in current through it, due to induced emf; its unit is henry (H).

Memory Tip: Inductance “hates” change in current.

Q3. Define capacitance and its unit.

Answer: Capacitance is the ability of a capacitor to store electric charge per unit voltage; its unit is farad (F).

Formula: $C = \frac{Q}{V}$, where C is capacitance, Q charge, V voltage.

Memory Tip: Capacitor = Charge tank.

Q4. What is electric current?

Answer: Electric current is the rate of flow of electric charge in a conductor; unit is ampere (A).

Formula: $I = \frac{Q}{t}$, I current, Q charge, t time.

Memory Tip: More electrons per second, more current.

Q5. Define voltage.

Answer: Voltage is the work done per unit charge to move a charge between two points; unit is volt (V).

Formula: $V = \frac{W}{Q}$, V voltage, W work, Q charge.

Memory Tip: Voltage = electrical “pressure”.

Q6. What is electric power?

Answer: Electric power is the rate at which electrical energy is converted into another form; its unit is watt (W).

Formula: $P = VI = I^2R = \frac{V^2}{R}$; P power, V voltage, I current, R resistance.

Memory Tip: Power triangle: $P = VI$.

Q7. What is electrical energy and its commercial unit?

Answer: Electrical energy is the total work done by an electric current in a given time; a commercial unit is kilowatt-hour (kWh).

Formula: $E = P \times t$; E energy, P power, t time.

Memory Tip: Energy = power × time.

Q8. State Ohm's law.

Answer: Ohm's law states that current through a conductor is directly proportional to the voltage across it, if temperature is constant.

Formula: $V = IR$; V voltage, I current, R resistance.

Memory Tip: Triangle: V at top, I and R at base.

Q9. How do resistances add in series?

Answer: In series, total resistance is the sum of individual resistances.

Formula: $R_{series} = R_1 + R_2 + ...$

Memory Tip: Series = add directly.

Q10. How do resistances add in parallel?

Answer: In parallel, the reciprocal of total resistance equals the sum of reciprocals of individual resistances.

Formula: $\frac{1}{R_{par}} = \frac{1}{R_1} + \frac{1}{R_2} + ...$

Memory Tip: Parallel = reciprocals add.

Q11. What is a magnetic circuit?

Answer: A magnetic circuit is a closed path followed by magnetic flux.

Memory Tip: Think of it as a "path" for flux like a loop for current.

Q12. Define magnetomotive force (MMF) and give its formula.

Answer: MMF is the driving force that sets up magnetic flux in a magnetic circuit; unit is ampere-turn (AT).

Formula: $MMF = NI$, N turns, I current.

Memory Tip: More turns or more current → more MMF.

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Q13. What is magnetic field strength (H)?

Answer: Magnetic field strength is MMF per unit length of the magnetic path; unit is A/m.

Formula: $H = \frac{MMF}{l} = \frac{NI}{l}$; l length.

Memory Tip: H is "MMF density" along the path.

Q14. Define reluctance.

Answer: Reluctance is the opposition offered by a magnetic circuit to the establishment of flux; unit is ampere-turn per weber.

Formula: $R = \frac{l}{\mu A}$; l length, μ permeability, A area.

Memory Tip: Reluctance in magnetics is like resistance in electrics.

Q15. What is the relation between flux, MMF and reluctance?

Answer: Flux equals MMF divided by reluctance, similar to current equals voltage divided by resistance.

Formula: $\phi = \frac{MMF}{R}$; ϕ flux.

Memory Tip: "Magnetic Ohm's law": $\phi = \frac{NI}{R}$.

Module 1: DC Circuits (Only Independent Sources) – CO1

Q1. State Kirchhoff's Current Law (KCL).

Answer: KCL states that algebraic sum of currents at a node is zero; sum of currents entering equals sum of currents leaving.

Memory Tip: "What comes in must go out."

Q2. State Kirchhoff's Voltage Law (KVL).

Answer: KVL states that algebraic sum of voltages around any closed loop is zero.

Memory Tip: "Total rise = total drop in a loop."

Q3. What is an ideal voltage source?

Answer: An ideal voltage source maintains a fixed voltage across its terminals independent of the current drawn.

Memory Tip: Infinite internal resistance is for current source, zero for ideal voltage source.

Q4. What is an ideal current source?

Answer: An ideal current source supplies a constant current regardless of the voltage across it.

Memory Tip: It "pushes" fixed current no matter what.

Q5. Define source transformation.

Answer: Source transformation is the process of converting a voltage source in series with resistance into an equivalent current source in parallel with the same resistance (and vice versa).

