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ESE - 2025

Preliminary Examination

QUESTIONS WITH DETAILED SOLUTIONS

ELECTRONICS & TELECOMMUNICATION ENGINEERING

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Electronics & Telecommunication Engineering

(SET - A)

SUBJECT WISE WEIGHTAGE

S.No.	Name of the Subject	No. Of Questions
1	Analog & Digital Communication Systems	8
2	Control Systems	9
3	Signals & Systems	10
4	Computer Organization & Architecture	16
5	Electro Magnetics	11
6	Advanced Electronics Topics	5
7	Advanced Communication Topics	18
8	Basic Electronics Engineering	7
9	Basic Electrical Engineering	11
10	Materials Science	13
11	Electronic Measurements & Instrumentation	15
12	Network Theory	9
13	Analog & Digital Circuits	11 + 7
Total No. Of Questions		**150**

01. Which one of the following is the maximum reverse voltage that can be applied to the P-N junction?
(a) Maximum forward voltage
(b) Peak inverse voltage
(c) Maximum average voltage
(d) Respective peak forward voltage

01. Ans: (b)

Sol: Peak inverse voltage of a PN diode is defined as the max voltage that can be applied to a diode in reverse bias.

02. The common-base DC current gain of a transistor is 0.967. If the emitter current is 10 mA, the base current will be
(a) 0.53 mA (b) 0.44 mA
(c) 0.33 mA (d) 0.24 mA

02. Ans: (c)

Sol: Given $\frac{I_C}{I_E} = 0.967$ [CB amplifier DC current gain]

and $I_E = 10mA$ (given)

$\therefore I_C = 0.967(10m)$

$= 9.67mA$

Base current $(I_B) = I_E - I_C$

$= 10m - 9.67m$

$= 0.33mA$

03. In actual MOSFET characteristic, a non-zero slope exists beyond the saturation point. For the saturation region, i.e., ($V_{DS} > V_{DS}$ (sat), the effective channel length decreases and this phenomenon is called
(a) base width modulation
(b) channel width modulation
(c) channel length modulation
(d) base length modulation

03. Ans: (c)

Sol: Channel length modulation in a MOSFET refers to the shortening of the effective channel length as the drain voltage increases in the saturation region. This shortening occurs because the increased drain voltage causes the depletion region around the drain to extend into the channel, effectively reducing the length available for current flow.

04. MOSFETs have characteristics similar in form to those of JFETs. Hence MOSFETs are also known as
(a) Depletion MOSFETs (D-MOSFETs)
(b) Enhancement MOSFETs(E-MOSFETs)
(c) Insulated Gate Field Effect Transistors (IGFETs)
(d) p-channel MOSFETs

04. Ans: (a)

Sol: MOSFET whose characteristics simillar to JFET → Depletion MOSFET (Depletion mode).

05. A transistor has $\alpha = 0.995$ and if the base current is 200 μA, the value of the emitter current will be
(a) 30 mA (b) 35 mA
(c) 40 mA (d) 45 mA

05. Ans: (c)

Sol: Given

$$\alpha = \frac{I_C}{I_E} = 0.995 \rightarrow \beta = \frac{\alpha}{1-\alpha} = \frac{0.955}{1-0.995} = 199$$

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Emitter current $(I_E) = (1 + \beta)I_B$
$= (1 + 199)200\mu$
$= (200)\ (0.2m)$
$= 40mA$

06. A common-emitter transistor amplifier has an input impedance of 2 kQ and a load resistance of 25 kQ. If the B of the transistor is 100, the power gain will be
(a) 112500 (b) 125000
(c) 150000 (d) 175000

06. Ans: (b)

Sol: Given $R_{in} = 2k\Omega$ [for CE amplifier] $= r_\pi$
$R_C = 25k\Omega$
$\beta = 100$
Voltage gain $(A_V) = -g_m R_C$
$= -\frac{\beta}{r_\pi}.R_C = -\frac{100}{2k}(25k) = -1250$
Current gain $(A_I) = -\beta$
Power gain $(A_P) = A_V.A_I$
$= (-1250)(-100)$
$= 125000$

07. Which one of the following amplifiers is called an emitter follower?
(a) Common-emitter amplifier
(b) Common-collector amplifier
(c) Common-base amplifier
(d) Common-drain amplifier

07. Ans: (b)

Sol: Common collector amplifier is a voltage buffer. It is also called emitter follower as the output at emitter follows input as base

08. Which one of the following is **not** the correct advantage of integrated circuits (ICs)?
(a) Low power consumption
(b) Very high reliability because failure rate becomes minimal as there is no exposed component
(c) There are no limitations of power and voltage rating
(d) Improved performance

08. Ans: (c)

Sol: ICs are excellent for low-power, low-voltage applications, but they do have limitations in terms of power and voltage handling, due to the small size and thermal constraints.

ICs generally do have low power consumption compared to discrete component circuits due to their small size and optimized design. So, this is an advantage.

ICs are known for high reliability. The components are encapsulated, reducing exposure to environmental factors, and the manufacturing process is highly controlled. This is an advantage.

ICs offer improved performance due to shorter signal paths, reduced parasitic effects, and the ability to integrate complex functions, leading to higher operating speeds and better overall system performance.

09. MOSFET, used as a load device, is referred to as
(a) critical load (b) dormant load
(c) active load (d) passive load

09. Ans: (c)

Sol: MOSFET used as an active load increases amplifier gain, reduces chip area and minimizes power consumption.

10. ICs in which circuits are fabricated, i.e., all the transistors in such circuits operate in cut-off and saturation regions, the adders, multiplexers and comparators are
(a) digital ICs (b) linear ICs
(c) analog ICs (d) hybrid ICs

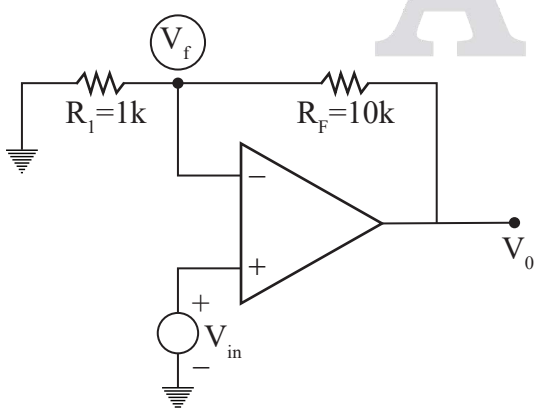
10. Ans: (a)

Sol: Digital ICs typically operate in cutoff or saturation to act as a switch

11. For a non-inverting amplifier, the input resistor R_1 = 1 kΩ and feedback resistor R_f = 10 kΩ The closed-loop voltage gain A_f and feedback factor β respectively are
(a) 11 and 0-07 (b) 11 and 0-09
(c) 13 and 0:07 (d) 13 and 0-09

11. Ans: (b)

Sol:



Closed loop voltage gain

$$(Af) = \frac{V_0}{V_{in}} = 1 + \frac{R_F}{R_1} = 1 + \frac{10k}{1k} = 11$$

Feedback factor

$$(\beta) = \frac{V_f}{V_0} = \frac{R_1}{R_F + R_1} = \frac{1k}{10k + 1k} = \frac{1}{11} = 0.09$$

12. Which one of the following is a three-region reverse-biased junction diode?
(a) P-N junction diode (b) Light-emitting diode
(c) PIN photodiode (d) Zener diode

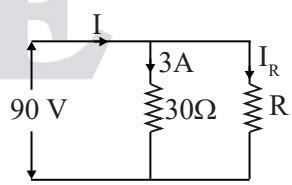
12. Ans: (c)

Sol: PIN photo diode need Reverse Bias for large responsivity

13. Two resistances, one of 30 Ω and another of unknown value are connected in parallel; the total power dissipated in the circuit is 450 W, when the applied voltage 1s 90 volts. The value of the unknown resistance will be
(a) 35 Ω (b) 40 Ω
(c) 45 Ω (d) 50 Ω

13. Ans: (c)

Sol:



Total power VI = 450 Watts

90 I = 450

I = 5 A

$I = I_{30\Omega} + I_R$

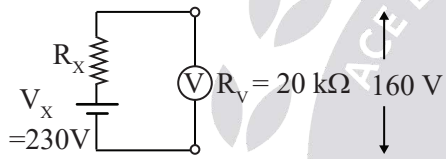
$5 = \frac{90}{30} + I_R \Rightarrow I_R = 2A$

$$R = \frac{V_R}{I_R} = \frac{90}{2} = 45\Omega$$

14. A voltmeter has a resistance of 20000 Ω. When connected in series with an external resistance across a 230 V supply, the instrument reads 160 V. The value of the external resistance will be
(a) 8750 Ω (b) 8560 Ω
(c) 8370 Ω (d) 8180 Ω

14. Ans: (a)

Sol:



$$160 = 230 \times \frac{20k}{20k + R_x}$$

$$R_x = 8750\ \Omega$$

15. Which one of the following is **not** the correct advantage of wound-rotor (or slip-ring) induction motor?
(a) It has high starting torque with low starting current
(b) It has adjustable speed
(c) It has high overload capacity
(d) It has high efficiency as compared to squirrel-cage motor

15. Ans: (d)

Sol: In general, for the same rating, a squirrel-cage induction motor is more efficient than a wound-rotor motor, especially at full load, because the wound rotor has additional losses in the rotor windings and the external resistance.

By adding external resistance to the rotor circuit via slip rings, the starting torque can be significantly increased while limiting the starting current.(statement-1)

By varying the external resistance in the rotor circuit, the speed-torque characteristics can be altered, allowing for speed control. (statement-2)

Wound-rotor motors generally do have good overload capacity, similar to or even better than squirrel-cage motors, especially when considering their ability to handle transient overloads during starting or sudden load changes. (Statement-3)

16. Which one of the following statements is correct regarding an ideal transformer?
(a) The leakage flux is large.
(b) The transformer core losses are large.
(c) The transformer core material has infinite permeability.
(d) The transformer windings are with large resistances.

16. Ans: (c)

Sol: For an ideal transformer, it's assumed that the core material has infinite permeability. This means that a negligible magnetizing current is required to establish the flux, and the core effectively channels all the flux.

In an ideal transformer, the entire flux produced by the primary winding links with the secondary winding. There is no leakage flux.

An ideal transformer is assumed to have no core losses (i.e., no hysteresis or eddy current losses).

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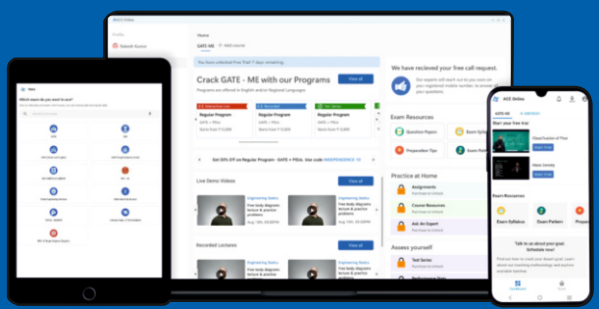

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In an ideal transformer, the windings are assumed to have zero resistance (i.e., they are perfectly conductive).

Property	Ideal Transformer
Core Losses	Zero (no hysteresis or eddy current losses)
Winding Resistance	Zero
Leakage Flux	Zero (all flux is perfectly linked between windings)
Core Permeability	Infinite (ensures zero magnetizing current)
Efficiency	100%
Voltage Ratio	$\frac{V_1}{V_2} = \frac{N_1}{N_2}$
Current Ratio	$\frac{I_1}{I_2} = \frac{N_2}{N_1}$
Power Conservation	$P_1 = P_2$, i.e., input power = output power
Magnetizing Current	Zero
Load Effect on Primary	Fully reflected as per turns ratio
Mutual Coupling	Perfect (coupling coefficient k = 1)
Phase Shift	None (except for winding orientation, if reversed)

17. A 3-phase, 4-pole, 50 Hz induction motor is running at 1455 r.p.m. The value of the slip will be
(a) 2% (b) 3%
(c) 4% (d) 5%

17. Ans: (b)

Sol: $N_s = \frac{120 \times f}{P} = \frac{120 \times 50}{4} = 1500$ rpm

$S = \frac{1500 - 1455}{1500} \times 100 = 3\%$

18. The e.mf. per turn of a single-phase, 10 kVA, 2200/220V, 50 Hz transformer is 10 V. If the maximum flux density is 1.5 T, the net cross-sectional area of the core will be
(a) 0.01 m^2 (b) 0.02 m^2
(c) 0.03 m^2 (d) 0.04 m^2

18. Ans: (c)

Sol: $E/N = 4.44 \times B \times A \times f$

$A = \frac{10}{4.44 \times 1.5 \times 50} = 0.03\ m^2$

19. A transformer rated 200/50 V, 10 kVA has a core loss of 100 W. If the full-load copper loss is 200 W and lagging power factor is 0.8, the load at maximum efficiency will be nearly
(a) 9 kVA (b) 7 kVA
(c) 5 kVA (d) 3 kVA

19. Ans: (b)

Sol: $kVA|_{max} = 10 \times \sqrt{\frac{100}{200}} = 7.07$ kVA

20. The impedance which transforms from one side of the ideal transformer to the other is in the direct
(a) square ratio of turns
(b) square root of ratio of turns
(c) ratio of turns
(d) square root of square ratio of turns

20. Ans: (a)

Sol: Let's consider an ideal transformer with a turns ratio $N_1/N_2 = a$. If an impedance Z_2 is connected to the secondary side, the equivalent impedance seen from the primary side, Z_1, is given by: $Z_1 = (N_1/N_2)^2 \times Z_2 = a^2 \times Z_2$

This means the impedance transforms by the square of the turns ratio.

