ESE - 2026
Preliminary Examination

QUESTIONS WITH DETAILED SOLUTIONS

ELECTRICAL ENGINEERING
(SET-C)

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Electrical Engineering (SET - C)

SUBJECT WISE WEIGHTAGE

S.No.	Name of the Subject	1 Mark
1	Engineering Mathematics	13
2	Electrical Materials	13
3	Electric Circuits & Fields	12
4	Electrical & Electronic Measurements	14
5	Computer Fundamentals	11
6	Basic Electronic Engineering	16
7	Digital Electronics & Microprocessors Communication Systems	4 + 2 + 4
8	Systems & Signal Processing	13
9	Control Systems	12
10	Electrical Machines	12
11	Power Systems	12
12	Power Electronics	12
Total No. Of Questions		**150**

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Questions with Detailed Solutions

ELECTRICAL ENGINEERING

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01. The page fault occurs
    (a) when a page currently in a memory is accessed
    (b) when a page currently not in a memory is accessed
    (c) when an existing page in a memory to replace with a new page is accessed
    (d) when a page from any process in the system for replacement is accessed

01. Ans: (b)

Sol: A page fault occurs when
- The CPU tries to access a page
- But that page is not present in main memory (RAM)
- So the OS must fetch it from secondary storage (disk)
- (a) If the page is already in memory → No page fault
- (c) Replaced may happen after a page fault, but it is not the cause
- (d) Replacement is a consequence of memory being full, not the definition.

02. Suppose that the failure of two drives are independent; that is, the failure of one is not connected to the failure of the other. Then, if the mean time between failures of a single drive is 100000 hours and the mean time to repair is 10 hours, the approximate mean time to data loss of a mirrored drive system is
    (a) 17000 years   (b) 77000 years
    (c) 47000 years   (d) 57000 years

02. Ans: (d)

Sol: Work (step-by-step):

Single-drive failure rate: $\lambda = \dfrac{1}{100000}$
$$= 10^{-5} \times 10 = 10^{-4}$$

Probability the other drive fails during a 10-hour repair: $\lambda \times \text{MTTR} = 10^{-5} \times 10 = 10^{-4}$

Either drive can fail first, so first-failure rate = 2λ
$$= 2 \times 10^{-5} \text{ per hour}$$

Data-loss rate = $(2\lambda) \times (\lambda.\text{MTTR})$
$$= 2\lambda^2 \text{MTTR}$$
$$= 2 \times (10^{-5})^2$$
$$= 2 \times 10^{-9} \text{ per hour}$$

$$\text{MTTDL} = \dfrac{1}{(2 \times 10^{-9})}$$
$$= 5 \times 10^8 \text{ hours}$$

Convert to years: 3×10^8 hours ÷ 8760 hours/year
$$\approx 5.71 \times 10^4 \text{ years} \approx 57,000 \text{ years}$$

03. Which one of the following modifiers tells the compiler that a variable's value may be changed in ways not explicitly specified by the program?
    (a) Volatile   (b) Identifier
    (c) Const   (d) Typedef

03. Ans: (a)

Sol: The volatile modifier tells the compiler:

"Do NOT optimize this variable-its value may change unexpectedly."

Where does this happen?
- Hardware registers
- Interrupt service routines
- Shared variables in multithreading
- Memory-mapped I/O

Why not others?
- Identifier → Just a name of a variable
- Const → Value cannot be changed
- Typedef → Creates a new type name

04. Consider the following statements regarding applications of a p-n junction diode:
    1. It is used as a switch in DC power supplies
    2. It is used as rectifiers in voltage stabilizing circuits.
    3. It is used as single diodes in communication circuits.

    Which of the above statements is/are correct?
    (a) 2 only
    (b) 2 and 3
    (c) 3 only
    (d) 1 and 3

04. Ans: (d)

Sol: PN diodes are used in DC power supplies and for signal conditioning in communication.

05. Consider the following statements regarding transistors:
    1. They can be made to oscillate with very small power consumption
    2. They cannot sustain mechanical shocks
    3. Their application is limited upto a few mega-cycles only

    Which of the above statements is/are correct?
    (a) 2 only
    (b) 2 and 3
    (c) 3 only
    (d) 1 and 3

05. Ans: (d)

Sol: Transistors are used in oscillators with low power consumption ranging to few mega cycles.

06. A field-effect transistor operates with a drain current of 100 mA and a gate source bias of –1V. The device has dynamic forward transconductance value of 0.25 S. If the bias voltage decreases to –1.2V, what is the new value of the drain current?
    (a) 50 mA
    (b) 75 mA
    (c) 150 mA
    (d) 125 mA

06. Ans: (a)

Sol: $g_m = \dfrac{\text{Change in } I_d}{\text{Change in } V_{gs}}$

$0.25 = \dfrac{100m - I_{d(new)}}{-1 - (-1.2)}$

$I_{d(new)} = 50 \text{ mA}$

07. Match the following Lists regarding bipolar junction transistors:

    List-I (Type of transistor)
    P. BC108 (n-p-n)
    Q. BF180(n-p-n)
    R. 2N3904 (n-p-n)
    S. 2N3055 (n-p-n)

    List-II (Application)
    1. Switching power
    2. General-purpose small-signal amplifier
    3. Low-frequency power
    4. RF amplifier

    Select the correct answer using the code given below.

    Codes:

	P	Q	R	S
(a)	4	2	1	3
(b)	4	3	2	1
(c)	3	4	1	2
(d)	2	4	1	3

07. Ans: (d)

Sol: BC108(npn) is used for small signal amplification (audio, sensors) and low power switching (P-2) so option (d) is the right answer.

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ENGINEERING MATHEMATICS	**20** Questions
NUMERICAL ABILITY	**20** Questions
VERBAL ABILITY	**10** Questions

No. of Questions: 50
Total Marks: 75
Duration: 90 Minutes
Mode: Online

08. Consider the following statements regarding p-n-p transistor:

    1. The base-collector junction is reverse biased to holes in the base region and electrons in the collector region

    2. The base region is very thin and is only lightly doped with electrons

    3. A large proportion of the electrons in the base region cross the base-collector junction into the collector region, creating a collector current.

    Which of the above statements is/are correct?

    (a) 2 only   (b) 2 and 3

    (c) 3 only   (d) 1 and 3

08.   Ans: (a)

Sol: In a pnp transistor B-C collector junction is RB to electrons in base and holes in collector

The base region is very thin and is only lightly doped with electrons.

In a pnp, the majority carriers are holes which consists collector current.

09. For a JFET, the typical values of amplification factor and transconductance are specified as 80 and 200 μs respectively. What is the dynamic drain resistance of this JFET?

    (a) 25 kΩ   (b) 25 μΩ

    (c) 400 kΩ   (d) 400 μΩ

09.   Ans: (c)

Sol: Given $\mu = 80$

$g_m = 200$ μs

We know $\mu = g_m r_{ds}$

$\therefore r_{ds} = \dfrac{80}{200\mu} = 400$ kΩ

10. There is no need of a driver stage, if FET is used as power amplifier instead of BJT, because

    (a) FET digital circuits need much less power compared to BJT circuits

    (b) there is no risk of thermal runaway in FET circuits

    (c) power gain of an FET is much higher than that of a BJT

    (d) FET is essentially a voltage-operated device

10.   Ans: (d)

Sol: There is no need of driver stage if FET is used as it has high input resistance and is essentially a voltage operated device.

11. Match the following Lists regarding field effect transistor amplifiers:

    List-I (Configuration)

    P. Common source

    Q. Common drain

    R. Common gate

    List-II (Typical application)

    1. Impedance matching stages

    2. General-purpose, AF and RF amplifiers

    3. RF and VHF amplifiers

    Select the correct answer using the code given below.

    Codes:

	P	Q	R
(a)	2	1	3
(b)	1	3	2
(c)	3	2	1
(d)	2	3	1

11.   Ans: (a)

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Sol: Common drain amplifier is for impedance matching similar to common collector.

So Q → 1.

12. Match the following Lists regarding bipolar transistor amplifiers:

List-I(Configuration)

P. Common emitter

Q. Common collector

R. Common base

List-II (Typical application)

1. RF and VHF amplifier

2. Impedance matching, input and output stages

3. General-purpose, AF and RF amplifiers

Select the correct answer using the code given below.

Codes:

	P	Q	R
(a)	2	1	3
(b)	1	3	2
(c)	3	2	1
(d)	3	1	2

12. Ans: (c)

Sol: Common collector is used for impedance matching Q - 2.

So, option (c) is the right answer.

13. Consider the following statements regarding frequency response of BJT amplifiers:

1. The CE amplifier has a high gain but a relatively narrow bandwidth.

2. The CC amplifier has a lower gain but a larger bandwidth.

3. The CB amplifier has a higher gain and a larger bandwidth.

Which of the above statements is/are correct?

(a) 2 only

(b) 2 and 3

(c) 3 only

(d) 1 and 2

13. Ans: (d)

Sol: CE amplifier has high gain and low bandwidth due to miller effect.

So, statement-1 1 is correct..

If statement-1 is correct then option (d) should be correct.

14. In a common-collector amplifier stage, the impedance between base and emitter is magnified because of

(a) source resistance

(b) negative feedback

(c) Miller effect

(d) high-frequency response

14. Ans: (b)

Sol: • Common collector gives series-shunt or voltage series negative feedback due to this it has high R_{in} and low R_0

• CC Amplifier is a VCVS

15. In Colpitts oscillator circuits, the amount of feedback is controlled by the

(a) position of the coil tap

(b) ratio of inductances

(c) ratio of capacitances

(d) ratio of resistances

15. Ans: (c)

Sol: $-K = \dfrac{-C_1}{C_2}$

16. An electrodynamometer-type wattmeter has a current coil with a resistance of $0.1\,\Omega$ and a pressure coil with resistance of $6.5\,\text{k}\Omega$. What is the percentage error while the meter is connected as current coil to the load side, if the load is specified as 12 A at 250 V with unity power factor?

    (a) 14.4%   (b) 0.48%
    (c) 4.8%   (d) 1.44%

16. Ans: (b)

Sol: $\%\in = \dfrac{I_L^2 R_{CC}}{V_L I_L \cos\phi} \times 100$

$= \dfrac{(12)^2 \times 0.1}{250 \times 12} \times 100 = 0.48\%$

17. What is the expression for deflecting torque in single-phase induction-type energy meter?

    (a) $T_d \propto \dfrac{\phi_P \phi_S \omega}{Z} \sin\beta\cos\alpha$

    (b) $T_d \propto \dfrac{\phi_{1m}\phi_{2m}}{\omega Z} \sin(\alpha - \theta)\cos\beta$

    (c) $T_d \propto \dfrac{\phi_{1m}\phi_{2m}\omega}{Z} \sin\alpha\cos\beta$

    (d) $T_d \propto \dfrac{\phi_P \phi_S}{\omega Z} \sin\alpha\cos\beta$

17. Ans: (a)

Sol: Deflecting torque, $T_d \propto \dfrac{\phi_P \phi_S \omega}{Z} \sin\beta\cos\alpha$

18. When secondary winding of current transformer is open circuited with primary winding still energized, the large flux greatly increases the

    (a) flux density in the core and pushes it towards saturation
    (b) power loss in the secondary winding
    (c) leakage flux manifolds
    (d) power loss in the primary winding

18. Ans: (a)

Sol: When sec. of CT gets opened while the primary is emergized, large amount of MMF is induced in the core and the core gets deeply saturated

19. The purpose of the start bit in digital voltmeter is to
    (a) hold the digital word in the display for a particular time
    (b) provide the display of the information that comes from the A/D conversion
    (c) give zero indication on the display during start of conversion
    (d) give information about polarity of the measured voltage given by the A/D converter

19. Ans: (c)

Sol:
    • In a DVM, a start bit (or start pulse) is meant to trigger analog to digital conversion process.
    • Another purspose is Auto-zeroing i.e., the initial phase of A to D cycle (as triggered by the start signal) involves grounding the input to auto-zero the circuit.

20. In general, the range of digital multimeter display is
    (a) –199 to +199   (b) –999 to +999
    (c) –9999 to +9999 (d) –1999 to +1999

20. Ans: (d)

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Sol: A $3\frac{1}{2}$ digit DMM (scale of 2000) can display up to 1999

21. Which one of the following code counters is used to remove the ambiguity during the change from one state of the counter to the next during the state transition?
    (a) Gray code counter   (b) BCD code counter
    (c) Excess-3 code counter (d) Binary code counter

21. Ans: (a)

Sol: Gray code counters are specially designed so that only one bit changes between consecutive states.