Formulas:

- From voltage to current: $I_s = \frac{V_s}{R}$.
- From current to voltage: $V_s = I_s R$.

  Memory Tip: Use $V = IR$ to switch between forms.

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Q6. What is a mesh in an electric circuit?

Answer: A mesh is a loop that does not contain any other loop within it.

Memory Tip: Smallest window in the circuit.

Q7. Explain mesh analysis in brief.

Answer: Mesh analysis uses KVL to write equations in terms of mesh currents for each independent mesh, then solves for these currents.

Memory Tip: One equation per mesh using loop voltages.

Q8. What is a node and what is nodal analysis?

Answer: A node is a point where two or more elements join; nodal analysis applies KCL at nodes using node voltages with respect to a reference node.

Memory Tip: One equation per node using currents.

Q9. Why are star–delta transformations used?

Answer: They are used to simplify complex resistor networks that are not purely series or parallel, making circuit analysis easier.

Memory Tip: Convert mixed shapes to solvable forms.

Q10. Write the formula to convert a star resistance R_A connected to nodes B and C into delta resistances (general form only).

Answer: Each delta resistance equals sum of pairwise products of star resistances divided by the opposite star resistance.

Formula: For star resistances R_a, R_b, R_c:

- $R_{ab} = \frac{R_a R_b + R_b R_c + R_c R_a}{R_c}$ (and similarly cyclic).

  Memory Tip: Numerator is "sum of all products", denominator is "opposite leg".

Q11. State the superposition theorem.

Answer: Superposition theorem says that in a linear circuit with multiple independent sources, response at any element is the algebraic sum of responses due to each source acting alone, with others turned off.

Memory Tip: "One source at a time, then add."

Q12. What is Thevenin's theorem?

Answer: Thevenin's theorem states that any linear two-terminal network can be replaced by an equivalent voltage source in series with a resistance as seen from those terminals.

Memory Tip: Complex network → single V source + series R.

Q13. State maximum power transfer condition for a DC source with internal resistance.

Answer: Maximum power is delivered to the load when load resistance equals Thevenin (or source) resistance.

Formula: $R_L = R_{th}$.

Memory Tip: Load must "match" source.

Module 2 : AC Circuits -CO2

Q1. How is alternating voltage generated?

Answer: Alternating voltage is generated when a conductor rotates in a uniform magnetic field, causing sinusoidal variation of flux linkage and induced emf.

Memory Tip: Rotation in a magnetic field → AC.

Q2. Define instantaneous value, peak value, and RMS value of AC.

Answer: Instantaneous value is value at any instant; peak is maximum value; RMS is equivalent DC value that produces the same heating effect.

Formula (sine wave): $V_{rms} = \frac{V_m}{\sqrt{2}}, V_{avg} = \frac{2V_m}{\pi}$.

Memory Tip: For sine, RMS ≈ 0.707 Vm, average ≈ 0.637 Vm.

Q3. What is a phasor?

Answer: A phasor is a rotating vector that represents the magnitude and phase of a sinusoidal quantity.

Memory Tip: Think of AC quantities as arrows in a complex plane.

Q4. What is phase difference?

Answer: Phase difference is the angular displacement between two sinusoidal waveforms of same frequency.

Memory Tip: Measured in degrees or radians.

Worked solution:

- $Z = \sqrt{10^2 + 20^2} = \sqrt{100 + 400} = \sqrt{500} \approx 22.36.$
- $I = \frac{V}{Z} = \frac{100}{22.36} \approx 4.47.$

  Memory Tip: Use triangle for R and XL to get Z.

Q5. Define real power, reactive power, and apparent power.

Answer: Real power (P) is actual power consumed in watts; reactive power (Q) is power alternately stored and returned in VAR; apparent power (S) is product of RMS voltage and current in VA.

Formulas: $P = VIcos\phi$, $Q = VIsin\phi$, $S = VI$.

Memory Tip: Power triangle: S at hypotenuse, P and Q as sides.

Q6. What is power factor?

Answer: Power factor is cosine of angle between voltage and current, $cos\phi = \frac{P}{S}$.

Memory Tip: PF close to 1 means efficient power use.

Q7. What is admittance?

Answer: Admittance (Y) is reciprocal of impedance, indicating how easily a circuit allows current flow; unit is siemens (S).

Formula: $Y = \frac{1}{Z} = G + jB$, where G is conductance, B susceptance.

Memory Tip: Admittance = "ease" of current.

Q8. Define resonance in an RLC circuit.

Answer: Resonance occurs when inductive reactance equals capacitive reactance, making net reactance zero and circuit purely resistive.

Condition: $X_L = X_C \Rightarrow \omega L = \frac{1}{\omega C}$.