(a) square ratio of turns
(b) square root of ratio of turns
(c) ratio of turns
(d) square root of square ratio of turns (This is the same as ratio of turns)

21. In which one of the following machines, the field poles are on the stator (and are DC excited) and the rotor constitutes the armature?
(a) Induction machine
(b) Elementary synchronous machine
(c) DC machine
(d) AC machine

21. Ans: (c)

Sol: In a DC machine, the field poles are on the stator (and are DC excited), and the armature winding (where the voltage is induced and current is commutated) is on the rotor.

In a typical induction machine, the stator carries the AC windings that produce a rotating magnetic field, and the rotor (squirrel cage or wound rotor) has induced currents. There are no DC-excited field poles on the stator in the conventional sense.

In an elementary (and most common) synchronous machine (alternator or motor), the field poles (DC excited electromagnets) are typically on the rotor, and the armature winding (where the AC voltage is induced or applied) is on the stator.

While some AC machines might have stator fields, the specific configuration of DC-excited field poles on the stator and the rotor as the armature is characteristic of the DC machine.

22. A 6-pole synchronous a generator driven at 1000 r.p.m feeds a 4-pole induction motor. If it is loaded to run at a slip of 4 %, the motor speed will be
(a) 1360 r.p.m. (b) 1440 r.p.m.
(c) 1560 r.p.m. (d) 1640 r.p.m.

22. Ans: (b)

Sol: $N_s = 1000$ rpm, $P = 6$; $f = 50$ Hz

$P = 4$, $S\% = 4\%$, $N_S = 1500$ rpm

$N_r = 1000\ (1 - 0.04) = 1440$ rpm

23. An 8-pole, lap-wound, DC generator has 1000 armature conductors, a flux of 20 mWb per pole and the e.m.f. generated is 200 V. What is the speed of the machine?
(a) 300 r.p.m. (b) 600 r.p.m.
(c) 900 r.p.m. (d) 1200 r.p.m.

23. Ans: (b)

Sol: $P = 8$, Lap, $A = 1000$, $\phi = 20$mWb/pole

$E_S = 200$ V

$$E_g = \frac{\phi ZNP}{60A}$$

$$N = \frac{200 \times 60}{20 \times 10^{-3} \times 1000} = 600\text{rpm}$$

24. Consider the following statements regarding transformer:
    1. It is a device that transfers electric power from one circuit to another.
    2. In transformer, the two electric circuits are linked by mutual induction.

    Which of the above statements is/are correct?

    (a) 1 only (b) 2 only
    (c) Both 1 and 2 (d) Neither 1 nor 2

24. Ans: (c)

Sol: A transformer transfers electrical power between circuits without physical connection, maintaining frequency.

Power transfer is enabled by mutual induction between the primary and secondary windings.

Transfer Property	**Details**
Basic Function	Transfers electrical power between circuits using electromagnetic induction
Working Principle	Mutual induction between two windings
Core Types	Laminated core, toroidal core, shell type, core type
Winding Names	Primary (input), Secondary (output)
Ideal Transformer Assumptions	No core loss, no winding resistance, no leakage flux, 100% efficiency
Voltage Ratio	$V_1/V_2 = N_1/N_2$
Current Ratio	$I_1/I_2 = N_2/N_1$
Impedance Transformation	$Z' = Z(N_1/N_1)^2$
Efficiency (Practical)	Typically 95-99%, depending on size and type
Types by Core Use	Power transformer, distribution transformer, isolation transformer
Types by Phase	Single-phase, three-phase
Types by Usage	Step-up (increases voltage), step-down (decreases voltage)
Transfer Property	Details
Losses in Practical Transformer	Core losses (hysteresis & eddy current), Copper losses (I^2R)
Cooling Methods	Air-cooled, oil-cooled, water-cooled, forced cooling
Regulation	Indicates voltage drop from no-load to full-load
Applications	Power distribution, impedance matching, isolation, voltage conversion

25. Whenever a charged particle has an angular momentum, it will contribute to the permanent dipole moment. The following are the contributions to the angular momentum, of an atom:
1. Orbital angular momentum of electron
2. Electron spin angular momentum
3. Nuclear spin angular momentum
(a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

25. Ans: (a)

Sol: When a charged particle has an angular momentum, it will contribute to the permanent dipole moment. The following are the contributions to the angular momentum
1. Orbital motion of electron
2. Spin of electron

26. A substance of FCC lattice is having a molecular weight of 60.2 and density of 6250 kg/m^3. If the value of N is 6.02×10^{26} /kg-mole, the lattice constant will be
(a) 2 A (b) 4 A
(c) 6 A (d) 8 A

26. Ans: (b)

Sol: For the given FCC Lattice:
number of atoms/unit cell, n = 4
Atomic weight = 60.2 g/mol
Avogadro's number = N = 6.023×10^{23}g/mol

$$\text{Theoretical density} = \rho = \frac{n \times AW}{AN \times V_{uc}} = 6250 \text{kg/m}^3$$

$$6250 \times 10^3 \text{g/m}^3 = \frac{4 \times 60.2}{6.023 \times 10^{23} \times a^3}$$

$a^3 = 6.396 \times 10^{-29}$
$a = 3.999 \times 10^{-10}$m = 4A°

27. Steatite is made from
(a) talc mixed with small quantity of clay and fedspar
(b) metal oxides and titanium dioxide
(c) aluminium dioxide
(d) barium titanate

27. Ans: (a)

Sol: Steatite is primarily composed of talc and a small quantity of clay and feldspar. It is ceramic material used in thermal and electrical insulation.

28. Which of the following are the important varieties of electrical mica?
(a) Muscovite mica and phlogopite mica
(b) Muscovite mica and pyrex mica
(c) Phlogopite mica and quartz mica
(d) Phlogopite mica and pyrex mica

28. Ans: (a)

Sol: The two major electrical grade varieties of mica are
1. Muscovite mica (better electrical properties)
2. Phlogopite mica (better thermal properties)

29. The dielectric strength of rubber is 40000 volts/mm at frequency 60 Hz. What is the thickness of insulation on a wire carrying 33 kV to sustain the breakdown?
(a) 0.64 mm (b) 0.72 mm
(c) 0.82 mm (d) 0.94 mm

29. Ans: (c)

Sol: The dielectric strength of rubber= 40000 volts/mm
Break down voltage = V = 33kV

$$\text{Thickness of insulation} = t = \frac{\text{Breakdown voltage}}{\text{Dielectric strength}}$$

$$t = \frac{33000}{40000} = 0.82\text{mm}$$

30. STM stands for
(a) Scanning Tunneling Microscope
(b) Scientific Technical Microscope
(c) Scanning Technical Microscope
(d) Scientific Tunneling Microscope

30. Ans: (a)

Sol: A scanning tunneling microscope (STM) is a type of scanning probe microscope that uses quantum tunneling that creates image of surfaces at the atomic level.

31. An iron rod of 2 m length and 4 cm^2 cross-section is in the form of a closed ring. The permeability of the iron ring is 50×10^{-4} H-m^{-1} To produce a magnetic flux of 4×10^{-4} Wb, the required ampere-turns will be
(a) 200 A/m (b) 225 A/m
(c) 250 A/m (d) 275 A/m

31. Ans: (a)

Sol: Iron rod length = $l = 2m$

Area = $A = 4cm^2 = 4\times10^{-4}m^2$

Permeability of iron = $\mu_{Fe} = 50\times10^{-4}H/m$

Magnetic flux = $B = 4\times10^{-4}Wb$

Magnetic flux/m^2 = $B = \frac{4\times10^{-4}}{4\times10^{-4}} = 1Tesla$

$B = \mu H$

$H = B/\mu = \frac{1}{50\times10^{-4}} = 200A/m$

32. When transactions are executing concurrently in an interleaved fashion, then the order of execution of operations from the various transactions is known as
(a) schedule (b) serializability
(c) concurrency (d) controllable

32. Ans: (a)

Sol: In database management systems, the schedule defines the actual order in which operations from concurrent transactions are executed.

33. Which one of the following is one of the most popular solutions processing for nanoparticles (mostly oxides) production?
(a) CVD technique
(b) Sol-gel technique
(c) Aerogel synthesis technique
(d) Co-precipitation technique

33. Ans: (b)

Sol: The sol-gel technique is bottom-up approach method is widely used for producing oxide based nanoparticles, particularly due to its control over particle size and purity in solution based synthesis.

34. The transition temperature T_c of a superconductor varies with its isotopic mass M as
(a) $T_c \propto M^{-\frac{1}{2}}$ (b) $T_c \propto M^{\frac{1}{2}}$
(c) $T_c \propto M^{-2}$ (d) $T_c \propto M^{2}$

34. Ans: (a)

Sol: Isotopic effect in superconductor:
The relationship between transition temperature of super conductor and mass of isotope is

$T_C \propto \frac{1}{\sqrt{M}}$

35. The 'Cooper pairing' is related to
(a) chemical vapour deposition
(b) thermal conductivity
(c) superconductivity
(a) flame pyrolysis

35. Ans: (c)

Sol: Cooper pair is an electron pair generated at very low temperature. This pair occurs due to an attractive interaction between electrons mediated by phonons. Cooper pairs are fundamental to the phenomenon of superconductivity.

36. For mercury of mass number 202, the value of α is 0.5 and T_c = 4.153K. For the isotope of mercury of mass number 200, the transition temperature is nearly
(a) 3.4K (b) 4.2K
(c) 5.4K (d) 6.2K

36. Ans: (b)

Sol: Isotopic effect in super conductor

$$T_C \propto \frac{1}{\sqrt{M_{isotope}}}$$

T_C = Critical temperature

$M_{isotope}$ = Mass of isotope

$M_1 = 202, \alpha = 0.5, T_{C1} = 4.153$

$M_2 = 200$

$$\frac{T_{C_2}}{T_{C_1}} = \sqrt{\frac{M_1}{M_2}}$$

$$T_{C_2} = T_{C_1} \times \sqrt{\frac{M_1}{M_2}} = 4.153 \times \sqrt{\frac{202}{200}} = 4.173K$$

37. Which one of the following is **not** a correct method of obtaining damping?
(a) Air friction (b) Fluid friction
(c) Magnetic field (d) Eddy current

37. Ans: (c)

Sol: A magnetic field itself is not a direct method of damping. However, a magnetic field is essential for eddy current damping, which is a common and efficient method. The magnetic field interacts with induced currents to produce a damping force.

Without the "eddy current" part, "magnetic field" alone isn't a method of damping.

Air friction (or Pneumatic damping): This is a very common method. A light aluminum piston or vane is attached to the moving system and moves in a closed air chamber. The compression and suction of air within the chamber oppose the motion, providing damping.

Fluid friction: Similar to air friction, a light disc or vane attached to the moving system is submerged in a damping fluid (like oil). The viscous drag of the fluid opposes the motion, providing damping. This is typically used in electrostatic instruments.

Eddy current: This is a very effective and widely used method. A conducting disc (usually aluminum or copper) is attached to the moving system and moves in the magnetic field of a permanent magnet. As the disc cuts the magnetic flux lines, eddy currents are induced in it. According to Lenz's Law, these eddy currents produce a magnetic field that opposes the motion that created them, thus providing a damping torque.

38. A 0.25 A ammeter has a guaranteed accuracy of 1% of full-scale reading. If the current Measured by this instrument is 10 A, the limiting error will be
(a) 2.5% (b) 2.0%
(c) 1.5% (d) 1.25%

38. Ans: (a)

Sol: $\%LE = \frac{25}{10} \times \pm 1\% = \pm 2.5\%$

39. The torque of an ammeter is directly Proportional to the current flowing through it. A current of 10 A causes a deflection of 60°. When the instrument is spring-controlled, for a deflection of 40°, the value of the current will be nearly
(a) 6.7 A (b) 5.7 A
(c) 4.9 A (d) 3.9 A

39. Ans: (a)

Sol: $T_d \propto I$; $T_c \propto \theta$

$\therefore \theta \propto I \Rightarrow \frac{\theta_2}{\theta_1} = \frac{I_2}{I_1}$

$\therefore I_2 = \frac{40}{60} \times 10 = \frac{40}{6} = 6.67$ A

40. The basic Permanent Magnet Moving Coil (PMMC) instrument mechanism is often called
(a) electrodynamic movement
(b) galvanometer movement
(c) iron vane movement
(d) d'Arsonval movement

40. Ans: (d)

Sol: This refers to the original design by Jacques-Arsène d'Arsonval, which forms the basis of the PMMC instrument. It consists of a coil suspended in a strong permanent magnetic field. When current flows through the coil, it experiences a torque, causing it to deflect.