22. Which one of the following gates is most commonly used in the design of a bus system?
    (a) OR gate   (b) NOT gate
    (c) XOR gate   (d) Buffer gate

22. Ans: (d)

Sol: In the bus system, multiple devices share the same set of data lines to avoid the cross talk, the buffer (or) tri-state buffers (made of gates) are used.

23. Consider the following characteristics of CISC architecture:
    1. A large number of instructions
    2. A large variety of addressing modes
    3. Instructions that manipulate operands in memory.
    4. Fixed-length instruction formats
    Which of the above characteristics are correct?
    (a) 1 and 2 only   (b) 2, 3 and 4
    (c) 1, 2 and 4   (d) 1, 2 and 3

23. Ans: (d)

Sol: The statements 1, 2, & 3 are standard statements.

24. Match the following Lists related to the registers with their functions:

List-I (Register name)
P. Data Register(DR)
Q. Address Register (AR)
R. Accumulator (AC)
S. Instruction Register (IR)
T. Program Counter (PC)

List-II (Function)
1. Holds instruction code
2. Processor register
3. Holds address of instruction
4. Holds memory operand
5. Holds address for memory

Select the correct answer using the code given below.

Codes:

	P	Q	R	S	T
(a)	4	5	2	1	3
(b)	5	4	3	1	2
(c)	3	5	1	2	4
(d)	1	4	5	2	3

24. Ans: (a)

Sol: Program counter holds address of Next instruction
$T \rightarrow 3$
Instruction register holds currently fetched instruction code
$S \rightarrow 1$
Address Register holds Address for memory location
$Q \rightarrow 5$
Data Register holds memory operand
$P \rightarrow 4$
Accumulator is a processor Register
$R \rightarrow 2$

25. Which one of the following types of instructions is useful for initializing registers to assign a constant value?

    (a) Implied mode instructions
    (b) Direct mode instructions
    (c) Immediate mode instructions
    (d) Indirect mode instructions

25. Ans: (c)

Sol: Instruction used for initilizing Registers to assign a constant value is immediate mode instruction.

26. Which one of the following is not an operation performed by call subroutine instruction?

    (a) The address of the next instruction available in the program counter is stored in a temporary location, so the subroutine knows where to return.
    (b) Control is transferred to the beginning of the subroutine.
    (c) The instruction return from subroutine, transfers the return address from the temporary location into the program counter.
    (d) The address of the next instruction available in the program counter is stored in an accumulator and returns whenever it is required.

26. Ans: (d)

Sol: TA is target Address

NA is Next Address

RA is Return Address

Main Program — Sub Routine diagram: TA 0845H. Next Address Pulses (PC) = 1003H into stack Top and vectors to 0845H (i.e., counter transferred to begining of SR). 1000H: CALL 0845H. NA 1003H: Next instruction (RA). Pops Return Addres 1003H into program counter from stack Top. Ret. HLT.
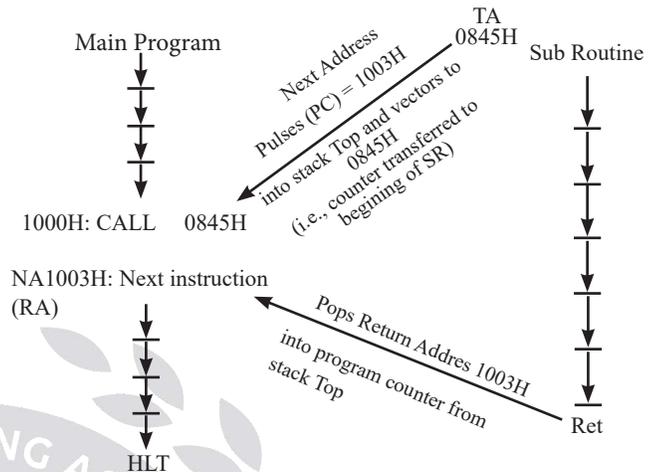
27. Which of the following lines/diagrams are used when the data transfer is between an interface and an I/O device?

    (a) Strobe lines   (b) Handshaking lines
    (c) Timing diagrams   (d) State diagrams

27. Ans: (a)

Sol: Strobe signals are used for the data transfer between an interface and I/O device

28. In which one of the following data transfer schemes, the CPU stays in a program loop until the 1/0 unit indicates that it is ready for data transfer while transferring data to and from peripherals?

    (a) Programmed I/O
    (b) Interrupt-initiated I/O
    (c) Direct memory access
    (d) Programmed interrupt I/0

28. Ans: (a)

Sol: In programmed IO, CPU stays in a loop until the I/O device indicates that it is ready.

29. Which one of the following methods is used to detect burst errors occurring in the communication channel?

(a) Cyclic redundancy check

(b) Bit stuffing

(c) Pulse code checking

(d) Bit spoofing

29. Ans: (a)

Sol: CRC is one of the most powerful error-detection techniques used in communication networks.

Bit stuffing $\rightarrow$ Prevents flag confusion in frames (not error detection)

Pulse code checking $\rightarrow$ Not a standard busrt-error method

Bit security attack term, not detection

30. In operating systems, which one of the following approaches is used to keep track of system activities such as the number of system calls made or the number of operations performed to a network device or disk?

(a) Counters   (b) Tracing

(c) Scheduling   (d) Pipelining

30. Ans: (a)

Sol: Operating systems use counters to maintain numeric statistics such as:

Number of system calls

Disk read/rite operations

Network packets processed

Interrupt counts

CPU usage events

Since the question specifically mentions "number of ..." it directly points to counters

Tracing $\rightarrow$ Records the sequence of events for debugging, no just totals.

Scheduling $\rightarrow$ Decides which process runs next.

Pipelining $\rightarrow$ CPU instruction execution technique.

31. For the network given below, what are the Norton's current and Thevenin's voltage at the terminals a and b?
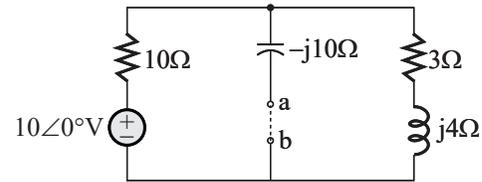
(a) $I_{ab} = \left[\dfrac{10\angle 0°}{10 + \dfrac{(-j10)(3-j4)}{3+j6}}\right]\left(\dfrac{3-j4}{3+j6}\right)A$ and

$V_{ab} = \dfrac{3-j4}{13+j4}(10\angle 0°)\,V$

(b) $I_{ab} = \left[\dfrac{10\angle 0°}{10 + \dfrac{(-j10)(3+j4)}{3+j6}}\right]\left(\dfrac{3-j4}{3+j6}\right)A$ and

$V_{ab} = \dfrac{3-j4}{13+j4}(10\angle 0°)\,V$

(c) $I_{ab} = \left[\dfrac{10\angle 0°}{10 + \dfrac{(-j10)(3-j4)}{3-j6}}\right]\left(\dfrac{3-j4}{3-j6}\right)A$ and

$V_{ab} = \dfrac{3+j4}{13-j14}(10\angle 0°)\,V$

(d) $I_{ab} = \left[\dfrac{10\angle 0°}{10 + \dfrac{(-j10)(3+j4)}{3-j6}}\right]\left(\dfrac{3+j4}{3-j6}\right)A$ and

$V_{ab} = \dfrac{3+j4}{13+j4}(10\angle 0°)\,V$

31. Ans: (d)

Sol: $I_{ab} = \dfrac{10\angle 0°}{10 + \{(-j10)//(3+j4)\}} \times \dfrac{3+j4}{(3+j4-j10)}$

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$$I_{ab} = \left[\frac{10\angle 0°}{10 + \dfrac{(-j10)(3+j4)}{(3-j6)}}\right] \times \frac{(3+j4)}{(3-j6)} \text{ A}$$

$$V_{ab} = 10\angle 0° \left[\frac{3+j4}{13+j4}\right] \text{ V}$$

32. Consider the following statements regarding power measurement by two-wattmeter method:

1. Two wattmeters connected in any two lines of a three-phase, three-wire system will correctly indicate the total three-phase power by the sum of the two meter readings.

2. A meter will attempt to go downscale if the phase angle between the voltage and current exceeds 180°

3. In practical case, the balanced load is usually known to be inductive ($\theta > 0°$).

Which of the above statements is/are correct?

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

(c) 2 and 3   (d) 2 only

32. Ans: (b)

33. What are the Z-parameters for the network given below?
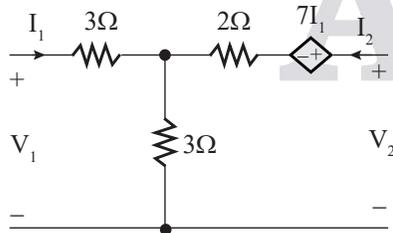
(a) $Z_{11} = 6$; $Z_{12} = 3$; $Z_{21} = 10$; $Z_{22} = 5$

(b) $Z_{11} = 5$; $Z_{12} = 10$; $Z_{21} = 3$; $Z_{22} = 6$

(c) $Z_{11} = 6$; $Z_{12} = 10$; $Z_{21} = 10$; $Z_{22} = 5$

(d) $Z_{11} = 6$; $Z_{12} = 3$; $Z_{21} = 3$; $Z_{22} = 5$

33. Ans: (a)

Sol: Step-1:

Z_{11} & $Z_{21} \rightarrow I_2 = 0$
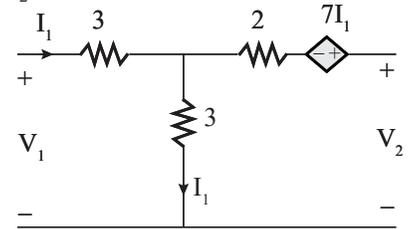
$V_1 = Z_{11}I_1 + Z_{12}I_2$

$V_2 = Z_{21}I_1 + Z_{22}I_2$

$V_1 = 6I_1 \rightarrow Z_{11} = 6\Omega$

KVL:

$+V_2 = 7I_1 + 3I_1 \rightarrow V_2 = 10I_1 \rightarrow Z_{21} = 10\Omega$

Step-2:

For Z_{22} & $Z_{12} \rightarrow I_1 = 0$
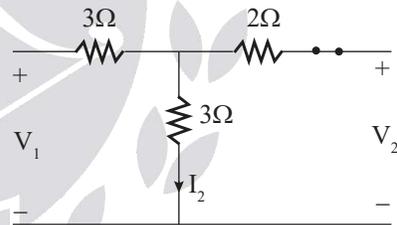
$V_2 = 5I_2 \rightarrow Z_{22} = 5\Omega$

$V_1 = 3I_2 \rightarrow Z_{12} = 3\Omega$

$$[Z] = \begin{bmatrix} 6 & 3 \\ 10 & 5 \end{bmatrix}$$

34. The simplified model of a bipolar junction transistor for small signals is shown in the figure below:
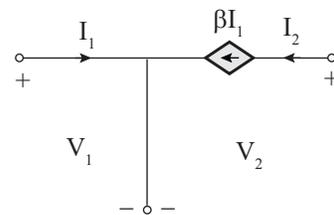
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What are the h-parameters?

(a) $h_{11} = h_{22} = h_{21} = 0$ and $h_{12} = \beta$

(b) $h_{22} = h_{12} = h_{21} = 0$ and $h_{11} = \beta$

(c) $h_{11} = h_{12} = h_{22} = 0$ and $h_{21} = \beta$

(d) $h_{11} = h_{12} = h_{21} = 0$ and $h_{22} = \beta$

34. Ans: (c)

Sol: $V_1 = h_{11}I_1 + h_{12}V_2$

$I_2 = h_{21}I_1 + h_{22}V_2$

For

h_{11} & $h_{21} \rightarrow V_2 = 0$
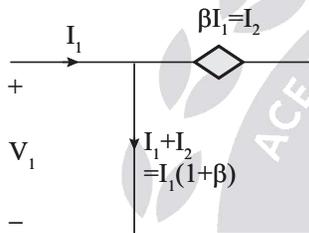
$V_1 = 0 \rightarrow h_{11} = 0$

$I_2 = \beta I_1 \rightarrow h_{21} = \beta$

For h_{22} & $h_{12} \rightarrow I_1 = 0$
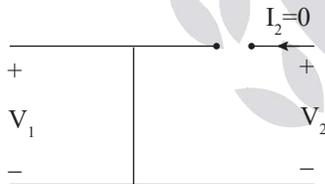
$I_2 = 0 \rightarrow h_{22} = 0$

$V_1 = 0 \rightarrow h_{12} = 0$

So, $[h] = \begin{bmatrix} 0 & 0 \\ \beta & 0 \end{bmatrix}$

35. Which one of the following statements is not correct regarding mutual inductance and transformers?

(a) When the assumed currents both enter or both leave a pair of coupled coils by the dotted terminals, the signs on the M-terms will be the same as the signs on the L-terms.