Memory Tip: At resonance, XL and XC cancel.

Q9. Give formula for resonant frequency in series RLC.

Answer: Resonant angular frequency is $\omega_0 = \frac{1}{\sqrt{LC}}$; corresponding frequency is $f_0 = \frac{1}{2\pi\sqrt{LC}}$.

Memory Tip: Remember "1 over root LC".

Q10. What happens to current and power factor at resonance in a series circuit?

Answer: Circuit current is maximum and power factor is unity at resonance.

Memory Tip: Series resonance behaves like pure resistor.

Q11. What is a three-phase system?

Answer: A three-phase system consists of three sinusoidal voltages of same frequency and equal magnitude, displaced by 120° in phase.

Memory Tip: "Same f, same magnitude, 120° apart."

Q12. In a balanced star connection, what is relation between line and phase voltage?

Answer: Line voltage is $\sqrt{3}$ times phase voltage and line current equals phase current.

Formulas: $V_L = \sqrt{3}V_{ph}$, $I_L = I_{ph}$.

Memory Tip: Star: line voltage is bigger.

Q13. In a balanced delta connection, relate line and phase currents.

Answer: Line current is $\sqrt{3}$ times phase current, while line voltage equals phase voltage.

Formulas: $I_L = \sqrt{3}I_{ph}$, $V_L = V_{ph}$.

Memory Tip: Delta: line current is bigger.

Module 3: Single-Phase Transformer – CO3

Q1. State the working principle of a transformer.

Answer: A transformer works on the principle of mutual induction, where a changing flux in the primary winding induces voltage in the secondary winding.

Memory Tip: No change in flux → no transformer action.

Q2. Why can a transformer not work on DC?

Answer: On DC, there is no time-varying flux, so no mutually induced emf; only high current flows causing overheating.

Memory Tip: Transformer needs changing flux, not steady.

Q3. Define transformation ratio (k).

Answer: Transformation ratio is ratio of secondary voltage to primary voltage.

Formula: $k = \frac{V_2}{V_1} = \frac{N_2}{N_1}$, where N is turns.

Memory Tip: More turns → more voltage.

Q4. Distinguish between step-up and step-down transformer.

Answer: Step-up transformer has higher secondary voltage than primary; step-down has lower secondary voltage than primary.

Memory Tip: Up: V2 > V1, Down: V2 < V1.

Q5. Mention two types of single-phase transformer w.r.t. core construction.

Answer: Core-type and shell-type transformers.

Memory Tip: In core type, windings surround core; in shell type, core surrounds windings.

Q6. What is an ideal transformer?

Answer: An ideal transformer has no losses and zero leakage flux, so input power equals output power.

Formula: $V_1 I_1 = V_2 I_2$.

Memory Tip: Efficiency is 100% in ideal case.

Q7. Name main types of transformer losses.

Answer: Core (iron) losses and copper losses; core losses include hysteresis and eddy current losses.

Memory Tip: Iron → core losses, copper → I^2R losses.

Q8. What are hysteresis and eddy current losses?

Answer: Hysteresis loss is due to repeated magnetization and demagnetization of core; eddy current loss is due to circulating currents induced in core.

Memory Tip: Use laminated core to reduce eddy current loss.

Q9. Define transformer efficiency.

Answer: Efficiency is ratio of output power to input power, usually expressed in percentage.

Formula: $\eta = \frac{P_{out}}{P_{in}} \times 100\%$.

Memory Tip: Losses reduce efficiency.

Q10. Mention any three applications of single-phase transformers.

Answer: Used in power distribution, electronic device power supplies, and isolation between circuits.

Memory Tip: From grid to gadgets.

Module 4: Electrical Machines – CO4

Q1. State the working principle of a DC motor.

Answer: A DC motor works on the principle that a current-carrying conductor placed in a magnetic field experiences a mechanical force.

Memory Tip: Electrical to mechanical via force on conductor.

Q2. Name main parts of a DC motor.

Answer: Yoke, field winding, armature core, armature winding, commutator, and brushes.

Memory Tip: Remember field + armature + commutator.

Q3. Give two applications of DC motors.

Answer: Used in electric traction (trains), rolling mills, and variable-speed drives.

Memory Tip: Where speed control is important, DC motors are used.

Q4. What is the principle of operation of a three-phase induction motor?

Answer: It works on induction principle: a rotating magnetic field in stator induces current in rotor, producing torque.

Memory Tip: No direct electrical connection to rotor

Q5. Define slip in induction motor.

Answer: Slip is the difference between synchronous speed and rotor speed expressed as a fraction of synchronous speed.

Formula: $s = \frac{N_s - N_r}{N_s}$.