Electrodynamic movement: This refers to instruments where both the fixed and moving coils are current-carrying (e.g., dynamometer type instruments used for AC power measurement).

Galvanometer movement: While a PMMC is a type of galvanometer (a device for detecting and measuring small electric currents), "d'Arsonval movement" specifically refers to the mechanism. Not all galvanometers are PMMC.

Iron vane movement: This refers to instruments where a moving piece of soft iron is attracted to or repelled by a fixed coil carrying current. These are typically used for AC measurements.

41. Which one of the following types of instruments will be used for AC measurements (current, voltage, power and energy)?
(a) Moving iron
(b) Moving coil permanent magnet
(c) Moving coil dynamometer
(d) Induction

41. Ans: (d)

Sol: Induction instruments are specifically designed to measure AC quantities. They operate based on the principle of electromagnetic induction, where a changing magnetic field creates a current in a coil.

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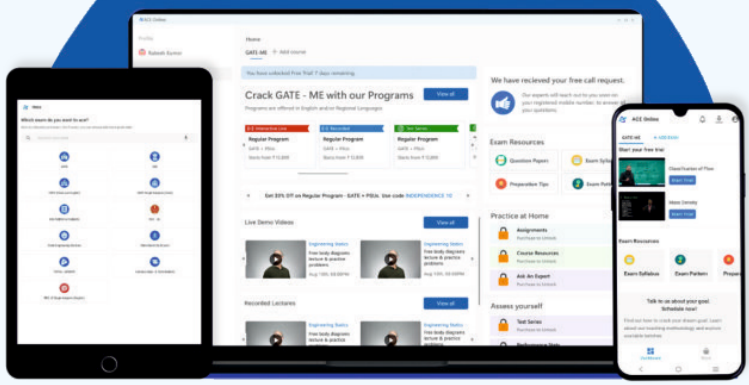

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This makes them ideal for measuring AC current, voltage, power, and energy.

Moving iron instruments can measure AC current and voltage. They work on the principle of magnetic attraction or repulsion, which is independent of the direction of current (as both fixed and moving iron pieces are magnetized in the same direction).

However, they are generally not used for power or energy directly.

PMMC instruments are inherently DC instruments. They rely on the interaction between a permanent magnetic field and the magnetic field of a current-carrying coil. For AC, the direction of torque would reverse every half cycle, resulting in zero average deflection (unless rectified AC is applied).

Dynamometer type instruments are versatile and can measure AC current, voltage, and power. They have both fixed and moving coils, and the torque depends on the product of the currents in these coils. For power measurement, one coil carries current proportional to the circuit current, and the other proportional to the voltage.

42. In a measurement system, if the force (across) is a measured variable, then its associated variable (power-based) will be
(a) translational displacement
(b) translational acceleration
(c) translational velocity
(d) rotational acceleration

42. Ans: (c)

Sol:

- Power = Force × Velocity (in translational systems)
- If force is the "across variable", then the associated "through variable" for power calculation is velocity.

So, Force × Velocity = Power

$\Rightarrow$ correct answer is translational velocity.

43. A coil with a resistance of 5 Ω is connected to the terminals of a Q-meter. Resonance occurs at an oscillator frequency of 8 MHz and resonating capacitance of 150 pF. What is the percentage error introduced by the insertion resistance of 0.1 Ω?
(a) 4% (b) 3%
(c) 2% (d) 1%

43. Ans: (c)

Sol: $\%\varepsilon = \dfrac{-R}{R + R_{coil}} \times 100$

$\%\varepsilon = \dfrac{-0.1}{5 + 0.1} \times 100 = \dfrac{0.1}{5.1} \times 100 = 1.96\% = 2\%$

44. The speed of a 6-pole induction motor supplied at 50 Hz is measured by a stroboscopic method. The neon lamp is supplied from the same source to which the induction motor is connected. The stroboscopic disc has 6 black and 6 white sectors. When the sector appears to be moving at 50 r.p.m., the speed of the induction motor will be
(a) 990 r.p.m. (b) 950 r.p.m.
(c) 890 r.p.m. (d) 840 r.p.m.

44. Ans: (b)

Sol: $N_s = 1000$ rpm

$N = 50$ rpm

950 rpm

45. An accelerometer has a seismic mass of 0.06 kg and a spring constant of 4500 N/m. If the maximum mass displacement is ± 0.025 m (before the mass hits the top), the maximum measurable acceleration will be

(a) 1675 m/s^2 (b) 1765 m/s^2

(c) 1875 m/s^2 (d) 1965 m/s^2

45. Ans: (c)

Sol: $F = ma$

$$a = \frac{F}{m} = \frac{kx}{m}$$

$$a = \frac{4500 \times 0.025}{0.06} = 1875 \text{ m/s}^2$$

46. The deflection sensitivity of a CRT is 0.05 mm/V and an unknown voltage applied to the horizontal deflection plates shifts the spot by 5 mm towards the right in the horizontal direction. The unknown applied voltage will be

(a) 100V (b) 125 V

(c) 150 V (d) 200 V

46. Ans: (a)

Sol: $S_D = 0.05$ mm/V ; 5mm

V = 100 Volts

47. A capacitive transducer with its plate separation of 0.05 mm under static conditions has a capacitance of 5×10^{-12} F. For causing a change of capacitance of 0.75×10^{-12} F, the displacement will be nearly

(a) 0.22 mm (b) 0.33 mm

(c) 0.42 mm (d) 0.53 mm

47. Ans: (*)

Sol: We know

$$C = \frac{\varepsilon A}{d} \Rightarrow C \propto \frac{1}{d}$$

So, $\frac{C_2}{C_1} = \frac{d_1}{d_2}$

given

$C_1 = 5\times10^{-12}$ F, $d_1 = 0.05$

For causing a change of capacitance of 0.75×10^{-12} F,

$C_2 = C_1 + 0.75\times10^{-12}$ F $= 5.75\times10^{-12}$ F,

$d_2 = ?$

$$d_2 = \frac{C_1}{C_2} \times d_1 = \frac{5 \times 10^{-12}}{5.75 \times 10^{-12}} \times 0.05 = 0.043 \text{ mm}$$

(OR)

given

$C_1 = 5\times10^{-12}$ F, $d_1 = 0.05$

$C_2 = 0.75\times10^{-12}$ F, $d_2 = ?$

$$d_2 = \frac{C_1}{C_2} \times d_1 = \frac{5 \times 10^{-12}}{0.75 \times 10^{-12}} \times 0.05 = 0.33 \text{ mm}$$

48. The input for most of the instrumentation systems is non-electrical. This is converted into an electrical signal by a device called

(a) rectifier (b) oscillator

(c) amplifier (d) transducer

48. Ans: (d)

Sol: A transducer is a device that converts one form of energy into another. In instrumentation, it commonly converts a nonelectrical physical quantity (like temperature, pressure, force, light) into an electrical signal (voltage, current, resistance).

a) rectifier: A rectifier converts AC to DC. It doesn't convert non-electrical signals to electrical signals.

b) oscillator: An oscillator generates an oscillating electronic signal. It doesn't convert non-electrical signals to electrical signals.

c) amplifier: An amplifier increases the amplitude of an electrical signal. It doesn't convert non-electrical signals to electrical signals.

***49.** Which of the following statements are correct?

1. Cut-off matrix provides a compact and effective means of writing algebraic equations giving branch voltages in terms of tree branches.
2. In cut-set matrix, the number of independent node-pair terminals is equal to the number of tree branches.
3. Tie-set matrix is used to find the branch currents.

Select the correct answer.

(a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

49. Ans: (d)

Sol: 1. Cut-set matrix provides a compact and effective means of writing algebraic equations giving branch voltages in terms of tree branches.

Explanation:

$[Q]^T [V_{twig}] = [V_b]$

Branch Voltages interms of tree branches
= twig voltages = cut set voltages

2. In cut-set matrix, the number of independent node-pair terminals is equal to the number of tree branches.

Explanation:

If Independent node pair voltages
= Node pair terminals = cut set voltages
= Number of twigs
= n – 1

3. Tie-set matrix is used to find the branch currents.

Explanation:

$[B]^T[I_{link}] = [I_b]$

Finally branch currents can be calculated interms of links or tie-set currents = tie-set currents.

50. Which of the following statements are correct?

1. The end points of a line segment on the junction between two or more branches or the end points of an isolated branch are called nodes.
2. If a sub-graph consists of an ordered sequence of branches, traversing from one node to another, this particular sub-graph is known as path.
3. The closed contour selected in a graph is known as loop.

Select the correct answer.

(a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

50. Ans: (c)

Sol: 1. The end points of a line segment on the junction between two or more branches or the end points of an isolated branch are called nodes.

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Explanation:

Isolated branch positions are not called nodes

2. If a sub-graph consists of an ordered sequence of branches, traversing from one node to another, this particular sub-graph is known as path.

Explanation:

Tree is sub graph which is no having closed path

3. The closed contour selected in a graph is known as loop.

Explanation:

Loop is nothing but a closed path which is formed with each link of tree.

So, 2 and 3 are correct.

51. Which of the following statements are correct?

1. A connected sub-graph of a connected graph having all the nodes of a graph without any loop is known as a tree.
2. The branches of the tree are known as twigs.
3. The branches that are removed from the tree are termed links.

Select the correct answer.

(a) 1 and 2 only (b) 1 and 3 only

(c) 2 and 3 only (d) 1, 2 and 3

51. Ans: (d)

Sol: 1. A connected sub-graph of a connected graph having all the nodes of a graph without any loop is known as a tree.

Explanation:

Tree is defined as which contains all nodes in the given graph without any closed path

2. The branches of the tree are known as twigs.

Explanation:

Twigs are tree branches = (n – 1)

where n = number of nodes in the given graph

3. The branches that are removed from the tree are termed links.

Explanation:

Links are removed branches (l) = b – n + 1

So, 1, 2 and 3 are correct.

52. Consider a reduced incidence matrix of a graph:

$$[A] = \begin{bmatrix} 1 & 1 & 0 & 0 & 0 & 1 \\ 0 & -1 & 1 & -1 & 0 & 0 \\ -1 & 0 & -1 & 0 & -1 & 0 \end{bmatrix}$$

The number of possible trees will be

(a) 16 (b) 24

(c) 26 (d) 28

52. Ans: (a)

Sol: Consider a reduced incidence matrix of a graph

$$[A'] = \begin{bmatrix} 1 & 1 & 0 & 0 & 0 & 1 \\ 0 & -1 & 1 & -1 & 0 & 0 \\ -1 & 0 & -1 & 0 & -1 & 0 \end{bmatrix}_{(n-1)\times b}$$

incidence matrix form the given reduced incidence matrix

$$[A] = \begin{array}{c} \\ (1) \\ (2) \\ (3) \\ (4) \end{array} \begin{array}{c} \begin{array}{cccccc} a & b & c & d & e & f \end{array} \\ \begin{bmatrix} 1 & 1 & 0 & 0 & 0 & 1 \\ 0 & -1 & 1 & -1 & 0 & 0 \\ -1 & 0 & -1 & 0 & -1 & 0 \\ 0 & 0 & 0 & 1 & 1 & -1 \end{bmatrix}_{\substack{n\times b \\ (4\times 6)}} \end{array}$$

n = number of nodes = 4

b = number of branches = 6

The given graph is complete graph

$$b = {}^{n}C_2 = \frac{n(n-1)}{2} = {}^{4}C_2 = 6$$

So the number of possible tree for a complete graph $= n^{n-2} = 4^{4-2} = 16$

53. The Laplace transform of a function f(t) is defined by

$$L\{ff(t)\} = F(s) = \int_0^{\infty} f(t)e^{-st}dt$$

where s is a complex variable given by

(a) $\sigma - j\omega$ (b) $\sigma + j\omega$

(c) $\sigma/j\omega$ (d) $j\omega/\sigma$

53. Ans: (b)

Sol: $F(s) = \int_0^{\infty} f(t)e^{-st}dt$ where $s = \sigma + j\omega$

54. In an induction type energy meter, normally the flux due to shunt magnet does not lag the supply voltage exactly by 90°. The reason being that the shunt coil has some resistance. Due to this, the angle of phase is less than 90°, as a result, the torque on the disc is not zero at zero power factor. This type of error is called

(a) speed error (b) creeping

(c) phase error (d) torque error

54. Ans: (b)

Sol: It's a common issue in induction type energy meters where the meter disk slowly rotates even when there is no load connected. This happens because the voltage coil (shunt magnet) has some resistance, preventing its flux from lagging the supply voltage by a perfect 90 degrees. This phase deviation leads to a small, continuous torque on the disc, even at zero power factor.