(b) When one current enters by a dotted terminal while the other leaves by a dotted terminal, the signs on the M-terms will be opposite to the signs on the L-terms.

(c) The term 'close coupling' is used to describe the case where most of the flux links the coils, either by way of a magnetic core to contain the flux or by interleaving the turns of the coils directly over one another. Coils placed side-by-side without a core are loosely coupled and have correspondingly high values of k.

(d) If all the flux links the coil without any leakage flux, then k = 1. On the other extreme, the coil axes may be oriented such that no flux from one can induce a voltage in the other, which results in k = 0.

35. Ans: (c)

Sol: a → correct

b → correct

c → wrong

d → correct

(Actually, 'k' should be Low]

36. Consider the following statements regarding factors affecting the capacitance:

1. The area of the plates is directly proportional to the charge; the larger the plate area, the more electric charges that can be stored.

2. The longer the distance between the two plates, the stronger the produced electric field that will increase the ability to store charges. Therefore, the distance between the two plates is directly proportional to the capacitance.

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3. Different insulating materials will have different impacts on capacitance. The dielectric constant is directly proportional to the capacitance.

Which of the above statements is/are correct?

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

(c) 1 and 3   (d) 3 only

36. Ans: (c)

Sol: $C = \dfrac{\varepsilon_0 \varepsilon_r A}{d}$

$\dfrac{q}{V} = \dfrac{\varepsilon_0 \varepsilon_r A}{d}$ $(\because q = CV)$

$1 \rightarrow$ correct $[q \propto A]$

$2 \rightarrow$ wrong $[C \propto \dfrac{1}{d}$

$3 \rightarrow$ correct $[C \propto \varepsilon_r]$

37. Which of the following is/are not discharging equation/equations for an R-C circuit?

1. Capacitor voltage $v_C = V_0 e^{\frac{-t}{RC}}$

2. Resistor voltage $v_R = E e^{\frac{-t}{RC}}$

3. Discharging current $i = \dfrac{V_0}{R} e^{\frac{-t}{RC}}$

Select the correct answer using the code given below.

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

(c) 1 and 3   (d) 1 only

37. Ans: (*)

Sol:

Source-free 1st order R-C circuit,

Since discharging concept is asked,

Let $V(0) = V_0 \rightarrow$ Initial condition

KCL:

$i_R + i_C = 0$

$\dfrac{V}{R} + C\dfrac{dV}{dt} = 0 \Rightarrow C\dfrac{dV}{dt} = -\dfrac{V}{R}$

$\int \dfrac{dV}{V} = -\int \dfrac{dt}{RC} \Rightarrow \ln[V] = \dfrac{-t}{RC} + \ln[A]$

$\ln\left[\dfrac{V}{A}\right] = -\dfrac{t}{RC} \Rightarrow V = Ae^{\frac{-t}{RC}}$

At $t = 0 \rightarrow V \Rightarrow V_0 = Ae^0 \Rightarrow A = V_0$

So, capacitor voltage $V(t) = V_C = V_0 e^{\frac{-t}{RC}}$

$i_c = C\dfrac{dV}{dt} = C\dfrac{d}{dt}\left\{V_0 e^{\frac{-t}{RC}}\right\}$

$= CV_0 e^{\frac{-t}{RC}} - \dfrac{1}{RC}$

$i_C = -\dfrac{V_0}{R} e^{\frac{-t}{RC}}$

But this become charging current as capacitor is initially taken as sink globally,

but discharging current

$i_C = +\dfrac{V_0}{R} e^{\frac{-t}{RC}}$ A

So, given

1. $V_C = V_0 e^{\frac{-t}{RC}} \rightarrow$ correct

2. $V_R = V_C = E e^{\frac{-t}{RC}} \rightarrow$ wrong

3. $i = \dfrac{V_0}{R} e^{\frac{-t}{RC}} \rightarrow$ correct

But he asked which are NOT discharging equations, only '2' is answer but No option matches

If print mistake '$-ve$' sign is considered then (2) & (3) are wrong, then option (b) is correct.

38. Match the following Lists regarding time constant with capacitor discharging voltage:

List-I	List-II
(Time constant)	**(Capacitor discharging voltage)**
P. 1τ	1. 0.67% of E
Q. 2τ	2. 36.8% of E
R. 3τ	3. 13.5% of E
S. 4τ	4. 5% of E
T. 5τ	5. 1.87% of E

Select the correct answer using the code given below.

Codes:

	P	Q	R	S	T
(a)	1	2	3	4	5
(b)	5	2	3	4	1
(c)	1	3	2	4	5
(d)	2	3	4	5	1

38. Ans: (d)

Sol: $V_c(t) = V_0 e^{-t/\tau} \rightarrow$ Discharging voltage

$V_c(t = 0) \rightarrow V_0 = V_0$

$V_c(t = \tau) \rightarrow e^{-1}V_0 = 0.367V_0$

$V_c(t = 2\tau) \rightarrow e^{-2}V_0 = 0.135V_0$

$V_c(t = 3\tau) \rightarrow e^{-3}V_0 = 0.049V_0$

$V_c(t = 4\tau) \rightarrow e^{-4}V_0 = 0.018V_0$

$V_c(t = 5\tau) \rightarrow e^{-5}V_0 = 0.006V_0$

(P) $\rightarrow 2$

(Q) $\rightarrow 3$

(R) $\rightarrow 4$

(S) $\rightarrow 5$

(T) $\rightarrow 1$

39. A single-range laboratory-type potentio-meter has an 18-step dial switch where each step represents 0.1 V. The dial resistors are 10 Ω each. The slide wire of the potentiometer is circular and has 11 turns and a resistance of 1Ω per turn. The slide wire has 100 divisions and interpolation can be done to one-fourth of a division. What is the measuring range of the potentiometer?

(a) 1.1 V   (b) 0.25 V
(c) 1.91 V   (d) 0.01 V

39. Ans: (c)

Sol: $V_{dial} = 18 \times 0.1 = 1.8$ V

$R_{wire} = 11 \times 1\Omega = 11\Omega$

$V_{wire} = V_{step} \times \dfrac{R_{wire}}{R_{step}}$

$= 0.1 \times \dfrac{11\Omega}{10\Omega} = 0.11$ V

$V_{total} = V_{dial} + V_{wire}$

$= 1.8 + 0.11 = 1.91$ V

40. Consider the following statements regarding Maxwell's bridge:

1. Maxwell's bridge is limited to measurement of low Q inductors.

2. The final balance equations of Maxwell's bridge are dependent of frequency.

3. The balance equation of Maxwell's bridge is dependent of losses associated with the inductor.

Which of the above statements is/are correct?

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

40. Ans: (c)

Sol: Maxwell's bridge is for measurement of quality factors Q < 10 [1 < Q < 10]

Balance equations are independent on frequency

41. Match the following Lists:

    List-I (Name of the bridge)

    P. Maxwell's Inductance bridge

    Q. Hay's bridge

    R. Anderson's bridge

    S. Owen's bridge

    List-II(Inductance equation)

    1. $L_1 = \dfrac{R_2 R_3 C_4}{1 + \omega^2 R_4^2 C_4^2}$

    2. $L_1 = C\dfrac{R_3}{R_4}(r(R_2 + R_4) + R_2 R_4]$

    3. $L_1 = L_2 \dfrac{R_3}{R_4}$

    4. $L_1 = R_2 R_3 C_4$

    Select the correct answer using the code given below.

    Codes:

	P	Q	R	S
(a)	3	1	2	4
(b)	4	1	3	2
(c)	3	2	4	1
(d)	3	2	1	4

41. Ans: (a)

Sol: Maxwell's Inductance bridge: $L_1 = \dfrac{L_2 R_3}{R_4}$

Hay's bridge: $L_1 = \dfrac{R_2 R_3 C_4}{1 + \omega^2 R_4^2 C_4^2}$

Anderson's bridge: $L_1 = C\dfrac{R_3}{R_4}[r(R_2 + R_4) + R_2 R_4]$

Owen's bridge: $L_1 = R_2 R_3 C_4$

42. The coil of a moving-coil voltmeter is 40 mm long and 30 mm wide, and has 100 turns on it. The control spring exerts a torque of 240×10^{-6} N-m when the deflection is 100 divisions on full scale.

If the flux density of the magnetic field in the air gap is $1 Wb/(m^2)$, what is the resistance that must be put in series with the coil to give one volt per division? (The resistance of the voltmeter coil may be neglected)

(a) 120×10^3 Ω

(b) 50×10^3 Ω

(c) 5×10^3 Ω

(d) 12×10^3 Ω

42. Ans: (b)

Sol: $T_d = BINA$

$= B\dfrac{V}{R}NA$

$R = \dfrac{1 \times 100 \times 100 \times 40 \times 30 \times 10^{-6}}{240 \times 10^{-6}} = 50\,k\Omega$

43. Consider the following statements regarding moving-iron instruments:

    1. Moving-iron instruments have their deflection proportional to the square of the current flowing through the coil.

    2. Moving-iron instruments have uniform scale marking.

    3. Whatever be the polarity of the current in the coil, the deflection of a moving-iron instrument is in the same direction.

    Which of the above statements is/are correct?

    (a) 2 and 3

    (b) 2 only

    (c) 1 only

    (d) 1 and 3

43. Ans: (d)

Sol: In MI instruments $T_d \propto I_2$

$\Rightarrow$ Scale is non uniform,

$\Rightarrow$ Deflection does not get varied when polarity is changed.

44. What is the equation for deflection of the pointer in an electrodynamometer-type instrument when it is operated with AC?

(a) $\theta = \dfrac{I_1 I_2}{k} \cos\phi \dfrac{dM}{d\theta}$

(b) $\theta = \dfrac{I^2}{k} \dfrac{dM}{d\theta} \displaystyle\int_0^T i^2 \, dt$

(c) $\theta = \dfrac{I_1 I_2}{k} \dfrac{dM}{d\theta}$

(d) $\theta = \dfrac{1}{k} \dfrac{dM}{d\theta} \dfrac{1}{T} \displaystyle\int_0^T i^2 \, dt$

44. Ans: (a)

Sol: In electgrodynamometer type instrument,

$$\theta = \dfrac{I_1 I_2}{k} \cos\phi \dfrac{dM}{d\theta}$$

45. Consider the following statements regarding induction-type instruments:

1. If $\alpha = 0$, i.e., if two fluxes are in phase, then the net torque is maximum. If, on the other hand, $\alpha = 90°$, the net torque is maximum for given values of ϕ_{1m} and ϕ_{2m}.
2. The net torque is in such a direction as to rotate the disc from the pole with lagging flux towards the pole with leading flux.
3. The expression for torque has a steady value at all times.

Which of the above statements is/are correct?

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

(c) 1 only   (d) 1 and 3

45. Ans: (b)

Sol: If $\alpha = 0$, net torque is minimum

46. What is the drift velocity of electrons knowing that in metals, the free electron concentration is about $n_0 = 10^{28}$ electrons/m³? (Take maximum admitted value of the density of electric current for metals as $J = 10^7$ A/m² and electrical charge of the electron as $q_0 = 1.602 \times 10^{-19}$ C)

(a) 1.6×10^{-3} m/s   (b) 6.24×10^{-22} m/s

(c) 1.6×10^{-22} m/s   (d) 6.24×10^{-3} m/s

46. Ans: (d)

Sol: Given data,

$n_0 = 10^{28}$ electrons/m³

$J = 10^7$ A/m²

$q_0 = 1.602 \times 10^{-19}$ C

$J = n_0 q_0 V_d$

$$V_d = \dfrac{J}{n_0 q_0} = \dfrac{10^7}{n_0 q_0} = \dfrac{10^7}{10^{28} \times 1.602 \times 10^{-19}}$$

$$= 6.24 \times 10^{-3} \text{ m/s}$$

47. Which one of the following is generated by the supplementary (precession) movements of the conduction electrons that appear when the material is introduced in a magnetic field?

(a) Langevin diamagnetism

(b) Landau diamagnetism

(c) Lorentz diamagnetism

(d) Larmor diamagnetism

47. Ans: (d)

Sol: Larmor diamagnetism is the diamagnetism shown by materials due to the change in orbital motion of electrons when an external magnetic field is applied.