Memory Tip: Rotor always slightly slower than rotating field.

Q6. Why is single-phase induction motor not self-starting?

Answer: Because a single-phase supply produces only a pulsating field, not a rotating one, resulting in zero starting torque.

Memory Tip: Needs auxiliary means (start winding/capacitor).

Q7. Mention any two applications of single-phase induction motor.

Answer: Used in fans, pumps, refrigerators, and domestic appliances.

Memory Tip: Common in household devices.

Q8. What is a BLDC motor?

Answer: A Brushless DC (BLDC) motor is a synchronous motor powered by DC through an inverter, using electronic commutation instead of brushes.

Memory Tip: “Brushless” but behaves like DC motor with electronic control.

Q9. Give two advantages of BLDC motor.

Answer: High efficiency, low maintenance, and better speed control.

Memory Tip: More reliable than brushed DC motors.

Module 5: Special Purpose Diodes – CO5

Q1. What is a Zener diode?

Answer: A Zener diode is a special diode designed to operate in reverse breakdown region at a nearly constant voltage.

Memory Tip: Reverse-biased constant-voltage device.

Q2. Define Zener breakdown voltage.

Answer: It is the reverse voltage at which a Zener diode starts conducting heavily and maintains nearly constant voltage.

Memory Tip: Symbolised as V_Z.

Q3. How is a Zener diode used as a voltage regulator?

Answer: It is connected in reverse bias across load; when input varies, Zener maintains constant voltage across load by adjusting its current.

Memory Tip: Zener "clips" variations in output voltage.

Q4. What happens if Zener diode current exceeds maximum rated value?

Answer: The diode may overheat and get permanently damaged.

Memory Tip: Always use series resistor to limit current.

Q5. What is an LED?

Answer: A Light Emitting Diode is a semiconductor diode that emits light when forward biased.

Memory Tip: Current in, light out.

Q6. Briefly describe LED structure.

Answer: LED is a P-N junction made from direct band-gap semiconductor, often placed in a transparent package with reflective cup to direct light.

Memory Tip: PN junction + special material for light.

Q7. Mention two advantages of LEDs over incandescent lamps.

Answer: Higher efficiency, longer life, low power consumption, and smaller size.

Memory Tip: LEDs save power and last longer.

Q8. Give two applications of LEDs.

Answer: Used in indicator lamps, seven-segment displays, and general lighting.

Memory Tip: From small indicators to room lighting.

Module 6: Introduction to Transistors – CO6

Q1. What is a BJT?

Answer: A Bipolar Junction Transistor is a three-terminal semiconductor device that uses both electrons and holes as charge carriers.

Memory Tip: Bi-polar = two types of carriers.

Q2. Name the three terminals of a BJT.

Answer: Emitter, base, and collector.

Memory Tip: E-B-C like "Earning Brings Cash".

Q3. Distinguish between NPN and PNP transistor (basic).

Answer: NPN has P-type base between two N-type regions; in PNP, N-type base lies between two P-type regions, and current directions are opposite.

Memory Tip: Arrow on emitter points out for NPN, in for PNP.

Q4. Explain basic operation of a BJT as a switch.

Answer: In cutoff, both junctions are off and transistor acts as open switch; in saturation, both junctions are forward biased and transistor acts as closed switch.

Memory Tip: Cutoff = OFF, Saturation = ON.

Q5. What is common emitter configuration?

Answer: In CE configuration, emitter is common to both input and output circuits; input is between base-emitter, output between collector-emitter.

Memory Tip: Most commonly used for amplification.

Q6. Define current gain in common emitter configuration.

Answer: It is ratio of change in collector current to change in base current, denoted by β.

Formula: $\beta = \frac{\Delta I_C}{\Delta I_B}$.

Memory Tip: Small base current controls large collector current.

Q7. What is an FET and how does it differ from BJT?

Answer: A Field Effect Transistor is a unipolar device where current is controlled by electric field at the gate; it mainly uses one type of carrier, unlike BJT.

Memory Tip: FET is voltage-controlled, BJT is current-controlled.

Q8. Name main terminals of a JFET or MOSFET.

Answer: Source, gate, and drain.

Memory Tip: S-G-D like "Source Gives Drain".

Q9. Write two advantages of FET over BJT.

Answer: Higher input impedance and lower noise.

Memory Tip: FET "loads" the previous stage less.

Q10. Mention one application each of BJT and FET in amplification, switching, or oscillators.

Answer: BJT used as audio amplifier or in digital logic switching; FET used in MOSFET power switches or RF amplifiers.

Memory Tip: BJTs popular for low-level analog, MOSFETs for power and digital.