Energy Meter Errors

Error Type	Description	Potential Causes
Creeping	Disc rotates continuously with no load connected.	Shunt flux phase angle < 90°, excess friction, vibration, stray fields.
Speed Error (General)	Meter registers energy incorrectly (too fast or too slow) at specific loads/speeds.	Calibration issues, friction, incorrect braking torque, temperature variations.
Phase Error (Specific context)	Error due to incorrect phase relationships between fluxes (e.g., shunt flux not exactly 90° from voltage).	Resistance in shunt coil, incorrect inductance. Leads to creeping.
Torque Error (General)	Incorrect driving torque developed for a given power.	Incorrect flux magnitudes, incorrect phase angles, friction.

55. Which one of the following statements is **not** correct regarding moving iron instruments?
(a) These instruments possess high operating torque.
(b) In these instruments, power consumption is higher for low voltage ranges.
(c) These instruments are capable of giving accuracy within the limits of both precision and industrial grades.
(d) Scales of these instruments are uniform. and

55. Ans: (d)

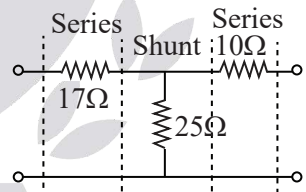
Sol: The scale of a moving iron instrument is non-uniform, especially near the lower end (due to the square-law behavior of deflection with current).
Moving iron instruments have a non-uniform (cramped at the beginning, expanded at the end) or squared scale because the deflecting torque is proportional to the square of the current ($T_d \propto I^2$).

Moving iron instruments are known for having relatively high power consumption due to the significant current required to magnetize the iron vanes. This power consumption is generally higher than PMMC instruments, but the statement linking it specifically to "low voltage ranges" as a unique characteristic for higher consumption in MI instruments compared to other ranges is the problematic part. All ranges have relatively high consumption. The impedance of the coil is fixed, and for low voltage ranges, the resistance would need to be lower, leading to higher currents for a given deflection, contributing to higher power consumption. However, the overarching characteristic is high power consumption generally, not specifically higher for low voltage ranges in a way that differentiates it as an advantage or disadvantage in this context. Let's re-evaluate after checking others.

56. If the z-parameters for a network are $z_{11} = 42\ \Omega$, $z_{22} = 35\ \Omega$, $z_{12} = 25\ \Omega$ and $Z_{21} = 25\ \Omega$, then the parameters A, B, C and D are respectively
(a) 1.68, 33.8 Ω, 0.04 mho, 1.4
(b) 2.68, 33.8 Ω, 0.04 mho, 0.4
(c) 1.68, 13.8 Ω, 0.14 mho, 1.4
(d) 2.68, 13.8 Ω, 0.14 mho, 0.4

56. Ans: (a)

Sol: For a two-port network, given Z-parameters are
$z_{11} = 42\ \Omega$, $z_{22} = 35\ \Omega$, $z_{12} = z_{21} = 25\ \Omega$
As per the given Z-parameters it is reciprocal network ($z_{12} = z_{21}$)
We can develop T-network



$$\begin{bmatrix} A & B \\ C & D \end{bmatrix} = \begin{bmatrix} 1 & 17 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 \\ \frac{1}{25} & 1 \end{bmatrix} \begin{bmatrix} 1 & 10 \\ 0 & 1 \end{bmatrix}$$

(For a cascade connection of ABCD parameters Total network ABCD parameters = product of individual network parameters)

$$\text{Series element} = \begin{bmatrix} A_1 & B_1 \\ C_1 & D_1 \end{bmatrix} = \begin{bmatrix} 1 & Z \\ 0 & 1 \end{bmatrix}$$

$$\text{Shunt element} = \begin{bmatrix} A_2 & B_2 \\ C_2 & D_2 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ \frac{1}{Z} & 1 \end{bmatrix}$$

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$$\text{Total Network } \begin{bmatrix} A & B \\ C & D \end{bmatrix} = \begin{bmatrix} 1 & 17 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 \\ \frac{1}{25} & 1 \end{bmatrix} \begin{bmatrix} 1 & 10 \\ 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} A & B \\ C & D \end{bmatrix} = \begin{bmatrix} 1.68 & 33.8 \\ 0.04 & 1.4 \end{bmatrix}$$

57. Which one of the following features is **not** correct for Electronic Voltmeter (EVM)?
(a) Sensitivity is of the order of 10 μV (full-scale)
(b) In EVM, we also put some impedance matching stages
(c) Has very small frequency operating range
(d) Has internal protection against overloading

57. Ans: (c)

Sol: EVMs have wide frequency ranges, much wider than analog voltmeters. EVMs, especially modern digital voltmeters and oscilloscopes, can operate over a very wide frequency range, from DC to hundreds of megahertz or even gigahertz, far exceeding the frequency limits of passive analog voltmeters.

EVMs (especially older analog ones, or certain types of digital multimeters) can achieve very high sensitivity. Full-scale ranges down to microvolts are possible with appropriate amplification.

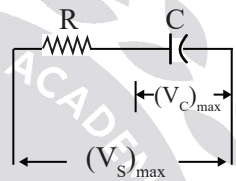
Impedance matching stages are used for accuracy and signal integrity.

Modern EVMs, especially DMMs, typically incorporate internal protection circuits (e.g., fuses, current limiting, voltage clamps) to prevent damage from accidental overloads.

58. In a series R-C circuit, the value of R is 10 Ω and C = 25 nF. A sinusoidal voltage of 50 MHz is applied and the maximum voltage across the capacitance is 2.5 V. The maximum voltage across the series combination will be nearly
(a) 233 V (b) 196 V
(c) 163 V (d) 136 V

58. Ans: (b)

Sol: In series R-C circuit



$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C}$$

$$= \frac{1}{2\pi \times 50 \times 10^6 \times 25 \times 10^{-9}} = 0.127\Omega$$

$R = 10\ \Omega$

$(V_C)_{max} = 2.5\ V$

By voltage division rule

$$(V_C)_{max} = \frac{(V_s)_{max} X_C}{\sqrt{R^2 + X_C^2}}$$

$$2.5 = \frac{(V_s)_{max}(0.127)}{\sqrt{10^2 + (0.127)^2}}$$

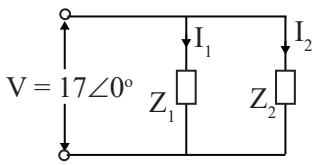
$(V_s)_{max} = 196.8$ Volts

59. An impedance $Z_1(2 - j5)\ \Omega$ is connected in parallel with another impedance of $Z_2\ (1 + j1)\ \Omega$. If the applied voltage is $17\angle 0^o$ V, then the currents through Z_1 and Z_2 are respectively
(a) $3.16\angle 68.2°$ A and $10.02\angle -35°$ A
(b) $2.16\angle 48.2°$ A and $10.02\angle -35°$ A
(c) $3.16\angle 68.2°$ A and $12.02\angle -45°$ A
(d) $2.16\angle 48.2°$ A and $12.02\angle -45°$ A

59. Ans: (c)

Sol: The given circuit is parallel connection of two impedances

Z_1 & Z_2



$Z_1 = (2 - j5)\ \Omega$ & $Z_2 = (1 + j)\ \Omega$

$$I_1 = \frac{V}{Z_1} = \frac{17\angle 0^\circ}{(2-j5)} = \frac{17\angle 0^\circ}{5.385\angle -68.2^\circ} = 3.16\angle 68.2^\circ \text{ A}$$

$$I_2 = \frac{V}{Z_2} = \frac{17\angle 0^\circ}{(1+j)} = \frac{17\angle 0^\circ}{\sqrt{2}\angle 45^\circ} = 12.02\angle -45^\circ \text{ A}$$

60. The P-N junction diodes and thermistors used to compensate can for be variations in current, thus stabilizing the operating point. Such methods are known as

(a) thermal runaway (b) thermal stabilization
(c) bias compensation (d) fixed bias

60. Ans: (c)

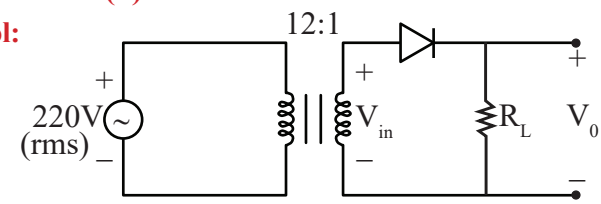
Sol: Bias compensation techniques are used to stabilize the operating point. Diodes are best for simple linear compensation whereas thermistors are used for precise non linear compensation in critical circuits.

61. The turns ratio of a transformer used in a half-wave rectifier is $n_1 : n_2 = 12:1$. The primary is connected to the power mains 220 V, 50 Hz. If the diode resistance in forward bias is zero, the PIV of the diode will be nearly

(a) 16 V (b) 19 V
(c) 22 V (d) 26 V

61. Ans: (d)

Sol:



Input peak voltage $220\sqrt{2}$

V_{in} peak $= \frac{220\sqrt{2}}{12}$ (at the secondary)

The peak inverse voltage

$$= \frac{200\sqrt{2}}{12} = 25.927$$

≈ 26V

62. FET amplifiers are introduced at the initial stages of receivers to make

(a) the final output less noisy
(b) the bandwidth very large
(c) the gain very large
(d) the output impedance very low

62. Ans: (a)

Sol: FET amplifies at the initial stages of receivers are favored due to their low noise generation, high input impedance and their ability to handle weak signals.

These characteristics make them ideal for amplifying the very small radio frequency signals received by antenna without loading down the signal source.

63. A JFET has $V_p = -4.5$ V, $I_{DSS} = 10$ mA and $I_{DS} = 2.5$ mA. The trans-conductance will be nearly

(a) 3·2 mA/V (b) 2.8 mA/V
(c) 2.2 mA/V (d) 1.8 mA/V

63. Ans: (c)

Sol: Given $I_{DSS} = 10mA$

$I_{DS} = 2.5mA$

$V_P = -4.5V$

$g_m(\text{transconductance}) = \frac{\partial I_D}{\partial V_{gs}}$

$I_d = I_{DSS}\left[1 - \frac{V_{GS}}{V_P}\right]^2$

$$g_m = \frac{\partial I_d}{\partial V_{gs}} = 2I_{DSS}\left[1 - \frac{V_{GS}}{V_P}\right]\left[\frac{-1}{V_P}\right]$$

$$= 2I_{DSS}\sqrt{\frac{I_d}{I_{DSS}}}\left[\frac{-1}{V_P}\right]$$

$$= 2(10m)\sqrt{\frac{2.5m}{10m}}\left(\frac{-1}{-4.5}\right)$$

$= 2.2mA/V$

64. Which one of the following is **not** the correct advantage of negative feedback in amplifiers?

(a) Less harmonic distortion

(b) Reduced noise

(c) Highly stabilized gain

(d) Decreased bandwidth

64. Ans: (d)

Sol: Negative feedback while the overall gain is decreased, the frequency range or bandwidth over which the amplifier operates effectively is increased.

65. The advantage of the dual-slope ADC is its

(a) high sensitivity to noise and to variations in its component values caused by pressure changes

(b) low sensitivity to noise and to variations in its component values caused by pressure changes

(c) high sensitivity to noise and to variations in its component values caused by temperature changes

(d) low sensitivity to noise and to variations in its component values caused by temperature changes

65. Ans: (d)

Sol: Dual slope ADC is low sensitive to noise and to variations in its component values caused by temperature changes.