48. The cermet of Au/SiO is obtained by

(a) the deposition on glass support and consists in conductive particles of gold speeded in amorphous matrix of SiO_2

(b) transforming the silicon monoxide at the deposition in a reactive component (Si) and in an insulating one (SiO_2)

(c) the mixture of α-Cr, Cr_3Si and SiO_2 amorphous

(d) the expansion of both non-conductive and conductive zones of a reactive component (Si)

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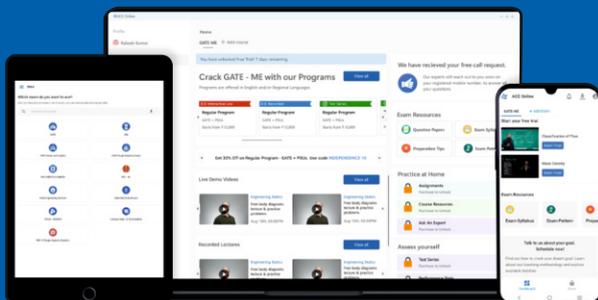
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48. Ans: (a)

Sol: The cermet of Au/SiO is obtained by the deposition on glass support and consists in conductive particles of gold speeded in amorphous matrix of SiO_2

49. Match the following Lists:

List-I (Class of the material)

P. A

Q. E

R. H

S. Y

List-II (Limiting working temperature)

1. 120 °C

2. 180 °C

3. 90 °C

4. 105 °C

Select the correct answer using the code given below

Codes:

	P	Q	R	S
(a)	3	2	4	1
(b)	4	1	3	2
(c)	3	1	2	4
(d)	4	1	2	3

49. Ans: (d)

Sol:

Class of Insulating material	Max. working Temp
A	105 °C
E	120 °C
H	180 °C
Y	90 °C

50. A transformer core is wound with a coil carrying an alternating current at a frequency of 50 Hz. The hysteresis loop has an area of 70000 units, when the axes are drawn in units of 10^{-4} Wb-m^{-2} and 10^2 A-m^{-1}. What is the hysteresis loss by assuming the magnetization to be uniform throughout the core volume of 0.02 m^3?

(a) 350 W   (b) 700 W

(c) 3500 W   (d) 7000 W

50. Ans: (b)

Sol: Given data

f = 50 Hz; Area of loop = 70000 Units

Area units = 10^{-4} Wb/m^2 & 10^2 A/m

Total area = $7 \times 10^{-4} \times 10^2$

$= 7 \times 10^2$ N/m^3

Volume = 0.02 m^3

Hysteresis loss = $7 \times 10^2 \times 0.02 \times 50 = 700$ W

51. L is measured value of inductance with magnetic core, L_0 is measured value of inductance without magnetic core, μ_0 is magnetic permeability of free space, h is height of the material under test, c is outer diameter of the material under test, d is inner diameter of the material under test. What is the formula for relative magnetic permeability (μ_r)?

(a) $\mu_r = \dfrac{\mu_0}{2\pi} \dfrac{L - L_0}{h \ln\left(\dfrac{c}{d}\right)}$

(b) $\mu_r = \dfrac{L - L_0}{\mu_0} \dfrac{2\pi}{h \ln\left(\dfrac{c}{d}\right)}$

(c) $\mu_r = \dfrac{\mu_0}{2\pi} \dfrac{L - L_0}{h \ln\left(\dfrac{d}{c}\right)}$

(d) $\mu_r = \dfrac{L - L_0}{\mu_0} \dfrac{2\pi}{h \ln\left(\dfrac{d}{c}\right)}$

51.   Ans: (b)

Sol: The relative magnetic permeability

$$\mu_r = \frac{L - L_0}{\mu_0} \cdot \frac{2\pi}{h \ln\left(\frac{c}{d}\right)}$$

L = Inductance
L_0 = Inductance without magnetic core
h = height of material
c = outer diameter of material
d = inner diameter of material

52.   Consider the following statements regarding ferrites:

1.   Ferrites are linear materials and present hysteresis cycle.
2.   The values of saturation induction and remanent induction are lower.
3.   Magnetic permeability is lower and more sensitive at the action of external magnetic fields.

Which of the above statements is/are correct?
(a) 1 and 2   (b) 2 only
(c) 3 only   (d) 2 and 3

52.   Ans: (b)

Sol: Ferrites:

1.   Ferrites are non-linear materials and present hysteresis loss
2.   Saturation induction and remanent induction are lower in compare with ferromagntetic material
3.   Magnetic permeability is high and less sensitive to external magnetic field

53.   What is the conductivity of copper at 300 K, if the collision time 't' for electron scattering is 2×10^{-14} s at this temperature? (Take the number of free electrons per m^3 of copper as 8.5×10^{28} electron charge as 1.602×10^{-19} C and mass of free electron as 9.1×10^{-31} kg)
(a) 4.8×10^7 ohm^{-1}-m^{-1} (b) 6×10^{-11} ohm^{-1}-m^{-1}
(c) 4.8×10^{-17} ohm^{-1}-m^{-1} (d) 6×10^7 ohm^{-1}-m^{-1}

53.   Ans: (a)

Sol: Given data: t = 2×10^{-14} s
n = 8.5×10^{28} electrons/m^3
e = 1.602×10^{-19} C
m = 9.1×10^{-31} kg

$$\sigma = \frac{ne^2 t}{m} = \frac{8.5 \times 10^{28} \times (1.6 \times 10^{-19})^2 \times 2 \times 10^{-14}}{9.1 \times 10^{-31}}$$

$$= 4.8 \times 10^7 \ (\Omega m)^{-1}$$

54.   Match the following Lists:

List-I (Material)	List-II (Density)
P. Silver	1. 2.70×10^3 kg-m^{-3}
Q. Copper	2. 8.96×10^3 kg-m^{-3}
R. Gold	3. 10.49×10^3 kg-m^{-3}
S. Aluminium	4. 19.32×10^3 kg-m^{-3}

Select the correct answer using the code given below:

Codes:

	P	Q	R	S
(a)	3	2	1	4
(b)	4	1	3	2
(c)	3	2	4	1
(d)	4	1	2	3

54.   Ans: (c)

Sol:

Material	Density (kg/m³)
Silver	10.49×10^3
Copper	8.96×10^3
Gold	19.32×10^3
Aluminium	2.7×10^3

55. The resistivity of pure copper at room temperature is 1.8×10^{-8} Ω-m . The resistivity of Cu-4% Ni alloy at room temperature is 7.0×10^{-8} Ω-m. What is the resistivity due to impurity scattering by 1% of nickel in the copper lattice?

    (a) 2.2×10^{-8} Ω-m   (b) 6.5×10^{-8} Ω-m

    (c) 0.2×10^{-8} Ω-m   (d) 1.3×10^{-8} Ω-m

55. Ans: (d)

Sol: Given data,

$\rho_{\text{pure copper}} = 1.8 \times 10^{-8}$ Ω-m

$\rho_{\text{Cu +4\% Ni}} = 7.0 \times 10^{-8}$ Ω-m

$\rho_{\text{Total}} = \rho_{\text{pure}} + \rho_{\text{impure}}$

$\rho_{\text{impure}} = \rho_{\text{Total}} - \rho_{\text{pure}}$

$\quad\quad = 7 \times 10^{-8} - 1.8 \times 10^{-8}$

$\quad\quad = 5.2 \times 10^{-8}$ Ω-m

$\rho_{1\%Ni} = \dfrac{5.2 \times 10^{-8}}{4} = 1.3 \times 10^{-8}$ Ω-m

56. What is the power supplied by each element in the circuit shown below?
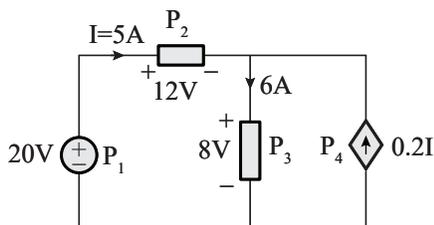
(a) $P_1 = -100W$; $P_2 = 60W$; $P_3 = -48W$; $P_4 = -8W$

(b) $P_1 = 100W$; $P_2 = -60W$; $P_3 = -48W$; $P_4 = 8W$

(c) $P_1 = -100W$; $P_2 = -60W$; $P_3 = 48W$; $P_4 = -8W$

(d) $P_1 = -100W$; $P_2 = 60W$; $P_3 = 48W$; $P_4 = -8W$

56. Ans: (b)

Sol:
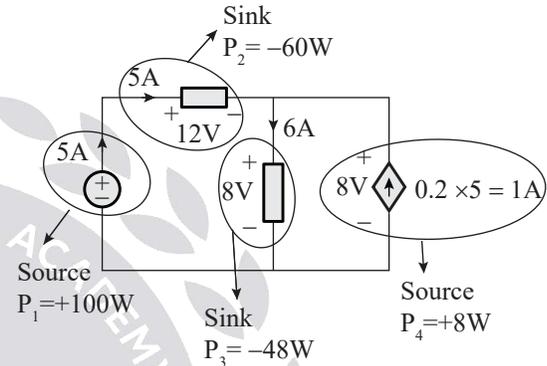
57. What are V_0 and i respectively in the circuit shown below?
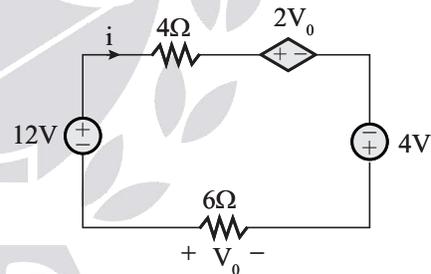
(a) $+48$ V, -8 A   (b) $+24$ V, -4 A

(c) -48 V, $+8$ A   (d) -24 V, $+4$ A

57. Ans: (a)

Sol:

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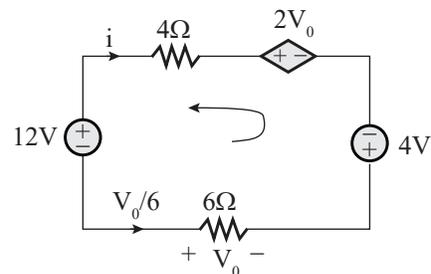
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KVL:

$$+V_0 + 4 - 2V_0 + \frac{V_0}{6}[4] + 12 = 0$$

$$V_0\left[-1 + \frac{2}{3}\right] = -16$$

$$V_0\left[-\frac{1}{3}\right] = -16 \Rightarrow V_0 = 48 \text{ V}$$

But $i = -\dfrac{V_0}{6} = \dfrac{-48}{6} = -8\text{A}$

58. The electron beam in a TV picture tube carries 10^{15} electrons per second. What is the voltage V_0 needed to accelerate the electron beam to achieve 4 W?
(a) 10 kV
(b) 15 kV
(c) 30 kV
(d) 25 kV

58. Ans: (d)

Sol: $I = ne$

$= 10^{15} \times 1.602 \times 10^{-19}$

$= 1.602 \times 10^{-4} \text{ A}$

$V = \dfrac{P}{I} = \dfrac{4}{1.602 \times 10^{-4}} = 25 \text{ kV}$

59. Consider the following statements regarding network theorems:
   1. With independent sources, superposition theorem can be used only when the control functions are external to the network containing the sources, so that the controls are unchanged as the sources act one at a time.
   2. A linear, active, resistive network, which contains one or more voltage or current sources, can be replaced by a single voltage source and a series resistance or by a single current source and a parallel resistance. The voltage is called the Thévenin equivalent voltage and the current is Norton current.

3. The two resistances are the same in both Thévenin's and Norton's theorems which are obtained by deactivating all the sources.
   Which of the above statements is/are correct?
   (a) 1 only
   (b) 2 only
   (c) 1 and 2
   (d) 2 and 3

59. Ans: (d)

Sol: $1 \rightarrow$ wrong

$2 \rightarrow$ Correct

$3 \rightarrow$ Correct

60. A 10-ohm resistor has a current of $i = 2.5\sin\omega t$ (A). What are the values of voltage and power respectively over one cycle of $\omega = 500$ rad/s?
   (a) $25\sin\omega t$(V); $62.5\sin^2 \omega t$(W)
   (b) $250\sin\omega t$(V); $625\sin^2 \omega t$(W)
   (c) $2.5\sin\omega t$(V); $62.5\sin^2 \omega t$(W)
   (d) $25\sin\omega t$(V); $625\sin^2 \omega t$(W)

60. Ans: (a)

Sol: $V = iR = [2.5\sin\omega t][10] = 25\sin\omega t$

$P = V.i = [25\sin\omega t][2.5\sin\omega t]$

$= 62.5\sin^2\omega t$

61. A box contains 10 screws, three of which are defective. If two screws are drawn at random without replacement, then what is the probability that neither of the two screws is defective?
   (a) 49/100
   (b) 14/30
   (c) 9/10
   (d) 2/3

61. Ans: (b)

Sol:

7 G	3 D

$= 10$

P(none is defective) = $\dfrac{7_{C_2}}{10_{C_2}} = \dfrac{7 \times 6}{10 \times 9} = \dfrac{42}{90} = \dfrac{14}{30}$

62. If the random variable X, which is the sum of the two numbers of two fair dice turned up, is discrete, then what is the probability of sum of at least 4 and at most 8?