66. Consider the following Boolean expression :

$f = A\overline{B}C + B + B\overline{D} + AB\overline{D} + \overline{A}C$

The simplified expression will be

(a) A+B (b) B+C

(c) C+D (d) A+D

66. Ans: (b)

Sol: $f = A\overline{B}C + B + B\overline{D} + AB\overline{D} + \overline{A}C$

AB \ CD	00	01	11	10
00			1	1
01	1	1	1	1
11	1	1	1	1
10			1	1

$f = B + C$

67. What is the result of Excess-3 (XS-3) addition of numbers 9 and 5?

(a) 11 (b) 12

(c) 13 (d) 14

67. Ans: (d)

Sol: $9 \rightarrow 1100$

$5 \rightarrow 1000$

$1\ 0100$

14

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68. The network that couples the output signal voltage of a stage to the input of the next stage of a multi-stage amplifier is called
(a) biasing network (b) resistive network
(c) feedback network (d) coupling network

68. Ans: (d)

Sol: In a multistage amplifier, the network that couples the output signal voltage of a stage to the input of the next stage is called coupling network

69. The expression
$f = (B + BC)(B + \overline{B}C)(B + D)$
after reduction is equivalent to
(a) B (b) B
(c) C (d) D

69. Ans: (b)

Sol: $f = (B + BC)(B + \overline{B}C)(B + D)$

$f = B(1 + C)(B + \overline{B})(B + C)(B + D)$

$= B(B + C)(B + D)$

$= (B + BC)(B + D)$

$= B(B + D)$

$= B + BD$

$= B$

70. PAL is the programmable logic device with a fixed OR array and a programmable AND array. Because only the AND gates are
(a) non-programmable, the PAL is easier to program than, but it is not as flexible as the PLA
(b) programmable, the PAL is not easier to program than, but it is flexible as the PLA
(c) non-programmable, the PAL is not easier to program than, but it is flexible as the PLA
(d) programmable, the PAL is easier to program than, but it is not as flexible as the PLA

70. Ans: (d)

Sol: AND is programmable but it is not flexible as PLA in which both AND and OR are programmable,

71. ROM is a
(a) non-volatile memory
(b) volatile memory
(c) read/write memory
(d) byte-organized memory

71. Ans: (a)

Sol: ROM is a non volatile memory

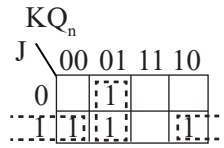
72. The characteristic equation of J-K flip-flop is
(a) $Q_{n+1} = \overline{Q_n}J + Q_n\overline{K}$ (b) $Q_{n+1} = \overline{Q_n}J - Q_n\overline{K}$
(c) $Q_{n+1} = \overline{Q_n}K + Q_nJ$ (d) $Q_{n+1} = \overline{Q_n}K - Q_nJ$

72. Ans: (a)

Sol:

	J	K	Q_n	Q_{n+1}
0	0	0	0	0
1	0	0	1	1
2	0	1	0	0
3	0	1	1	0
4	1	0	0	1
5	1	0	1	1
6	1	1	0	1
7	1	1	1	0

$Q_{n+1} = \sum m(1, 4, 5, 6)$



$Q_{n+1} = J\overline{Q_n} + \overline{K}Q_n$

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73. Which one of the following noise bandwidths is the bandwidth of that ideal bandpass system which produces the same noise power as the actual system?
(a) Equivalent noise bandwidth
(b) Linear noise bandwidth
(c) Actual noise bandwidth
(d) Generalized noise bandwidth

73. Ans: (a)

Sol: The equivalent Noise bandwidth ensures that the total Noise power integrated over the frequency spectrum is the same for both the real filter and the ideal rectangular filter.

74. If an audio signal s(t) = 3cos (2π500t) is quantized using 10-bit PCM, the signal-to-quantization noise ratio will be nearly
(a) 0.6×10^6 (b) 1.2×10^6
(c) 1.6×10^6 (d) 2.2×10^6

74. Ans: (c)

Sol: $S = \left(\frac{3}{\sqrt{2}}\right)^2 = 4.5\ W$

$N_q = \frac{\Delta^2}{12} = \frac{36}{2^{20}\times 12}$

$\therefore \frac{S}{N_q} = \frac{4.5\times 12\times 2^{20}}{36} = 1.5\times 2^{20} \simeq 1.6\times 10^6$

$\Delta = \frac{6}{2^{10}}$

75. In information probability, when the base is '2', the unit is a 'bit' and when the base is 'e', the unit is a
(a) 'bit' (b) 'decit'
(c) 'hartley' (d) 'nat'

75. Ans: (d)

Sol: The unit of information for natural logarithms is called a nat, sometimes also referred to as a nil (or) nepit.

76. An AM broadcast transmitter has carrier power output of 50kW. With 80% of modulation, the total power produced will be
(a) 66kW (b) 58kW
(c) 50kW (d) 42kW

76. Ans: (a)

Sol: $P_t = P_c\left[1+\frac{\mu^2}{2}\right]$

$P_t = 50\times 10^3\left[1+\frac{0.64}{2}\right] = 66\ kW$

77. A transmitter operates from a 12V supply with a collector current of 2A. If the modulation transformer has a turns ratio of 4:1, the load impedance seen by the audio amplifier will be
(a) 78Ω (b) 82Ω
(c) 88Ω (d) 96Ω

77. Ans: (d)

Sol: In amplitude modulation (AM) transmitters, a modulation transformer is often used to couple the audio modulating signal from the audio amplifier to the RF power amplifier's collector (or sometimes emitter or base) circuit.

Source Impedance, $\frac{V_{CC}}{I_C} = \frac{12}{2} = 6$ ohms.

N = 4 [4:1]
The load Impedance seen is
$(N^2)(6) = (4^2)(6) = 96$ ohms

78. The fall of $|A_v|$ and the increase of θ over 180° with decreasing frequency in the low frequency range are accounted by the
(a) coupling capacitors
(b) inter-electrode capacitors
(c) current gain of BJT (β)
(d) wring capacitors

78. Ans: (a)

Sol: Coupling capacitors are used to block DC signals while allowing AC signals to pass through. They are typically placed between different stages of an amplifier circuit , At low frequencies, the impedance of the coupling capacitors becomes significant, and a substantial portion of the signal voltage is dropped across them. This reduces the overall gain of the amplifier.

Inter-electrode capacitors:(wrong option because) These capacitors are inherent to the transistors themselves and primarily affect high-frequency response, not the low-frequency response.

79. Which one of the following is particularly useful when large amounts of code are needed to handle infrequently occurring cases?
(a) Dynamic loading (b) Static loading
(c) Dynamic binding (d) Static binding

79. Ans: (a)

Sol: Dynamic loading allows parts of the program to be loaded into memory only when needed.

Dynamic loading: Dynamic loading is a technique where parts of a program are loaded into memory only when they are needed during execution, rather than at the start of the program. This is ideal for handling infrequently occurring cases or optional features, as it saves memory and reduces initial load time.

Static loading: Static loading involves loading the entire program (including all its routines and libraries) into memory at once before execution begins. This is not efficient for infrequently occurring code.

Dynamic binding: Dynamic binding (also known as late binding) refers to the process of resolving method calls or variable references at runtime, rather than at compile time. While related to runtime behavior, it's not primarily about loading code for infrequently occurring cases.

Static binding: Static binding (also known as early binding) occurs at compile time.

80. For a Pulse Amplitude Modulated (PAM) transmission of voice signal having maximum frequency equal to 2.5kHz, if the sampling frequency is 10kHz and the pulse duration is one-tenth of the sampling period, the transmission bandwidth will be
(a) 60kHz (b) 50kHz
(c) 40kHz (d) 30kHz

80. Ans: (b)

Sol: $T_p = \frac{T_s}{10}$

$BW = \frac{1}{T_p} = \frac{10}{T_s} = 100$ kHz for rectangular pulse.

If Sync pulses are used BW = 50 kHz

81. S(t) the output ASK signal for $kT < t \le (k+1)T$, is
(a) $Am(t)\,\omega_c(t + kT)$ (b) $Am(t)\,\omega_c(t - kT)$
(c) $Am(t)\cos\omega_c(t + kT)$ (d) $Am(t)\cos\omega_c(t - kT)$
where

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T is the time width
k is an integer constant
t is the continuous time variable
ω_c is the carrier frequency
m(t) is the modulating signal
A is the amplitude of the output signal

81. Ans: (d)

Sol: $s_1(t) = A_c \cos(\omega_c t), 0 \le t \le T \rightarrow$ for Bit 1
$s_2(t) = 0, 0 \le t \le T \rightarrow$ for Bit 0
Are expressions for B-ASK
We will consider delayed carrier signal.
Hence option (d).

82. Which of the following statements are correct?
1. A system is said to be linear if it obeys the principle of superposition
2. A system is said to be linear if it satisfies the homogeneity property.
3. A system is said to be non-linear if it obeys the principle of superposition.

Select the correct answer.
(a) 1 and 3 only (b) 2 and 3 only
(c) 1 and 2 only (d) 1, 2 and 3

82. Ans: (c)

Sol: 1. A system is linear if it obeys principle of superposition
2. A system is said to be linear if it satisfies homogeneity

83. An optical fiber has a bandwidth distance product of 500MHz-km. If a bandwidth of 85MHz is required for a particular mode of transmission, the maximum distance that can be used between repeaters will be nearly
(a) 5.9km (b) 9.7km
(c) 13.5km (d) 18.3km

83. Ans: (a)

Sol: Maximum distance $= \frac{500 \times 10^6}{85 \times 10^6} \simeq 5.9$ kms

84. A single-mode fiber has a numerical aperture of 0.15. What is the maximum core diameter it could have for use with infrared light with a wavelength of 820nm?
(a) 8.4μm (b) 6.3μm
(c) 4.2μm (d) 2.1μm

84. Ans: (c)

Sol: $V = \frac{2\pi a}{\lambda}(NA)$
$V = 2.405$ for SMF
$2.405 = \frac{(2a) \times \pi \times 0.15}{820 \times 10^{-9}}$
$\therefore 2a = 4.2\ (\mu m)$

85. Consider the following statements
A time invariant system is
1. also referred to equivalently as a shift invariant system
2. a system for which a time shift or delay of the input sequence causes a corresponding shift in the output sequence

Which of the above statements is/are correct?
(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

85. Ans: (c)

Sol: A time invariant system is
1. Also referred to as shift invariant system
2. A system for which a time shift or delay of the input sequence causes a corresponding shift in the output sequences.

86. Consider the following statements:
The Nyquist criteria
1. Provide the theoretical basis for using the loop frequency response to determine the stability of a closed-loop system
2. May be used to assess stability from experimental data describing the system
Which of the above statements is/are correct
(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

86. Ans: (c)

Sol:

→ Nyquist stability criteria uses loop frequency response [G(jω)H(jω)] to get closed loop stability.

→ If experimental data consist of ω_{pc} & ω_{gc}, then we can assess the stability by using Nyquist criteria.

87. Consider the following statements:
Bode diagram is
1. a method for studying the stability of a linear feedback system
2. useful in developing engineering intuition regarding the effect of pole-zero placement on the frequency response L (jω)
Which of the above statements is/are correct?
(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

87. Ans: (c)

Sol:

→ Bode plot gives the close loop stability of linear control system by using gain margin and phase margin

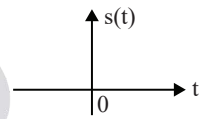
→ Bode plot is useful in finding effect of pole-zero placement.

88. A unit impulse function is defined as
1. $\delta(t) = \begin{cases} 0 \text{ for } t \neq 0 \\ \infty \text{ for } t = 0 \end{cases}$
2. $\int_{-\infty}^{\infty} \delta(t)dt = 1$
3. $\int_{-\infty}^{\infty} \delta(t)f(t)dt = f(0)$
Which of the above are correct?
(a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

88. Ans: (d)

Sol:

1. $\delta(t) = \begin{cases} \infty; & t = 0 \\ & t \to 0 \\ 0; & t \neq 0 \end{cases}$



2. Area under unit impulse is 1 i.e $\int_{-\infty}^{+\infty} \delta(\tau)d\tau = 1$

3. $\int_{-\infty}^{\infty} f(t)\delta(t)dt = f(0)$ → sampling property

89. Consider the characteristic equation
$s^2 + s(2 + K) + 4K = 0$
The open-loop transfer function of the system G(s) H(s) is
(a) $\frac{K(s+2)}{s(s+4)}$ (b) $\frac{K(s+4)}{s(s+2)}$
(c) $\frac{K(s+4)}{(s+2)}$ (d) $\frac{K(s+2)}{(s+4)}$

89. Ans: (b)

Sol: $\underrightarrow{CE}$ $s^2 + s(2 + k) + 4k = 0$

$\underrightarrow{CE}$ $s^2 + 2s + ks + 4k = 0$

$\underrightarrow{CE}$ $s(s + 2) + k(s + 4) = 0$

Divide CE by s(s + 2)

$\underrightarrow{CE}$ $1 + \frac{k(s+4)}{s(s+2)} = 0$

Compare with $\underrightarrow{CE}$ $1 + G(s) H(s) = 0$

$$G(s)H(s) = \frac{k(s+4)}{s(s+2)}$$

90. Which one of the following is not the correct property of signal flow graph?
(a) The signal flow graph is applicable to non-linear time-invariant systems
(b) The value of the variable at each node is equal to the algebraic sum of all signals entering at that node
(c) The signal gets multiplied by the branch gain when it travels along it
(d) The signal flow graph is not the unique property of the system

90. Ans: (a)

Sol:

→ Signal flow graph is applicable to linear time-invariant system only.
option (a) is wrong.

91. A closed-loop control system has the characteristic equation
$s^3 + 4.5s^2 + 3.5s + 1.5 = 0$
As per Routh-Hurwitz criterion, the system will be
(a) stable (b) unstable
(c) absolutely unstable (d) semi-stable

91. Ans: (a)

Sol: CE → $s^3 + 4.5s^2 + 3.5s + 1.5 = 0$

s^3	1	3.5
s^2	4.5	1.5
s^1	3.16	
s^0	1.5	

→ No sign change → So CL system is stable.