    (a) 26/36   (b) 1/6

    (c) 23/36   (d) 1/12

62. Ans: (c)

Sol: X = {2, 3, 4 ..... 12}

$P(4 \le X \le 8) = \dfrac{3 + 4 + 5 + 6 + 5}{36} = \dfrac{23}{36}$

63. A bag contains 7 green and 5 yellow balls. Two balls are selected at random, one at a time. What is the probability that the two balls are of different colours, if the selection is made with replacement?

    (a) 5/12   (b) 37/72

    (c) 5/72   (d) 35/72

63. Ans: (d)

Sol: Required probability

$= \dfrac{7}{12} \times \dfrac{5}{12} + \dfrac{5}{12} \times \dfrac{7}{12} = \dfrac{70}{144} = \dfrac{35}{72}$

64. If the events A and B are such that P(A) = 0.6, P(B) = 0.2 and P(A∪B) = 0.7, then P(B|A) is

    (a) 1/4   (b) 1/6

    (c) 2/3   (d) 1/7

64. Ans: (b)

Sol: P(A∩B) = P(A) + P(B) −P(A∪B)

         = 0.6 + 0.2 − 0.7

         = 0.1

$P\left(\dfrac{B}{A}\right) = \dfrac{P(A \cap B)}{P(A)} = \dfrac{0.1}{0.6} = \dfrac{1}{6}$

65. If X ~ Binomial $(16, \frac{1}{2})$, then what is the variance of the random variable?

    (a) 8   (b) 4

    (c) 2   (d) 6

65. Ans: (b)

Sol: n = 16; p = $\dfrac{1}{2}$; q = $\dfrac{1}{2}$

Variance = npq = $16 \times \dfrac{1}{4} = 4$

66. If X ~ N(15, 6.25), then what is the value of X, which is 1.2 standard deviations below the mean?

    (a) 12   (b) 15

    (c) 16   (d) 14

66. Ans: (a)

Sol: Given

$\mu = 15$; $\sigma^2 = 6.25$

$\sigma = \sqrt{6.25} = 2.5$

1.2 standard deviation below mean = $\mu - (1.2)\sigma$

           = 15 −(1.2)(2.5)

           = 15 − 3 = 12

X = 12

67. If the height h in meteres of a swing above the ground at time t seconds is given by h = 2−1.5sint for 0 < t < 3, then the maximum height of the swing is

    (a) 4 m   (b) 1.79 m

    (c) 2 m   (d) 6 m

67. Ans: (c)

Sol: f(x) 2 −1.5sinx

f'(x) = −1.5cosx = 0

$x = \dfrac{\pi}{2} = 1.5$

f(0) = 2 −1.5(sin(0) = 2

f(1.5) = 2 − (1.5)sin(2) = 2 −1.3639 = 0.6360

f(3) = 2 −(1.5)sin(3) = 2 −0.2116 = 1.7883

∴ Maximum is f(0) = 2

68. Consider the following statements regarding rank in terms of column vectors:

1. The rank r of a matrix A equals the maximum number of linearly independent column vectors of A.

2. The matrix A and its transpose A^T have the same rank.

3. Consider p vectors each having n components; if n < p, then these vectors are linearly independent.

Which of the above statements is/are not correct?

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

(c) 2 and 3   (d) 3 only

68. Ans: (d)

Sol: 1. $\rho(A)$ = maximum number of linear independent

2. $\rho(A) = \rho(A^T)$

3. $A = [x_1 \; x_2 \; .... \; x_P]_{n \times P} \to \rho(A_{np}) \le \min\{n, p\}$

         n < ρ

69. The eigenvector X_i of the n×n matrix A, corresponding to the eigenvalues λ= $λ_i$ is a solution of the homogeneous equation, if

(a) $(A - λ_i I)X_i = 0$ (b) $A - λ_i I = 0$

(c) $(A + λ_i I) X_i = 1$ (d) $A - λ_i I = 1$

69. Ans: (a)

Sol: $(A - λI)X = 0 \quad X \ne 0$

(or)

AX = λX

70. What is the value of the Fourier coefficient a_0 for the function given below?

$$f(x) = \begin{cases} \sin 2x, & -\pi < x < \dfrac{-\pi}{2} \\ 0, & \dfrac{-\pi}{2} \le x \le 0 \\ \sin n2x, & 0 < x \le \pi \end{cases}$$

(a) $\dfrac{1}{(2\pi)}$ (b) $\dfrac{1}{\pi}$

(c) $\dfrac{3}{(4\pi)}$ (d) $\dfrac{2}{\pi}$

70. Ans: (b)

Sol: Given $f(x) = \begin{cases} \sin(2x), & -\pi < x < \dfrac{-\pi}{2} \\ 0, & \dfrac{\pi}{2} \le x \le 0 \\ \sin(2x), & 0 < x \le \pi \end{cases}$

$$a_0 = \frac{1}{\ell} \int_{c}^{c+2\ell} f(x)\,dx = \frac{1}{\pi} \int_{-\pi}^{\pi} f(x)\,dx$$

$$= \frac{1}{\pi}\left[\int_{-\pi}^{-\pi/2} \sin(2x)\,dx + \int_{-\pi/2}^{0} 0\,dx + \int_{0}^{\pi} \sin(2x)\,dx \right]$$

$$= \frac{1}{\pi}\left[\left\{\frac{-\cos(2x)}{2}\right\}_{-\pi}^{-\pi/2} + \left\{\frac{-\cos(2x)}{2}\right\}_{0}^{\pi} \right]$$

$$= \frac{1}{\pi}\left[\left\{\frac{1}{2}(1-(-1)\right\} + \left\{\frac{1}{2}[1-1]\right\} \right] = \frac{1}{\pi}$$

71. The straight line **r**(t) = a**ti**+bt**j**+ ct**k**+**C**, with a, b and c as scalar constants and C as a constant vector, has
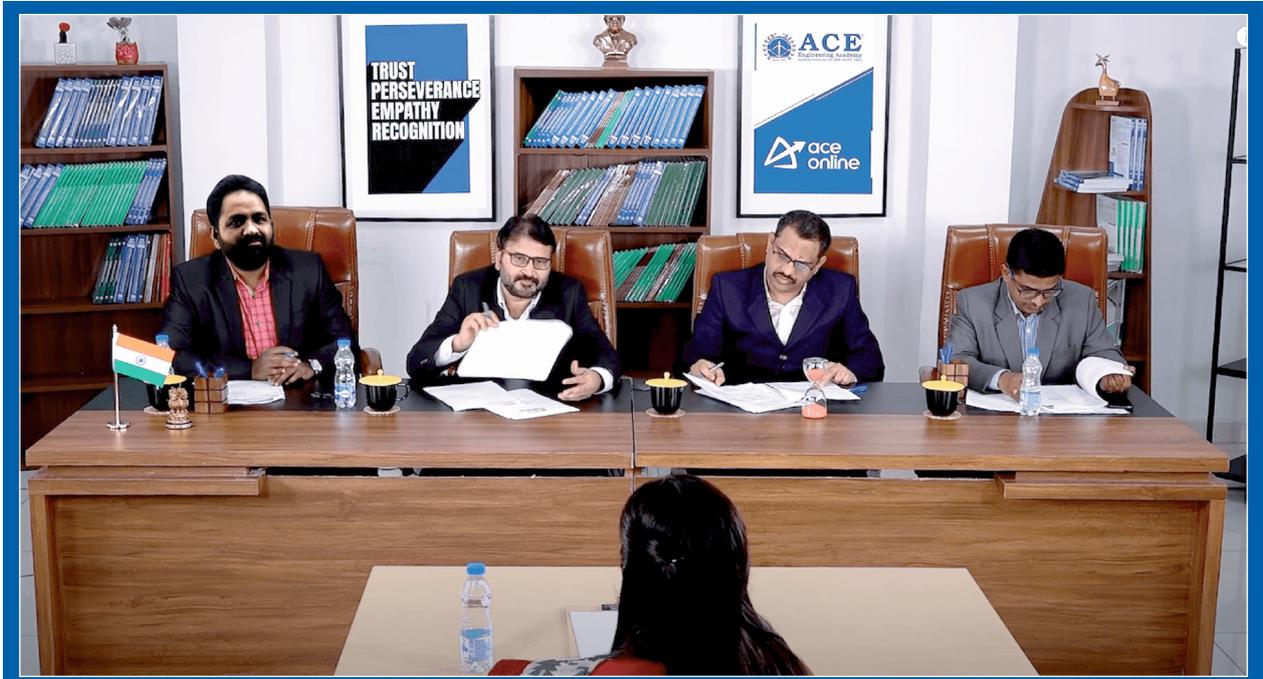
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(a) a finite radius of curvature at every point

(b) zero radius of curvature at every point

(c) an infinite radius of curvature at every point

(d) an infinite radius of curvature at a single point

71. Ans: (c)

Sol: Curvature measures how sharply a curve bends. A straight line does not bend at all, so its curvature is 0. Radius of curvature is the radius of a circle that fits the curve at a point. To fit a perfectly flat line we need a circle with an infinite radius.

72. Consider the following statements regarding properties of eigenvalues:

1. Any square matrix A and its transpose A^T have the same eigenvalues.

2. The eigenvalues of a triangular matrix are just the diagonal elements of the matrix.

3. The sum of the eigenvalues of a matrix is the product of the elements of the principal diagonal.

Which of the above statements are correct?

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

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

72. Ans: (d)

Sol: 1. A & A^T → λ correct

2. D → correct

3. $\lambda_1 + \lambda_2 + ... \lambda_n \neq a_{11}. a_{22}. a_{33} .... a_{nn}$

73. Let r be the rank for the coefficient matrix A of the system of homogeneous linear equations having m number of equations and n number of variables.

1. If r < n, then the equations have (n-r) linearly independent solutions.

2. If m < n, the number of solutions is finite.

3. If m = n, then such solution is non-trivial solution.

Which of the above statements is/are not correct?

(a) 1 and 2   (b) 2 only

(c) 1 only   (d) 2 and 3

73. Ans: (d)

Sol: $\rho(A_{m \times n}) = r \rightarrow AX = 0$

74. Consider the following statements regarding atomic bonds:

1. If two ions with same ionization potential form a bond, then this bond will most probably be ionic.

2. With the increase in the difference of the ionization potentials, the bond will be more and more ionic.

3. If the atom or molecule has completely filled outer shell, then the bonding between the atoms or molecules will be a primary bond at the time of solidification.

Which of the above statements is/are correct?

(a) 1 and 2   (b) 2 only

(c) 3 only   (d) 2 and 3

74. Ans: (b)

Sol: 1. If two ions with same ionization potential form a covalent bond.

2. The ionic bonds are formed between two ions of different ionization potential.

3. If the atoms or molecules has completely filled outer shell, then the bonding between the atoms or molecules will be weaker inter molecules bonds or secondary bonds.

75. Match the following Lists:

List-I (Metal)   List-II (Resistivity)
P. Li   1. 4.34×10^{-8} Ω-m
Q. Na   2. 1.56×10^{-8} Ω-m
R. Cu   3. 8.33×10^{-8} Ω-m
S. Ag   4. 1.47×10^{-8} Ω-m

Select the correct answer using the code given below.

Codes:

	P	Q	R	S
(a)	3	2	4	1
(b)	3	1	4	2
(c)	3	1	2	4
(d)	3	2	1	4

75. Ans: (c)

Sol:

Metal	Resistivity (Ω-m)
Li	8.33×10^{-8}
Na	4.34×10^{-8}
Cu	1.56×10^{-8}
Ag	1.47×10^{-8}

76. Consider the following statements with respect to the change in torque angle whenever a disturbance occurs:

1. There is no change in torque angle when the speed of the rotor is the synchronous speed.

2. The angle decreases in case of a motor, if $P_s > P_e$, i.e., the mechanical output is more than the electrical input and the speed goes down.

3. The angle increases, if the speed is more than the synchronous speed.

Which of the above statements is/are correct?

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

76. Ans: (d)

Sol: 1. $\frac{d\delta}{dt} = \omega - \omega_s$; when $\omega = \omega_s$ then $\frac{d\delta}{dt} = 0 \Rightarrow \delta$ is constant

∴ Statement-1 is correct

2. For motor, $\frac{d\delta}{dt} = \omega_s - \omega$ and $\frac{d\omega}{dt} = P_0 - P_s$

when $P_s > P_e \Rightarrow \frac{d\omega}{dt}$ decreases

∴ ω decreases

∴ $\omega < \omega_s$

$\frac{d\delta}{dt} = +ve \Rightarrow \delta$ increases

Statement-2 is incorrect

3. For generator $\frac{d\delta}{dt} = \omega - \omega_s \Rightarrow$ when $\omega > \omega_s$

$\Rightarrow \frac{d\delta}{dt} = +ve$

$\Rightarrow \delta$ increases

Statement-3 is correct

77. Which one of the following is not a feature of ideal control system for an HVDC converter?

(a) Control should be such that it should require less reactive power.

(b) The DC current is constant, i.e., ripple-free.

(c) Under steady-state conditions, the valve must be fired symmetrically.

(d) There should have continuous operating range from rectification to full inversion.

77. Ans: (d)

Sol: HVDC converters will always produce a ripple current

78. Consider the following statements regarding Static Synchronous Compensator (STATCOM):

    1. It is insensitive to transmission system harmonics.
    2. It has difficulty in operating with a very weak AC system.
    3. It can be used for small amount of energy storage.

    Which of the above statements is/are correct?

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

78. Ans: (b)

Sol: 1. STATCOM is sensitive to harmonics ($\times$)
    2. STATECOM will work effectively on weak AC systems ($\times$)
    3. STATCOM can be s used for small amount of energy ($\checkmark$)

79. A diode circuit consists of a diode in series with switch (S_1) resistance ($R = 44\Omega$) and capacitance ($C = 0.1\mu F$). The capacitor has an initial voltage $V_{CO} = V_C (t = 0) = 220$ V. If switch S_1 is closed at $t = 0$, what is the energy dissipated in the resistor R?

    (a) 3.86 mJ   (b) 5 mJ
    (c) 139.64mJ   (d) 2.42 mJ

79. Ans: (d)

Sol:
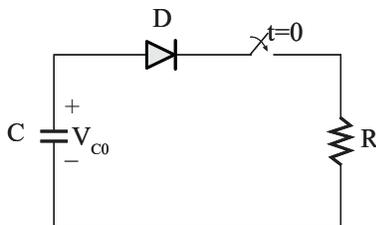
Energy dissipated in R = $\frac{1}{2}CV_{C0}^2$

$$= \frac{1}{2} \times 0.1 \times 10^{-6} \times (220)^2 = 2.42 \text{ mJ}$$

80. Which of the following is not a limitation of MOSFET?

    (a) High on-state drop, as high as 10 V
    (b) Unipolar voltage device
    (c) Slower switching speed
    (d) Lower off-state voltage capability

80. Ans: (c)

Sol: MOSFET has high switching speed

81. Two BJTs are connected in parallel to share the total current 25 A. The collector-to-emitter voltage of T_1 and T_2 are 1.5 V and 1.75 V respectively. What is the difference in emitter current sharing by the two transistors, when the current-sharing series resistances are $R_{E1} = 0.25$ Ω and $R_{E2} = 0.35$ Ω ?

    (a) 0.5 A   (b) 5 A
    (c) 0.25 A   (d) 2.5 A

81. Ans: (b)

Sol:
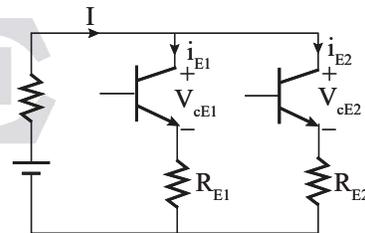
I = 25

$25 = I_{E1} + I_{E2}$ .... (1)

Voltage across parallel branches is same

$V_{CE1} + i_{E1} R_{E1} = V_{CE2} + I_{E2} R_{E2}$

$1.5 + I_{E1} \times 0.25 = 1.75 + I_{E2} \times 0.35$

$-0.25 = -0.25 I_{E1} + 0.35 I_{E2}$ .... (2)

Solving eqn. (1) and (2)

$I_{E1} = 15$ A, $I_{E2} = 10$ A

$\therefore \Delta I_E = I_{E1} - I_{E2} = 5$ A

82. The typical upper ratings of power transistor (MOSFET) are
(a) 600 V/40 A
(b) 800 V/40 A
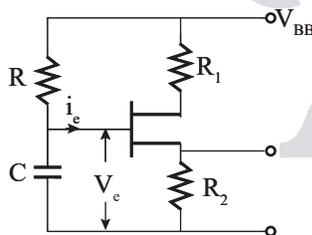(c) 1000 V/50 A
(d) 1200 V/50 A

82. Ans: (a)

Sol: Power MOSFET has voltage rating upto 600 V and current rating approx. 40 A

83. The firing frequency of relaxation oscillator is varied by changing the value of charging resistance R. What are the maximum and minimum values of R? (Assume $\eta = 0.65$, $I_P = 0.65$ mA, $V_P = 12$ V, $I_v = 2$ mA, $V_v = 1.5$ V, $V_{BB} = 20$ V and $C = 0.047 \mu F$)
(a) $R_{min} = 9.25$ kΩ and $R_{max} = 12.3076$ kΩ
(b) $R_{min} = 835$ Ω and $R_{max} = 4.5$ kΩ
(c) $R_{min} = 425$ Ω and $R_{max} = 18.2469$ kΩ
(d) $R_{min} = 11.86$ kΩ and $R_{max} = 19.2751$ kΩ

83. Ans: (a)

Sol:

$R_{max} = \dfrac{V_{BB} - V_P}{I_P} = \dfrac{20 - 12}{0.65 \times 10^{-3}} = 12.3076$ kΩ

$R_{min} = \dfrac{V_{BB} - V_V}{I_V} = \dfrac{20 - 1.5}{2 \times 10^{-3}} = 9.25$ kΩ

84. The capacitance (C_{J2}) value of reverse-biased junction J2 of a thyristor is independent of off-state voltage. The limit value of the charging current to turn the thyristor is about 15 mA. If the critical value of $\dfrac{dv}{dt}$ is 750 V /μs, what is the value of the junction capacitance (C_{J2})?
(a) 200 pF
(b) 200 μF
(c) 50 pF
(d) 50 μF

84. Ans: (c)

Sol: $i = C_j \left(Max. \dfrac{dV}{dt} \right)$

$15 \times 10^{-3} = C_j \left(\dfrac{750}{10^{-6}} \right) \Rightarrow C_{jmin} = 20$ pF

Suitable option is (c)

85. A single-phase, half-wave controlled rectifier with R load is supplied from a 230 V, 50 Hz AC source. When the average DC output voltage is 50% of maximum possible average DC output voltage, what are the firing angle of thyristor and average DC output voltage respectively?
(a) 45° and 37.32 V
(b) 90° and 36.61 V
(c) 90° and 51.78 V
(d) 45° and 26.39 V

85. Ans: (c)

Sol: $V_{0\,avg} = 0.5 \times [Max. V_{0avg}]$

$\dfrac{V_m}{2\pi}[1 + \cos\alpha] = 0.5 \times \dfrac{V_m}{\pi}$

$\therefore \alpha = 90°$

$V_{0avg} = \dfrac{V_m}{2\pi}[1 + \cos\alpha]$

$\qquad = \dfrac{230\sqrt{2}}{2\pi}\left[1 + \cos(90°)\right]$

$V_{0avg} = 51.75$ V

86. A single-phase semi-converter is supplied by 200 V, 50 Hz and it is connected with an R-L-E load, where R = 15 Ω, E = 80 V and L is very large so that the load current is ripple-free. What is the average output current at α = 90°?

    (a) 5.58 A   (b) 3.95 A

    (c) 0.66 A   (d) 0.24 A

86. Ans: (c)

Sol: $V_{0avg} = \dfrac{V_m}{\pi}[1 + \cos\alpha]$

$= \dfrac{200\sqrt{2}}{\pi}[1 + \cos(90°)]$

$V_{0\,avg} = 90$ V

$\dot{r}_{0avg} = \dfrac{V_{oavg} - E}{R} = \dfrac{90 - 80}{15} = \dfrac{10}{15}$

$= 0.66$ A

87. A step-down chopper has a load resistance of 20 Ω and input DC voltage is 200 V. When the chopper switch is 'on', the voltage across semiconductor switch is 2 V. If the chopping frequency is 1.5 kHz and duty ratio is 40%, what is the average DC output voltage?

    (a) 40 V   (b) 80 V

    (c) 39.6 V   (d) 174.4 V

87. Ans: (b)

Sol: $V_{0avg} = (V_S - V_{sw}) \times D$

$= (200 - 2) \times 0.4$

$= 79.2$ V

≈ 80 V

88. What is the expression for distortion factor (DF) in inverters?

    (a) $DF = \dfrac{\left[\sum\limits_{n=2,3,4,5,...}^{\infty}\left(\dfrac{V_n}{n^2}\right)^2\right]^{\frac{1}{2}}}{V_1}$

    (b) $DF = \dfrac{\left[\sum\limits_{n=2,3,4,5,...}^{\infty}\left(\dfrac{V_n}{n^2}\right)\right]^{\frac{1}{2}}}{V_1}$

    (c) $DF = \dfrac{\left[\sum\limits_{n=2,3,4,5,...}^{\infty}\left(\dfrac{V_n}{n}\right)^2\right]^{\frac{1}{2}}}{V_1}$

    (d) $DF = \dfrac{\left[\sum\limits_{n=2,3,4,5,...}^{\infty}\left(\dfrac{V_n}{n}\right)\right]^{\frac{1}{2}}}{V_1}$

88. Ans: (a)

Sol: $DF_n = \dfrac{V_n}{n^2 \times V_1}$

$D.F = \left[\sum\limits_{n=2,3,4,5}^{....\infty}(DF_n)^2\right]^{\frac{1}{2}}$

$= \left[\sum\limits_{n=2,3,4,5}^{....\infty}\left(\dfrac{V_n}{n^2 V_1}\right)^2\right]^{\frac{1}{2}}$

$= \dfrac{\left[\sum\limits_{n=2,3,4,5}^{....\infty}\left(\dfrac{V_n}{n^2}\right)^2\right]^{\frac{1}{2}}}{V_1}$

89. A separately excited DC motor is controlled by a single-phase full converter which is supplied from 440 V, 50 Hz AC supply. If the field circuit is fed through a single-phase full converter with 0° firing angle, the delay angle of armature converter is 30° and load current is 20 A, what is the field current? (Assume that the armature resistance R_a = 0.5Ω, field resistance R_f = 140 Ω, and the current waveforms are ripple-free)

    (a) 2.83 A   (b) 20 A

    (c) 20.19 A   (d) 0.79 A

89. **Ans: (a)**

Sol: $V_{favg} = \dfrac{2V_m}{\pi}\cos\alpha$

$= \dfrac{2 \times 440\sqrt{2}}{\pi}\cos(0) = 396\ V$

$i_{favg} = \dfrac{V_{favg}}{R_f} = \dfrac{396}{140} = 2.83\ A$

90. Consider the following statements regarding AC drives:

1. AC drives require simple control algorithms than DC drives.
2. Power converters used in AC drives are relatively simple and less expensive.
3. VSI, CSI, AC voltage controllers, PWM inverters are used in variable speed induction motor drives.

Which of the above statements is/are correct?

(a) 2 and 3   (b) 3 only

(c) 1 only   (d) 1 and 3

90. **Ans: (b)**

Sol: AC drives require complex control algorithms than DC drives

- Power converters used in AC drives are more complex and expensive
- VSI, CSI, AC voltage controllers, PWM inverters are used in variable speed induction motor drives

91. Which one of the following is not the remedy for reducing cross-magnetizing effect of the armature reaction?

(a) Introducing saturation in the teeth and pole shoe
(b) By chamfering the pole shoes which increases the air gap at the pole tips
(c) By making the field circuit resistance more

than the critical value
(d) Compensating the armature reaction mmf by a compensating winding located in the pole shoes

91. **Ans: (c)**

Sol: It is not used to introduce saturation in teeth and pole shoe

92. The total iron losses in the armature of a DC machine running at 875 rpm are 1100 W. What is the approximate braking torque due to iron losses?

(a) 8 N-m   (b) 16-42 N-m

(c) 8.85 N-m   (d) 12 N-m

92. **Ans: (d)**

Sol: Braking torque, due to Iron loss,

$T_B = \dfrac{P_{Loss}}{\omega} = \dfrac{1100}{2\pi \times 875} \times 60$

$T_B = 12\ Nm$

93. A 0.5 hp, 6-pole induction motor is excited by a 3-phase, 60 Hz source. If the full-load speed is 1140 rpm, what is the percentage of slip?