92. In paging, the percentage of times that a page number is found in the associative registers is called
(a) effective memory access time
(b) effective access time
(c) hit ratio
(d) register ratio

92. Ans: (c)

Sol:

- In paging, associative registers (also called Translation Lookaside Buffers – TLBs) store recent page table entries.
- When a page number is found in TLB, it's called a TLB hit.
- The hit ratio is the percentage of times the desired page number is found in the TLB.
  Hit ratio = (Number of TLB hits) / (Total memory accesses)
- It improves effective access time but is not the same as access time.

93. Which one of the following is an effect of phase lead network?
(a) Phase margin is decreased
(b) Bandwidth is decreased
(c) The velocity constant is usually decreased
(d) The slope of the magnitude curve is reduced at the gain crossover frequency, with the result relative stability improves

93. Ans: (d)

Sol: Phase lead compensator improves the relative stability of the system.

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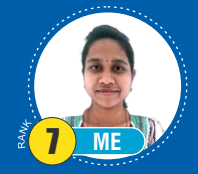

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94. For the first-order system with unit ramp function, the steady-state error is

(a) $\frac{1}{T}$ (b) 0

(c) T (d) 1

94. Ans: (c)

Sol: OLTF of 1st order system is $G(s) = \frac{1}{Ts}$, $H(s) = 1$

Steady state error for unit ramp is $= \frac{1}{k_V}$

$$k_V = \lim_{s\to 0} sG(s) = \lim_{s\to 0} s\left(\frac{1}{Ts}\right) = \frac{1}{T}$$

$$e_{ss} = \frac{1}{\frac{1}{T}} = T$$

95. A second-order system has a transfer function given by

$$G(s) = \frac{25}{s^2 + 8s + 25}$$

If the system initially at rest is subjected to a unit step input at t = 0, the second peak in the response will occur at

(a) πs (b) $\frac{\pi}{3}$s

(c) $\frac{2\pi}{3}$s (d) $\frac{\pi}{2}$s

95. Ans: (a)

Sol: $G(s) = \frac{25}{s^2 + 8s + 25}$ $\omega_n = 5$ r/sec, $\zeta = 0.8$

$$t_p = \frac{3\pi}{\omega_d} = \frac{3\pi}{\omega_n\sqrt{1-\zeta^2}} = \frac{3\pi}{5\sqrt{1-0.8^2}} = \frac{3\pi}{3} = \pi \text{ sec}$$

96. Which one of the following is not the correct advantage of frequency domain analysis?

(a) Frequency response tests are simple to perform

(b) Those systems which do not have rational transfer function, frequency response can be precisely applied to them also

(c) Transfer function can be obtained from frequency response of the system

(d) Frequency response methods can be applied for non-linear systems

96. Ans: (d)

Sol: Frequency domain methods applied to linear systems but not for non-linear system.

97. In computer memory, for the non-random access memory, an average time T_N to read or write N bits is

(a) $T_A + \frac{n}{R}$ (b) $R + \frac{n}{T_A}$

(c) $n + R + \frac{1}{T_A}$ (d) $\frac{R}{T_A} + n$

where

R is rate of transfer

n is number of bits

T_A is average access time

97. Ans: (a)

Sol: For Non-Random Access memory, n number of bits is accessed one after other, in a sequence.

Hence time for n bits [to read/write].

= Average Access time + n (time for 1 bit access)

$$= T_A + n\left(\frac{1}{R}\right)$$

$$= T_A + \frac{n}{R}$$

98. A fundamental characteristic of a memory is the order or sequence in which information can be accessed. If storage locations can be accessed in any order and access time is independent of the location being accessed, the memory is termed as

(a) sequential access memory

(b) random access memory

(c) serial access memory

(d) optical memory

98. Ans: (b)

Sol: In Random Access memory, storage locations can be accessed in any order.

99. Which one of the following is a small, fast memory that acts as a buffer for a slower, larger memory?
(a) SRAM (b) DRAM
(c) Cache memory (d) Flash memory

99. Ans: (c)

Sol: Cache memory is a small, fast memory.

100. Which of the following applications are characterized by the presence of many single-threaded processes?
(a) Java applications
(b) Multi-threaded native applications
(c) Multi-instance applications
(d) Multi-process applications

100. Ans: (d)

Sol:

- Multi-process applications involve multiple independent processes, each possibly single-threaded.
- Common in systems like web servers or Unix-based programs, where multiple processes are used instead of threads.
- Each process has its own memory space and runs independently.

- Multi-threaded apps share memory and use threads.
- Multi-instance apps refer to separate copies of the same app running (may or may not be single-threaded).
- Java apps often use multi-threading, not necessarily single-threaded processes.

Java supports multithreading, allowing for concurrent execution within a single process. While some Java applications might use only a single thread, the language and its runtime environment actively support multithreading.

Multi-threaded applications utilize threads within a single process to perform tasks concurrently. They leverage the capabilities of the operating system's threading mechanisms. A single multi-threaded application does not consist of multiple singlethreaded processes.

A multi-instance application involves running multiple copies of the same application, each as a separate process. While these processes may be single-threaded individually, the definition of "multi-instance" implies the presence of multiple independent processes, not a single process with many threads.

101. If c is the number of check bits required to achieve single-error correction with n-bit data words, clearly the check bits have 2^c patterns that must distinguish between n + c possible error locations and the single error-free case, then c must satisfy the inequality of
(a) $2^c \geq n + c + 1$ (b) $2^c \leq n + c + 1$
(c) $2^{c-1} \geq n + c + 1$ (d) $2^{c-1} \leq n + c + 1$

101. Ans: (a)

Sol: $2^c \geq n + c + 1$ [Using Hamming Code]

102. Which one of the following protocols allows the transaction of serial bit stream of any length without the implication of character boundaries?
(a) Bit-oriented protocol
(b) Check redundancy protocol

(c) Parity bit protocol
(d) Byte-oriented protocol

102. Ans: (a)

Sol: Bit-oriented protocols (like HDLC) transmit data as a continuous stream of bits, not constrained by character (byte) boundaries. Control information is embedded in bit patterns, not tied to byte structure. They are more flexible and efficient, especially in high-speed networks.

Check redundancy protocol: This refers to error detection methods (like CRC) but not the framing or bit-stream nature of the protocol itself.

Parity bit protocol: This is a simple error detection scheme for individual characters or bytes, implying character boundaries.

Byte-oriented protocol: These protocols (like BISYNC) define frames based on specific control characters, meaning that certain bit patterns within the data field are not allowed as they would be interpreted as control characters. They do imply character boundaries.

103. In which one of the following data transfer modes, the CPU momentarily stops the task for processing, branches to a service program to process the I/O transfer, and then returns to the task it was originally performing?
(a) Programmed I/O
(b) Interrupt-initiated I/O
(c) Direct memory access
(d) Hybrid memory transfer

103. Ans: (b)

Sol: An interrupt from an I/O device will stops the CPU present process and branches to a ISR (Interrupt Service Routine).

104. A collection of blocks that logically belong on the disk but are being kept in memory for performance reason is known as
(a) block cache (b) stream cache
(c) segment (d) page

104. Ans: (a)

Sol: An essential method for enhancing disc access performance in database and operating systems is block caching. The system can avoid sluggish physical reads from the disc drive by storing recently used or commonly used disc blocks in the speedier main memory (RAM). This raises the system's total throughput and drastically lowers the latency for data access.

105. A virus that could overwrite the master boot record or boot sector with devastating results is known as
(a) boot sector virus
(b) bootstrap virus
(c) memory-resident virus
(d) cavity virus

105. Ans: (a)

Sol: A virus that overwrites the master boot record (MBR) or boot sector is called a boot sector virus. This type of virus can render a computer unusable by corrupting the critical information needed for the operating system to start.

106. An employee might learn many job skills, and each job skill might be learned by many employees. Database designers label the relationship 'EMPLOYEE learns SKILL' as
(a) one-to-one relationship
(b) many-to-many relationship

Hearty Congratulations

To our students CIVIL ENGINEERING

Selected in SSC JE - 2024

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Roll No. 3008100089
Selected in: **CPWD**

RAMSWRUP
Roll No. 2404100567
Selected in: **CPWD**

LAKSHIT BHARDWAJ
Roll No. 3206106390
Selected in: **CPWD**

M V SIVA RAM REDDY
Roll No. 8008101372
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RAVINDRA DHAKAD
Roll No. 6005100485
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RAHUL KUMAWAT
Roll No. 2401100340
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VISHAL SINGH
Roll No. 3013105309
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S R JAFFER SHARIEF
Roll No. 8006102160
Selected in: **MES**

BEHARA SRIKANTH
Roll No. 8007102883
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ANIRUDH KOTIYAL
Roll No. 2003101448
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RINKESH KUMAR
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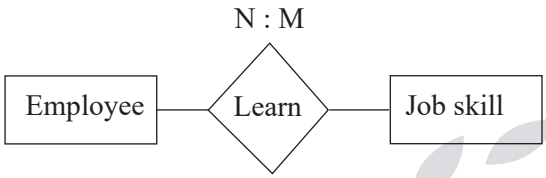
& many more..

Total 150+ Selections | **CE-98** | **EE-29** | **ME-24**

(c) one-to-many relationship
(d) many-to-one relationship

106. Ans: (b)

Sol: The E-R model for the given requirements are



107. In the 680X0 family, simple instructions are assigned short formats as follows:
ADD.L D1, D2
This instruction denotes
(a) register to register addition
(b) register to memory addition
(c) register to memory and register addition
(d) memory to memory addition

107. Ans: (a)

Sol: The instruction ADD.L D1, D2 in Motorola 680X0 assembly:

- L = Long word (32-bit)
- D1, D2 are data registers
- This means: Add the contents of register D1 to register D2

Therefore, it's a register-to-register operation.
Explanation in more details:
Let's analyze the instruction format:
• ADD: The operation is addition.
• L: This suffix specifies the operand size as Long word (32 bits).
• D1: This refers to Data Register 1.
• D2: This refers to Data Register 2.
The instruction ADD.L D1, D2 means "Add the contents of Data Register D1 to the contents of Data Register D2, treating them as 32-bit long words, and store the result in D2." Both operands are registers.

- (a) register to register addition: This matches the analysis.
- (b) register to memory addition: This would typically involve a memory address as one of the operands (e.g., ADD.L D1, (A0)).
- (c) register to memory and register addition: This would typically involve a memory address as one of the operands.
- (d) memory to memory addition: This would involve two memory addresses as operands.

108. Which one of the following is true for atomicity with respect to transaction properties?
(a) Requires that all operations of transactions be completed; if not transaction is aborted
(b) Indicates the permanency of the database's consistent state
(c) The results of the concurrent execution of several transactions
(d) The data used during the execution of a transaction cannot be used by a second transaction until the first one is completed

108. Ans: (a)

Sol: Atomicity property of a transaction indicates that either all operations of a transaction to be completed or none at all.

109. A pulse of a given frequency transmitted upward is received back after a period of 5 millisecond. If the value of c is 3×10^8 m/s, the virtual height of the reflecting layer will be

(a) 650 km (b) 700 km
(c) 750 km (d) 800 km

109. Ans: (c)

Sol: Time taken for traveling = 5 (ms)
(to and fro) Formulae: $h = \frac{cT}{2}$
one side time = 2.5 (ms)
height = $2.5\times10^{-3}\times3\times10^{5}$ (kms/sec) = 750 (kms)

110. The velocity factor V_f with respect to transmission line wave propagation is
(a) $\frac{V_P}{c}$ (b) $\frac{2V_P}{c}$
(c) $\frac{V_P}{3c}$ (d) $\frac{2V_P}{3c}$
where
V_P is actual velocity of propagation
c is velocity of propagation through free space

110. Ans: (a)

Sol: The velocity factor, $V_f = \frac{V_P}{c}$

111. A dielectric medium, in which the conduction current is almost non-existent in comparison with the displacement current, may be treated as
(a) homogeneous dielectric medium
(b) imperfect dielectric medium
(c) perfect dielectric medium
(d) isotropic dielectric medium

111. Ans: (c)

Sol:
- A perfect dielectric is an ideal insulator:
  - o No conduction current
  - o Only displacement current exists
- In such media, energy is not lost due to conduction, ideal for capacitors and high-frequency applications.

Explanation in more details:
Let's consider the characteristics of different dielectric media:

- Conduction current ($J_c = \sigma E$) is due to the movement of free charges (related to conductivity σ).
- Displacement current ($J_d = \partial D/\partial t = \epsilon \partial E/\partial t$) arises from the time-varying electric field (related to permittivity ϵ).

A perfect dielectric medium is an ideal material with zero conductivity (σ = 0). In such a medium, there is no conduction current, and any current flow under a time-varying field is purely displacement current.

(a) homogeneous dielectric medium: Implies uniform properties throughout. Doesn't specifically address current types.
(b) imperfect dielectric medium: An imperfect dielectric has some non-zero conductivity (σ>0), meaning both conduction and displacement currents exist.
(c) perfect dielectric medium: This aligns with the description where conduction current is negligible compared to displacement current.
(d) isotropic dielectric medium: Implies properties are the same in all directions. Doesn't specifically address current types.

112. A load of pure resistance of 60Ω is to be connected through a quarter-wave line to a transmission line of characteristic impedance 100Ω If VSWR = 1, the characteristic impedance of the quarter-wave line will be
(a) 82.5Ω (b) 77.5Ω
(c) 72.5Ω (d) 67.5Ω

112. Ans: (b)

Sol: $Z_0^1 = \sqrt{60 \times 100} = 77.4\Omega$

113. A lossless transmission line having characteristic impedance of 600Ω is terminated by a resistance of 300Ω. The voltage standing wave ratio in the line will be

(a) 4 (b) 3

(c) 2 (d) 1

113. Ans: (c)

Sol: $\Gamma = \frac{300-600}{300+600} = \frac{-300}{900} = \frac{-1}{3}$

$$\rho = \frac{1+\left|-\frac{1}{3}\right|}{1-\left|-\frac{1}{3}\right|} = \frac{1+\frac{1}{3}}{1-\frac{1}{3}} = \frac{4}{2} = 2$$

114. The antenna efficiency η (with regards to a radiation resistance) is

(a) $\frac{P_{rad}}{2P_{in}} \times 100$ (b) $\frac{P_{rad}}{P_{in}} \times 100$

(c) $\frac{2P_{rad}}{P_{in}} \times 100$ (d) $\frac{3P_{rad}}{P_{in}} \times 100$

where

P_{rad} is radiated power

P_{in} is input power

114. Ans: (b)

Sol: $\eta = \frac{P_{rad}}{P_{in}} \times 100$

115. Which one of the following relations is true for an angle of entrance θ_e on the axis of core?

(a) $\sin\theta_e = \frac{\sqrt{\eta_1^2+\eta_2^2}}{\eta_0}$ (b) $\sin\theta_e = \frac{\sqrt{\eta_1^2-\eta_2^2}}{\eta_0^2}$

(c) $\sin\theta_e = \frac{\sqrt{\eta_1^2-\eta_2^2}}{\eta_0}$ (d) $\sin\theta_e = \frac{\sqrt{\eta_1^2+\eta_2^2}}{\eta_0^2}$

where

η_1 is index of refraction of core

η_2 is index of refraction of cladding

η_0 is index of refraction of external medium

115. Ans: (c)

Sol: $n_0 \sin(\theta_e) = NA = (n_1^2 - n_2^2)^{1/2}$

$$\therefore \sin(\theta_e) = \frac{\sqrt{(n_1^2-n_2^2)}}{n_0}$$

116. When the cut-off frequency for TE_{10} mode is 3 GHz, and the value of v_0 is 3×10^{10}cm/s, the broad wall dimension of a rectangular waveguide will be

(a) 2 cm (b) 3 cm

(c) 4 cm (d) 5 cm

116. Ans: (d)

Sol: $f_{c/TE_{10}} = \frac{c}{2a}$

$$\Rightarrow 3 \times 10^9 = \frac{3 \times 10^{10}}{2 \times a}$$

$$\Rightarrow a = \frac{3 \times 10^{10}}{2 \times 3 \times 10^9} = \frac{30}{6} = 5\text{cm}$$

117. The wave of 1 GHz is radiated by an antenna to cover a distance of 100 km. If the velocity of propagation is 3×10^8m/s the time taken by the wave travel the above distance will be

(a) 369μs (b) 351μs

(c) 333μs (d) 315μs

117. Ans: (c)

Sol: Given:

- Distance = 100 km = 100,000 m
- Velocity v = 3×10^8v = 3×10^8 m/s

Time (t) = Distance/ Speed = 100,000/ 3×10^8

t = 3.33×10^{-4} seconds = 333.3 μst = 333.3μs

Hearty Congratulations to our students GATE - 2025

84 TIMES AIR 1st IN GATE

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AIR 1 EE Pradip Chauhan

AIR 1 IN Kailash Goyal

AIR 2 EE Kailash Goyal

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AIR 10 EE Neelava Mukherjee

AIR 10 ME Ashutosh kumar

AIR 10 ME Jetti Ganateja

AIR 10 ME Pitchika Kumar Vasu

AIR 10 CE Adnan Quasain

& mamy more....

118. The approximate –3 dB beam width for a parabolic antenna in degrees is

(a) $\theta = \frac{80\lambda}{D}$ (b) $\theta = \frac{70\lambda}{D}$

(c) $\theta = \frac{60\lambda}{D}$ (d) $\theta = \frac{50\lambda}{D}$

where

λ is wavelength

D is antenna mouth diameter

θ is beam width between half-power points (degrees)

118. Ans: (b)

Sol: The approximate –3dB beam width for a parabolic antenna is $\theta = \frac{70\lambda}{D}$.

119. The guide wavelength λ_g for a cut-off frequency and frequency of operation is

(a) $\lambda_g = \frac{c}{\sqrt{f^2 - f_c^2}}$ (b) $\lambda_g = \frac{c}{\sqrt{f_c^2 - f^2}}$

(c) $\lambda_g = \frac{c}{\sqrt{f^2 + f_c^2}}$ (d) $\lambda_g = \frac{c}{\sqrt{f_c + f}}$

where

c is free space propagation velocity

f is frequency of operation

f_c is cut-off frequency

119. Ans: (a)

Sol: $$\lambda_g = \frac{\lambda_0}{\sqrt{1 - \left(\frac{f_c}{f}\right)^2}} = \frac{\lambda_0}{\frac{\sqrt{f^2 - f_0^2}}{f}} = \frac{\lambda_0 \times f}{\sqrt{f^2 - f_0^2}}$$

$$\lambda_g = \frac{c}{\sqrt{f^2 - f_0^2}}$$

120. A broadside array operating at 100 cm wavelength consists of four half-wave dipoles spaced 50 cm. If each element carries radio frequency current in the same phase and of magnitude 0.5 A, and radiation resistance is 73Ω, the radiated power will be

(a) 68 W (b) 73 W

(c) 78 W (d) 83 W

120. Ans: (b)

Sol: $P_T = NP_{single}$

$= N I^2 \times R$

$= 4 \times (0.5)^2 \times 73$

121. Which one of the following, a polycrystalline material of high purity, is the raw material for the preparation of single-crystal silicon?

(a) Electronic Grade Silicon (EGS)

(b) Metallurgical Grade Silicon (MGS)

(c) Float Zone Silicon (FZS)

(d) Raw Silicon (RS)

121. Ans: (a)

Sol: Electronic Grade Silicon (EGS) is a polycrystalline material with a high level of purity, making it suitable for producing single crystal silicon used in semiconductor.

122. For a 1000 µm long bond pad locus, the number of bond pads placed on a 100 µm pitch along a bond pad will be

(a) 10 (b) 11

(c) 12 (d) 13

122. Ans: (b)

Sol: The no of bond pads $= \frac{\text{Total length}}{\text{Pitch}} + 1$

$= \frac{1000\mu m}{100\mu m} + 1$

$= 10 + 1$

$= 11$

123. Which one of the following incorporates both the level sensitivity and the scan path approach using shift registers?
(a) Built-in logic block observer
(b) Built-in test
(c) Level-sensitive scan design
(d) I_{DQ} test

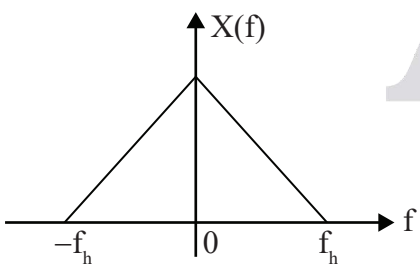
123. Ans: (c)

Sol: Level sensitive scan design uses both level sensitivity and scan path approach.

124. In a reconstruction filter, if the output is x(t) in time domain and $C_0X(f)$ in frequency domain with no frequency components above f_h and X(f) is zero for $|f| \geq f_h$, then such signal is called
(a) reconstructed (b) bandlimited
(c) constructed (d) delimited

124. Ans: (b)

Sol: A bandlimited signal of finite energy which has no frequency components higher than f_h, can be completely reconstructed if we sample at a rate $f_s \geq 2f_h$
Assume Band limited spectrum



125. Fourier series exists only when the function f(t) is well-defined and single-valued, possesses finite number of discontinuities, and finite number of positive and negative maxima in the period T. These conditions are called
(a) Parseval's conditions
(b) Blackman conditions
(c) Chebyshev conditions
(d) Dirichlet's conditions

125. Ans: (d)

Sol: Dirichlet's conditions (convergence of F.S):
They describe sufficient conditions for the existence of F.S. A periodic function x(t) will possess a unique F.S, if, over one period
1. x(t) is absolutely integrable
2. x(t) has finite number of maxima and minima and finite number of discontinuities.

126. If

$$X(z) = \frac{1+\frac{1}{2}z^{-1}}{1-\frac{1}{2}z^{-1}}$$

What is x(n)?

(a) $\frac{1}{2}[\delta(n)+2u(n-1)]$

(b) $\left(\frac{1}{2}\right)^n[\delta(n)+2u(n-1)]$

(c) $\left(\frac{1}{2}\right)^n[\delta(n)-2u(n-1)]$

(d) $\frac{1}{2}[\delta(n)-2u(n-1)]$

126. Ans: (b)

Sol:

$$X(z) = \frac{1+\frac{1}{2}z^{-1}}{1-\frac{1}{2}z^{-1}} = \frac{1-\frac{1}{2}z^{-1}+z^{-1}}{1-\frac{1}{2}z^{-1}}$$

$$= \frac{1-\frac{1}{2}z^{-1}}{1-\frac{1}{2}z^{-1}} + \frac{z^{-1}}{1-\frac{1}{2}z^{-1}} = 1 + \frac{z^{-1}}{1-\frac{1}{2}z^{-1}}$$

Applying I.Z.T

We know

$\delta(n) \xleftrightarrow{Z.T} 1$

$a^n u(n) \xleftrightarrow{Z.T} \frac{1}{1-az^{-1}}$

$x(n-n_0) \xleftrightarrow{Z.T} z^{-n_0}X(z)$

$x(n) = \delta(n) + \left(\frac{1}{2}\right)^{n-1} u(n-1)$

$= \left(\frac{1}{2}\right)^n \delta(n) + 2\left(\frac{1}{2}\right)^n u(n-1)$

From the given options $\delta(n) = \left(\frac{1}{2}\right)^n \delta(n)$

Product property of impulse $x(n)\,\delta(n-n_0) = x(n_0)\,\delta(n-n_0)$

$x(n) = \left(\frac{1}{2}\right)^n [\delta(n) + 2u(n-1)]$

127. A first-order low-pass Butterworth active filter has a cut-off frequency of 10 kHz and unity gain at low frequency. The voltage transfer function magnitude at 12 kHz for the filter will be

(a) 0.32 (b) 0.64

(c) 0.96 (d) 1.28

127. Ans: (b)

Sol: Butterworth filter frequency response is

$$|H(j\Omega)| = \frac{1}{\sqrt{1+\left(\frac{\Omega}{\Omega_C}\right)^{2n}}}$$

order, n = 1

Cut-off frequency, Ω_C = 10kHz

Ω = 12kHz

$$|H(j\Omega)| = \frac{1}{\sqrt{1+\left(\frac{12}{10}\right)^{2(1)}}}$$

$$= \frac{1}{\sqrt{1+(1.2)^2}}$$

$$= \frac{1}{\sqrt{2.44}} = 0.64$$

128. The filters that exhibit symmetry, have an odd-numbered filter length and are used in applications like decimation and interpolation are known as

(a) half-band filters (b) full-band filters

(c) bridge-band filters (d) multi-band filters

128. Ans: (a)

Sol: A half band FIR filter has an odd-length I.R, h(n) whose alternate samples are zero. The main advantage of half band filter is that their realization requires only half the no of multipliers and used in applications like decimation and interpolation.

129. The IIR filters involve designing of

(a) analog filter in analog domain and transforming into digital domain

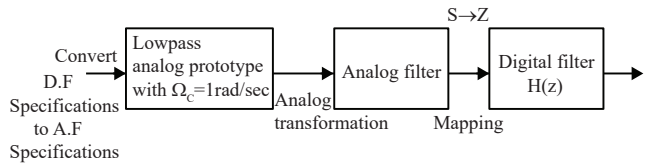
(b) digital filter in analog domain and transforming into digital domain

(c) analog filter in digital domain and transforming into analog domain

(d) digital filter in digital domain and transforming into analog domain

129. Ans: (b)

Sol:



130. If a pulse sent to the target returns after 15 μs, when the velocity of light is 300×10^6m/s, the distance of the target will be
(a) 4.25 km (b) 3.50 km
(c) 2.25 km (d) 1.50 km

130. Ans: (c)

Sol: Formulae:

$$\text{Range, } \left[R = \frac{CT}{2}\right]$$

Target distance
$= 3 \times 10^5 \text{ (kms/sec)} \times 7.5 \times 10^{-6}$
$= 22.5 \times 10^{-1}$
$= 2.25 \text{ (kms)}$

131. Pulse Width Modulation (PWM) mode is commonly used in embedded system application for
(a) controlling the speed of DC motors
(b) serial communication
(c) counting the electrical pulses
(d) recording the arrival time of either a rising or falling pulse

131. Ans: (a)

Sol: This is application of PWM systems

132. A chip with fewer transistors results into lower cost, less heat and less power requirements. These features are very desirable in small battery-powered embedded systems such as mobile phones. Which one of the following architectures is used?
(a) AMD (b) MIPS
(c) ARM (d) TDP

132. Ans: (c)

Sol: For small battery powered systems the ARM architecture is the one that widely used due to its advantages in terms fewer transistor leading lower cost, lesser heat and lesser power requirement.