(a) 6%   (b) 12%

(c) 5%   (d) 3%

93. **Ans: (c)**

Sol: 0.5HP, 6-pole, 60 Hz, 1140 rpm

$N_s = \dfrac{120 \times 60}{6} = 1200\ rpm$

Slip, $s = \dfrac{1200 - 1140}{1200} = 5\%$

94. A 50 Hz induction motor wound for pole-amplitude modulation has 20 initial poles and the modulating function has 8 poles. At what two speeds will the motor run?

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(a) 300 rpm and 214.286 rpm

(b) 400 rpm and 318.524 rpm

(c) 150 rpm and 414.495 rpm

(d) 450 rpm and 115.359 rpm

94. Ans: (a)

Sol: Initial poles are 20

$P_1 = 20$

First speed is $\dfrac{120 \times 50}{20} = 300$ rpm

Resultant poles PAM

$|20 \pm 8| = 28/12$

Other speed is $\dfrac{120 \times 50}{28} = 214.285$ rpm

95. A 3-phase synchronous generator produces an open-circuit line voltage of 6928 V, when the DC exciting current is 50 A. The AC terminals are then short-circuited and the three line currents are found to be 800 A. What is the synchronous reactance per phase?

(a) 138.5 Ω   (b) 8.6 Ω

(c) 80 Ω   (d) 5 Ω

95. Ans: (d)

Sol: $E_{OC} = 6928$ V $\rightarrow$ $I_f = 50$ A

$I_{SC} = 800$ A

$X_S = \dfrac{\dfrac{6928}{\sqrt{3}}}{800} = 4.99 = 5$ Ω

96. Consider the following advantages of hydrogen cooling of alternators in steam power generation:

1. Less noise due to the lower density of hydrogen

2. Ventilation losses (fan power absorbed) are higher by 10%

3. The heat transfer is more than that of air

Which of the above advantages is/are correct?

(a) 2 and 3   (b) 2 only

(c) 1 only   (d) 1 and 3

96. Ans: (d)

Sol: Advantages of Hydrogen cooling of alternators

1. Less noise due to the lower density of hydrogen

2. Ventilation losses reduced by 30% to 40%

3. The heat transfer is more than air

97. Match the following Lists regarding Surge Impedance Loading (SIL) of AC lines:

List-I[Conductor configuration and line voltage]

P. Quad Bersimis-400 kV

Q. Twin Moose-400 kV

R. Quad Zebra-400 kV

S. Triple Snowbird-400 kV

List-II [SIL (MW)]

1. 647

2. 605

3. 691

4. 515

Select the correct answer using the code given below.

Codes:

	P	Q	R	S
(a)	3	4	1	2
(b)	2	1	4	3
(c)	1	4	2	3
(d)	4	3	2	1

97. Ans: (a)

Sol: Quad Berrimis $\rightarrow$ SIL - 691 MW

Quad Zebra $\rightarrow$ SIL - 647 MW

Triple Snowbird $\rightarrow$ SIL - 605 MW

Twin Moose $\rightarrow$ SIL - 515 MW

98. If d is the distance between the conductors and e is the Euler's number, then the maximum critical disruptive voltage occurs when the radius (r) of the conductors is

(a) d×e

(b) d / (1 − e)

(c) d/e

(d) d / (1 + e)

98. Ans: (c)

Sol: $V_d = mgr \ln\left(\dfrac{d}{r}\right)$

when $r = \dfrac{d}{e}$

$V_d = mgr \ln\left(\dfrac{d}{d/e}\right)$

$= mgr$

Then V_d is maximum

99. Match the following Lists regarding cable conductors:

List-I (Property)

P. Specific gravity of copper

Q. Ultimate tensile strength of copper

R. Specific gravity of aluminium

S. Ultimate tensile strength of aluminium

List-II (Value)

1. 15 kg/mm²

2. 8.890

3. 40 kg/mm²

4. 2.71

Select the correct answer using the code given below.

Codes:

	P	Q	R	S
(a)	3	4	1	2
(b)	2	3	4	1
(c)	1	3	4	2
(d)	4	1	2	3

99. Ans: (b)

Sol: **Properties of copper:**

Specific gravity = 8.890

Ultimate tensile strength = 40 kg/mm²

Properties of Aluminium:

Specific gravity = 2.71

Ultimate tensile strength = 15 kg/mm²

100. Match the following Lists regarding percentage distribution of faults in various elements of a power system:

List-I (Element)	List-II (% of total faults)
P. Overhead lines	1. 10
Q. Underground cables	2. 50
R. Transformers	3. 7
S. Generators	4. 9

Select the correct answer using the code given below.

Codes:

	P	Q	R	S
(a)	3	4	1	2
(b)	2	1	4	3
(c)	2	4	1	3
(d)	2	3	4	1

100. Ans: (c)

Sol: Alternators - 7%

Underground cables - 9%

Transformers - 10%

Overhead lines - 50%

101. For a 735 kV line with a fault current of 4 kA, what is the arc resistance? (Assume no resistance in the ground return path)

(a) 4 Ω

(b) 8 Ω

(c) 183.75 Ω

(d) 0.183 Ω

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101. Ans: (d)

Sol: $R_{arc} = \dfrac{28710.\ell}{I^{1.4}}$

Let $\ell = 1m$

$R_{arc} = \dfrac{28710}{(4000)^{1.4}} = 0.261\Omega$

Approximate answer is 0.183Ω

---

102. Consider the following statements regarding static relays compared with electromechanical relays:
1. In static relays, frequent operations cause deterioration.
2. In static relays, there is a quick resetting and absence of overshoot.
3. Static relays are sensitive to voltage transients.

Which of the above statements is/are correct?
(a) 2 and 3
(b) 2 only
(c) 1 only
(d) 1 and 3

102. Ans: (a)

Sol: In static relays there will be quick resetting and absence of over-shoot and sensitive to voltage variations

---

103. What is the maximum value of restriking voltage across the contacts of the circuit breaker in a 132 kV system?
(a) 107.78 kV
(b) 215.56 kV
(c) 93.35 kV
(d) 186.64 kV

103. Ans: (b)

Sol: Peak value of restriking voltage $= 2V_m$

$= 2 \times \sqrt{2} \times V_{ph}$

$= 2\sqrt{2} \times \dfrac{V_L}{\sqrt{3}}$

$= 2\sqrt{2} \times \dfrac{132kV}{\sqrt{3}} = 215.56$ kV

---

104. Consider the following statements regarding radial distribution system:
1. Distributor far away from the substation is highly loaded.
2. Severe voltage variation to the consumers nearest to the substation is due to load variations.
3. Consumers are dependent on a single feeder and a single distributor, and a fault on either of them causes interruption of supply to all the consumers away from the fault.

Which of the above statements is/are correct?
(a) 2 and 3
(b) 3 only
(c) 1 only
(d) 1 and 3

104. Ans: (b)

Sol: 1. Distributor fed at far end should never have high load.
2. There will less voltage fluctuations near sub-station.
3. A fault at any location in radial system may cause interruption of supply.

---

105. Match the following Lists regarding bus classifications:

List-I (Bus type)

P. Generator bus

Q. Load bus

R. Slack bus

List-II (Quantities to be obtained)

1. Real power, reactive power

2. Reactive power, phase angle

3. Voltage magnitude, phase angle

Select the correct answer using the code given below.

Codes:

	P	Q	R
(a)	2	3	1
(b)	3	2	1
(c)	2	1	3
(d)	1	3	2

105. Ans: (a)

Sol:

Bus	Known	Unknown
Generator	P and |V|	Q and δ
Load	P and Q	|V| and δ
Slack	|V| and δ	P and Q

106. Consider the following statements regarding behavior of second-order underdamped system:

1. The peak time is inversely proportional to the imaginary part of the complex pole.
2. Percent overload is a function of only the damping ratio.
3. Settling time is directly proportional to the real part of the complex pole.

Which of the above statements are correct?

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

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

106. Ans: (c)

Sol: $t_p = \dfrac{\pi}{\omega_d}$ where ω_d is imaginary part of complex pole.

Percentage of overshoot is function of damping ratio.

Settling time is inversely proportional to real part of the complex pole.

107. For the closed-loop transfer function given below, what is the system condition based on the number of poles in the left-half plane, the right-half plane and the jω-axis?

$$T(s) = \frac{200}{s^4 + 6s^3 + 11s^2 + 6s + 200}$$

(a) The system is stable with four poles on the left-half of the plane.

(b) The system is unstable, since it has two right-half plane poles and two left-half plane poles.

(c) The system is marginally stable, since it has two left-half plane poles and two on jω-axis.

(d) The system is unstable, since it has one right-half plane pole and three left-half plane poles.

107. Ans: (b)

Sol: CE: $s^4 + 6s^3 + 11s^2 + 6s + 200 = 0$

s^4	1	11	200
s^3	6	6	
s^2	10	200	
s^1	-114		
s^0	200		

2 sign changes
2 poles RH s-plane
2 poles LH s-plane
Unstable

108. Consider the following statements regarding stability for linear, time-invariant systems using natural response :

1. A system is marginally stable, if the natural response neither decays nor grows but remains constant or oscillates.

2. A system is unstable, if the natural response approaches infinity as time approaches zero.

3. A system is unstable, if any bounded input yields unbounded output.

Which of the above statements is/are not correct?

(a) 1 only   (b) 2 only

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

108. Ans: (b)

Sol: A system unstable, if the natural response approaches infinity as time approaches infinity.

109. What are the values of positive constant (K_p), velocity constant (K_v) and acceleration constant (K_a) for a type '0' unity feedback system which has the transfer function $G(s) = \dfrac{1000(s+8)}{(s+7)(s+9)}$?

(a) $K_p = 0$; $K_v = 0$; $K_a = 127$

(b) $K_p = 0$; $K_v = 0$; $K_a = 0$

(c) $K_p = 0$; $K_v = 127$; $K_a = 127$

(d) $K_p = 127$; $K_v = 0$; $K_a = 0$

109. Ans: (d)

Sol: $G(s) = \dfrac{1000(s+8)}{(s+7)(s+9)}$, $H(s) = 1$

$$K_P = \underset{s \to 0}{Lt}\, G(s) = \underset{s \to 0}{Lt}\, \frac{1000(s+8)}{(s+7)(s+9)} = \frac{8000}{7 \times 9} = 127$$

$$K_V = \underset{s \to 0}{Lt}\, s\,G(s) = \underset{s \to 0}{Lt}\, s\left\{\frac{1000(s+8)}{(s+7)(s+9)}\right\} = 0$$

$$K_a = \underset{s \to 0}{Lt}\, s^2 G(s) = \underset{s \to}{Lt}\, s^2\left\{\frac{1000(s+8)}{(s+7)(s+9)}\right\} = 0$$

110. Consider the following statements regarding properties of a transfer function:

1. The unit of a transfer function is related to the units of the system input and output. A unit is essential.

2. The transfer function can be applied to describe only time-invariant linear systems whose parameters do not change or change only a little during operation.

3. The transfer function is dependent of the input to the system, since the characteristics of the system are modified by the input signal.

Which of the above statements is/are correct?

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

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

110. Ans: (d)

Sol: TF is the ratio of the output to input, can be dimentionless quantity. Physical unit is not always essential.

TF is independent of the input to the system

111. Consider the following and give the order of the steps to be followed in performing the block diagram reduction to get the final transfer function for that system:

Step 1: Combine all serial blocks

Step 2: Close all inner loops

Step 3: Combine all parallel blocks

Step 4: Move summing junctions to the left or right of a block and tie points to the left or right

Select the correct sequence for the above steps.

(a) Step 1, Step 2, Step 3, Step 4

(b) Step 1, Step 3, Step 2, Step 4

(c) Step 3, Step 2, Step 1, Step 4

(d) Step 2, Step 3, Step 1, Step 4

111. Ans: (b)

Sol: Order of priority to simplify Block diagram

1. Series blocks

2. Parallel blocks

3. Inner loops

4. Moving summing and take-off points

112. Consider the following statements regarding representation of block diagrams through signal flow diagrams:

1. The signal at a node is equal to the sum of all signals transmitted to the node. Sometimes, the transmittance may be positive.

2. The transmittances are simply related to the transfer functions.

3. The transmittances connected to the input/output nodes are both unity, and merely help to make the diagram clearer.

Which of the above statements is/are correct?

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

(c) 1 and 2   (d) 1 only

112. Ans: (c)

Sol: Signal at a node equal to the sum of all signals transmitted to the nodes.