133. Which kind of deposition has traditionally been done at higher temperatures to ensure that all the Si atoms being deposited are incorporated into lattice sites in order to obtain a single-crystal thin film?
(a) Epitaxial Si deposition
(b) Polysilicon deposition
(c) Silicon nitride deposition
(d) Silicon dioxide deposition

133. Ans: (a)

134. Which one of the following layers defines the procedure and functions that physical devices and interfaces have to perform for transmission to occur?
(a) Data link layer (b) Network layer
(c) Physical layer (d) Application layer

134. Ans: (c)

Sol: The layer that defines the procedure and functions physical devices and interfaces have to perform for transmission to occur is the Physical Layer. The Physical Layer is the lowest layer in the OSI model and is responsible for the actual transmission of raw bits over a physical medium, including defining how data is encoded, modulated, and transmitted through the network.

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AIR 1

Himanshu T

AIR 1

Rajan Kumar

AIR 1

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AIR 6

SANCHIT GOEL

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CHANDRIKA GADGIL

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AIR 6

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AIR 7

DEBARGHYA CH

AIR 7

MANTHAN SHARMA

AIR 7

DINESH KUMAR S

AIR 8

ROHIT KUMAR

AIR 8

VIDHU SHREE

AIR 8

MAYANK JAIMAN

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AIR 10

RAJESH BADUGU

AIR 10

RAJVARDHAN SHARMA

AIR 10

AKSHAY VIDHATE

TOTAL 36 SELECTIONS IN TOP 10 | **CE: 09 | ME: 10 | EE: 08 | E&T: 09**

135. Which one of the following carries multiple voice frequency circuits using either frequency division multiplexed or synchronous time division multiplexed?

(a) Subscriber (b) Local loop

(c) Exchange (d) Trunk

135. Ans: (d)

Sol: A trunk is a high-capacity communication line that carries a large number of voice calls between different switching centers. It can utilize both FDM and TDM to efficiently transmit multiple voice frequencies.

136. Five channels, each with a 100 kHz bandwidth, are to be multiplexed together. If there is a need for a guard band of 10 kHz between the channels to prevent interference, the minimum bandwidth of the link will be

(a) 540 kHz (b) 510 kHz

(c) 470 kHz (d) 440 kHz

136. Ans: (a)

Sol: $N = 5$

$BW = 5 \times 100 \times 10^3 + (5-1)10 \times 10^3$

$BW = 540\,(kHz)$

137. The entries in a CIDR routing table contain 32-bit IP address and a 32-bit mask. The CIDR enables a technique called

(a) supernetting (b) routing tables

(c) deployment of CIDR (d) logical packet flows

137. Ans: (a)

Sol: Supernetting (also known as route aggregation) is a technique where multiple smaller networks (or subnets) are grouped together to form a larger network for routing purposes. CIDR enables this by allowing the definition of network prefixes (the number of bits used to identify the network) that can represent a range of IP addresses.

138. The free space path loss L_p, incurred by an electromagnetic wave is

(a) $\left(\frac{4\pi fD}{c}\right)^2$ (b) $\left(\frac{2\pi fD}{c}\right)^2$

(c) $4\pi\left(\frac{fD}{c}\right)^2$ (d) $2\pi\left(\frac{fD}{c}\right)^2$

where

c is velocity of light in free space

f is frequency

D is distance

138. Ans: (a)

Sol: $L_P = \left(\frac{4\pi D}{\lambda}\right)^2$

$\lambda = \frac{c}{\mu}\,(or)\frac{c}{f}$

$\therefore L_P = \left(\frac{4\pi fD}{c}\right)^2$

139. Which one of the following amplifiers is widely used in transponders to provide the final output power required to the transmit antenna?

(a) Travelling-wave tube amplifier

(b) Power amplifier

(c) Two-stage wave tube amplifier

(d) Three-stage wave tube amplifier

139. Ans: (a)

Sol:

- A Travelling-Wave Tube Amplifier (TWTA) is commonly used in satellite transponders.

- It provides high output power with wide bandwidth, making it ideal for final amplification before signal transmission via antenna.
- It is a type of vacuum tube amplifier, efficient at microwave frequencies.

Travelling-wave tube amplifier (TWTA): TWTAs are commonly used in satellite transponders as output amplifiers. They can provide high power levels and operate over a broad range of frequencies, which is essential for satellite communication.

Power amplifier: This is a general term. While transponders use power amplifiers, the TWTA is a specific type often used in this application.

Two-stage wave tube amplifier: This is not a standard term. TWTAs can have multiple stages, but it's not the primary descriptor.

Three-stage wave tube amplifier: Similar to (c), it's not the standard term.

140. Which one of the following systems of satellites is sometimes called Internet in the Sky"?
(a) Globalstar
(b) Teledesic
(c) Iridium
(d) Medium Earth Orbit (MEO)

140. Ans: (d)

Sol: For providing Internet connection in sky we use LEO (or) MEO satellites.

141. A directional antenna with 10 dB gain radiates 500 watts. The receiving antenna at 15 km distance receives 2 microwatt. If there is a negligible ground and ionospheric reflection, the effective area of the receiving antenna will be nearly
(a) 3.1 m^2 (b) 2.3 m^2
(c) 1.1 m^2 (d) 0.3 m^2

141. Ans: (c)

Sol: $P_R = \frac{P_T \times G_T \times A_{eff}}{4\pi R^2}$

$\therefore A_{eff} = 1.1\ m^2$

142. The time used for all civil timekeeping purposes, and is the time reference which is broadcast by the National Bureau of Standards as a standard for setting clocks, is
(a) Mean Time Coordinated
(b) Universal Time Coordinated
(c) Epoch Time Coordinated
(d) Real Time Coordinated

142. Ans: (b)

Sol: Coordinated Universal Time (UTC) is the standard for civil timekeeping.

It is broadcast globally, including by agencies like the National Institute of Standards and Technology (NIST) in the USA.

UTC combines atomic time and Earth's rotation-based time.

UTC is the primary time standard by which the world regulates clocks and time. It is the basis for civil timekeeping and is broadcast by national standards bodies like the National Institute of Standards and Technology (NIST) (formerly the National Bureau of Standards in the US) as a standard for setting clocks.

Epoch Time Coordinated: This isn't a standard term. Epoch time refers to a system of counting seconds since a specific date/time origin (the "epoch").

143. The point on the earth vertically under the satellite is referred to as the

(a) reference point (b) meridian point
(c) apparent point (d) sub-satellite point

143. Ans: (d)

Sol: The sub-satellite point is the geographical location directly beneath the satellite on the Earth's surface. It is used in satellite tracking and coverage mapping. For geostationary satellites, this point remains fixed on the equator.

The sub-satellite point is the point on the Earth's surface directly below the satellite at any given time.

reference point: This is a general term and not specific to satellite positions.

meridian point: This refers to a point on the Earth's meridian (line of longitude), but not necessarily directly under a satellite.

apparent point: This isn't a standard term in satellite positioning.

144. The total reduction of power level in optical fiber cable, A(dB) is

(a) $25\log\frac{P_{out}}{P_{in}}$ (b) $20\log\frac{P_{out}}{P_{in}}$

(c) $15\log\frac{P_{out}}{P_{in}}$ (d) $10\log\frac{P_{out}}{P_{in}}$

where

P_{in} is cable input power

P_{out} is cable output power

144. Ans: (d)

Directions:

Each of the following **six (06)** items consists of two statements, one labelled as 'Statement (I)' and the other as 'Statement (II)'. You are to examine these two statements carefully and select the answers to these items using the codes given below:

Codes:

(a) Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I)

(b) Both Statement (I) and Statement (II) are individually true but Statement (II) is not the correct explanation of Statement (I)

(c) Statement (I) is true but Statement (II) is false

(d) Statement (I) is false but statement (II) is true

145. **Statement (I):**

Stokes' theorem gives relation between a double integral and a single integral, and is applied only to an open surface.

Statement (II):

Gauss' divergence theorem gives relation between a triple integral and a double integral, and is applied only to a closed surface.

145. Ans: (b)

Sol: Stokes' Theorem relates the line integral of a vector field around a closed curve to the surface integral of the curl of the vector field over any open surface (with the given curve as its boundary).

Gauss' Divergence Theorem relates the surface integral of a vector field over a closed surface to the volume integral of the divergence of the vector field within the volume enclosed by that surface.

Both statements accurately describe their respective theorems and their application conditions. However, Statement (II) is not an explanation for Statement (I); they are independent mathematical theorems.

(b) Both Statement (I) and Statement (II) are individually true but Statement (II) is not the correct explanation of Statement (I).

146. **Statement (I):**

The microwave junction can be defined as S-parameters or scattering parameters.

Statement (II):

A scattering matrix is a square matrix which gives all the combinations of power relationships between the various input and output ports of a microwave junction.

146. Ans: (a)

Sol: S-parameters (Scattering parameters) are indeed the standard way to characterize microwave junctions, especially at high frequencies where voltage and current are hard to define uniquely due to standing waves. They relate incident and reflected power waves.

The scattering matrix (S-matrix) is a square matrix whose elements (Sij) represent the ratio of the complex amplitude of the wave emerging from port i due to a wave incident on port j. These parameters fundamentally relate to power (specifically, the square of the magnitude of S-parameters relates to power transfer). The matrix indeed gives all the combinations of input/output relationships.

Statement (II) provides a correct and more detailed description of what S-parameters and the scattering matrix are, which directly explains why microwave junctions are defined by them (as stated in Statement I).

147. **Statement (I):**

Electron lithography offers higher resolution than optical lithography.

Statement (II):

Electron lithography has small wavelength of the 10-50 keV electrons.

147. Ans: (a)

Sol: Electron beam lithography uses a focused beam of electrons to create patterns on a resist. Due to the much shorter wavelength of electrons compared to UV light, electron lithography can achieve significantly higher resolution and smaller feature sizes than optical lithography.

The de Broglie wavelength of electrons is inversely proportional to their momentum. For electrons accelerated with energies in the range of 10-50 keV (kiloelectronvolts), their de Broglie wavelength is indeed very small (on the order of picometers), much smaller than the wavelength of UV light used in optical lithography. This small wavelength is the reason for the higher resolution.

148. **Statement (I):**

In communication network, the element of the network should be designed such that maximum power transfer takes place between the source to the load.

Statement (II):

The maximum power is absorbed by one network from another network, when the impedance of one is the complex conjugate of the other.

148. Ans: (a)

Sol: **Statement (I):**
In communication network, the element of network should be designed such that maximum power transfer takes place between the source to the load
Statement (II):
The maximum power is absorbed by one network from another network, when the impedance of one is the complex conjugate of the other.

Explanation: Statement I is correct, since communication network's are application of maximum power transfer theorem and statement II is also correct and also statement II is correct explanation of statement I.

149. **Statement (I):**
A network is two or more devices connected together through links.
Statement (II):
A link is a communication pathway that transfers data from one device to another.

149. Ans: (a)

Sol: A network is defined by having two or more devices linked together. These devices can be computers, printers, smartphones, or any other device capable of communicating over the network. A link provides the physical or logical connection that allows data to be transferred between the devices on the network. These links can be physical (like cables) or wireless (like Wi-Fi).

150. **Statement (I):**
Mode partition noise is a multiplicative noise in an optical fiber link.
Statement (II):
Mode partition noise arises when the optical source emits several frequencies in a rapid succession.

150. Ans: (a)

Sol: Mode Partition Noise (MPN) occurs in multi-mode lasers (like Fabry-Perot lasers) and arises from the random fluctuations in power distribution among the longitudinal modes of the laser. It interacts with chromatic dispersion in the fiber, causing signal distortion that is data-dependent. This makes it a multiplicative noise (its effect scales with the signal power and data pattern).
Mode partition noise arises because the total output power of a multi-longitudinal mode laser remains relatively constant, but the power in individual modes fluctuates randomly from one instant to the next. These fluctuations occur very rapidly (on the order of nanoseconds or picoseconds), effectively meaning the source "emits several frequencies in rapid succession" with varying power distribution among them.
Statement (II) describes the phenomenon that leads to mode partition noise, which in turn manifests as multiplicative noise as stated in Statement (I) due to its interaction with dispersion and data. So, Statement (II) provides the mechanism for Statement (I).
(a) Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I).

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