Transmittance is ratio of any two nodes.

113. Consider the following statements regarding Nyquist stability criterion:

1. The Nyquist stability criterion is one of the geometric criterion and graphical method in frequency domain.

2. It uses open-loop Nyquist diagram to judge the stability of the closed-loop system.

3. Instead of solving the characteristic roots of the open-loop system, the Nyquist criterion gets the stability of the closed-loop system by means of an open-loop frequency characteristic diagram.

Which of the above statements are correct?

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

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

113. Ans: (a)

Sol: Nyquist plot is a graphical method in frequency domain.

In Nyquist plot, uses open loop transfer function to judge closed stability.

114. A transformer on no load has a core loss of 50 W, draws a current of 2 A (rms) and has an induced emf of 230 V (rms). What is the core loss current?

(a) 0.216 A   (b) 1.988 A

(c) 2.328 A   (d) 0.456 A

114. Ans: (a)

Sol: Core loss = 50 W

$V_0 I_0 \cos\phi_0 = 50$

$230 \times I_w = 50$

$I_w = \dfrac{50}{230} = 0.217 \text{ A}$

115. A 500 kVA transformer has an efficiency of 95% at full load and also at 60% of full load; both at unity power factor. Separate out the losses of the transformer.

(a) P_i = 12.42 kW and P_c = 18.52_kW

(b) P_i = 2.45 kW and P_c = 8.35 kW

(c) P_i = 8.43 kW and P_c = 13.25 kW

(d) P_i = 9.87 kW and P_c = 16.45 kW

115. Ans: (d)

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(ME: 10 | EC: 04 | EE: 05 | CE: 04 | CS: 02 | IN: 05 | DA: 01 | PI: 07 | XE: 02 | ES: 01)

Sol: $\eta_{FL} = 0.95$

$$0.95. = \frac{5 \times 10^5 \times 1}{5 \times 10^5 + W_i + W_{cu}}$$

$W_i + W_{cu} = 26315.8$ .... (1)

$\eta_{60\%FL, \, UPF} = 0.95$

$$0.95 = \frac{0.6(5 \times 10^5 \times 1)}{0.6(5 \times 10^5) + W_i + (0.6)^2 W_{cu}}$$

$W_i + (0.6)^2 W_{cu} = 15789.5$ W .... (2)

$\therefore$ Solving (1) & (2)

$W_i = 9.86$ kW

$W_{cu} = 16.45$ kW

116. Consider the following statements regarding three-phase transformer connections:
   1. Delta/delta is economical for small HV transformers.
   2. Star/star suits large LV transformers.
   3. Star/delta is the most commonly used connection for power systems.
   Which of the above statements is/are correct?
   (a) 2 and 3
   (b) 3 only
   (c) 1 only
   (d) 1 and 2

116. Ans: (c)

Sol: Δ/Δ is suitable for small HV transformers
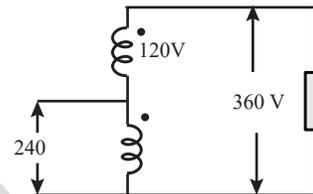
Y/Y transformer is best for HV

Y/Δ is very less used in power system

117. A 240 V/120 V, 12 kVA transformer has full-load unity power factor efficiency of 96.2%. It is connected as an auto-transformer to feed a load at 360 V. What is the auto-transformer rating?
   (a) 36 kVA
   (b) 18 kVA
   (c) 54 kVA
   (d) 34.63 kVA

117. Ans: (a)

Sol: 240 V/120 V transformer is connected as auto transformer to a load at 360 V.

$$(kVA)_{Atfr} = \frac{1}{1 - \dfrac{240}{360}}(12k)) = 36 \text{ kVA}$$

118. The magnetic flux density on the surface of an iron face is 1.6 T, which is a typical saturation level value for ferromagnetic material. What is the force density on the iron face?
   (a) 1.6×10^6 N/m^2
   (b) 1.02×10^6 N/m^2
   (c) 1.02×10^7 N/m^2
   (d) 1.6×10^7 N/m^2

118. Ans: (b)

Sol: Force density $= f = \dfrac{B^2}{2\mu_0}$

$B = 1.6$ T

$\mu_0 = 4\pi \times 10^{-7}$

$$f = \frac{(1.6)^2}{2 \times 4\pi \times 10^{-7}} = 1.02 \times 10^6 \text{ N/m}^2$$

119. For a 6-pole DC armature with 16 slots having two coil sides per slot and single-turn coils, what is the commutator pitch (y_c) for a wave winding?
   (a) 8 segments
   (b) 9 segments
   (c) 6 segments
   (d) 5 segments

119. Ans: (d)

Sol: P = 6, slots 16

No. of coils = slots = 16 = C

Commutator pitch, $Y_C = \dfrac{C \pm 1}{P/2} = \dfrac{16 - 1}{3} = 5$

120. Consider the following statements regarding speed control of DC motors:

1. In field control method, speeds higher than the rated speed cannot be obtained.

2. For motors requiring a wide range of speed control, field control method leads to unstable operating conditions or poor commutation.

3. Field control method is not suited to applications needing speed reversal.

Which of the above statements is/are correct?

(a) 2 and 3　　　　(b) 3 only

(c) 1 only　　　　(d) 1 and 2

120. Ans: (a)

Sol: Field control method will provide higher than rated speed.

In this method, motor cannot be reversal due to flux cannot be reverse immediately.

121. The signal space should be divided as

(a) periodic only, whereas the system should be either time scaling or shifting

(b) non-periodic only, whereas the system should be time shifting

(c) either periodic or non-periodic, whereas the system should be either time scaling or shifting

(d) neither periodic nor non-periodic, whereas the system should be time scaling

121. Ans: (c)

Sol: The signal space should be divided as either periodic or non-periodic, where as the system should be either time scaling (or) shifting.

122. Consider a non-recursive filter with the impulse response h(n) shown in the figure below:
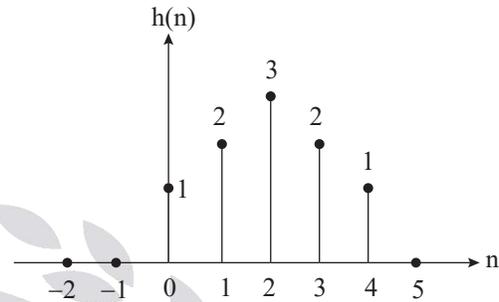
What is the group delay in terms of frequency?

(a) 1　　　　(b) 2

(c) 3　　　　(d) 4

122. Ans: (b)

Sol: Length of the filter N = 5

$\theta(\omega) = -\alpha\omega$

$\alpha = \dfrac{N-1}{2} = \dfrac{5-1}{2} = \dfrac{4}{2} = 2$

$\theta(\omega) = -2\omega$

Group delay $= \dfrac{-d\theta(\omega)}{d\omega}$

$= \dfrac{-d}{d\omega}(-2\omega)$

Group delay $= 2$

123. If $h(t) = \left[-\dfrac{2}{3}e^t + \dfrac{2}{3}e^{-2t}\right]u(-t) + \delta(t)$, then the function is

(a) Causal and Stable

(b) Non-causal and Stable

(c) Causal and Unstable

(d) Non-causal and Unstable

123. Ans: (d)

Sol: $h(t) = \left[\dfrac{-2}{3}e^t + \dfrac{2}{3}e^{-2t}\right]u(-t) + \delta(t)$

Here, h(t) ≠ 0 for t < 0

So, non-causal system

$$\int_{-\infty}^{\infty} |h(t)|\, dt = \int_{-\infty}^{0} \frac{-2}{3} e^{t}\, dt + \int_{-\infty}^{0} \frac{2}{3} e^{-2t}\, dt + \int_{-\infty}^{\infty} \delta(t)\, dt = \infty$$

So, unstable system.

124. The unit impulse response of an LTI system is h(t) = e^{-t} sin2t u(t). What is the response to x(t) = sin(t) by using the Laplace transform?

(a) y(t) = sin(2t)

(b) y(t) = $\dfrac{\sin(2t)}{s+1}$

(c) y(t) = 0.447 sin(t)

(d) y(t) = 0.447 sin(t − 26.6°)

124. Ans: (d)

Sol: Given h(t) = e^{-t}sin(2t)u(t)

$e^{-at}\sin(bt)u(t) \leftrightarrow \dfrac{b}{(s+a)^2 + (b)^2}$

So, H(s) = $\dfrac{2}{(s+1)^2 + (2)^2}$

x(t) = Asin(ω_0t) → [H(s)] → y(t) = A|H(jω_0)|.sin[ω_0t + ∠H(jω_0)]

x(t) = sin(t)

$\omega_0 = 1$

H(jω) = $\dfrac{2}{(j\omega + 1)^2 + 4}$

H(jω_0) = $\dfrac{2}{(j+1)^2 + 4} = \dfrac{2}{j^2 + 1 + 2j + 4}$

H(jω_0) = $\dfrac{2}{2(j+2)} = \dfrac{1}{j+2}$

|H(jω_0)| = $\dfrac{1}{\sqrt{1+4}} = \dfrac{1}{\sqrt{5}}$

∠H(jω_0) = $-\tan^{-1}\left(\dfrac{1}{2}\right) = -26.6°$

So, y(t) = 0.447sin(t −26.6°)

125. If x(n) = {...., 0, 0, $\underset{\uparrow}{1}$, 1, 1, 1, 1, 1, 1, 0, 0, ...}

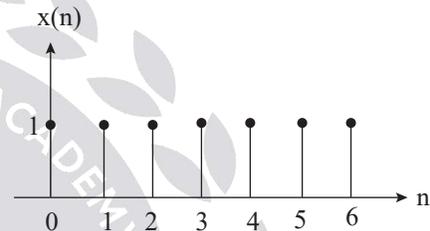what is the value of y(n) = x(2n) ?

(a) y(n) = x(2n) + x(n)

(b) y(n) = u(n) − u(n − 7)
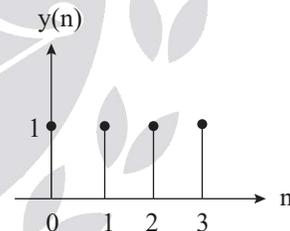
(c) y(n) = u(n) − u(n − 4)
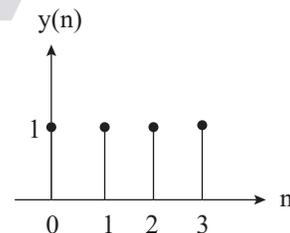
(d) y(n) = x(n) − x(n − 7)

125. Ans: (c)

Sol:

y(n) = x(2n)

It is a time scaling operation.

From option (c)

y(n) = u(n) −u(n−4)

126. Consider a finite-duration sequence such as $x(n) = \{\underset{\uparrow}{1}, 2, 4, 8, 16\}$. What is the new sequence produced, when it revolves 4 units in the circular shift operation?

(a) $\{\underset{\uparrow}{4}, 8, 16, 1, 2\}$ (b) $\{\underset{\uparrow}{2}, 4, 8, 16, 1\}$

(c) $\{\underset{\uparrow}{1}, 2, 4, 8, 16\}$ (d) $\{\underset{\uparrow}{16}, 1, 2, 4, 8\}$

126. Ans: (b) & (d)

Sol: $x(n) = \{\underset{\uparrow}{1}, 2, 4, 8, 16\}$

It is a circular left shift,. Then

$x((n-1))_5 = \{16, 1, 2, 4, 8\}$

$x((n-2))_5 = \{8, 16, 1, 2, 4\}$

$x((n-3))_5 = \{4, 8, 16, 1, 2\}$

$x((n-4))_5 = \{\underset{\uparrow}{2}, 4, 8, 16, 1\}$ Option (b)

If it is a circular right shift, then

$x((n+1))_5 = \{2, 4, 8, 16, 1\}$

$x((n+2))_5 = \{4, 8, 16, 1, 2\}$

$x((n+3))_5 = \{8, 16, 1, 2, 4\}$

$x((n+4))_5 = \{\underset{\uparrow}{16}, 1, 2, 4, 8\}$ .... Option (d)

127. What is the linear convolution response y(5) of the given sequence?

$$x(n) = \begin{cases} \dfrac{2}{\sqrt{3}}\sin\left(\dfrac{\pi n}{3}\right), & 0 \leq n \leq 5 \\ 0 & , \text{ eslsewhere} \end{cases}$$

and $h(n) = \{\underset{\uparrow}{1}, 2, 3, 2, 1\}$

(a) 0   (b) 9

(c) 14   (d) 28

127. Ans: (a)

Sol: $x(n) = \begin{cases} \dfrac{2}{\sqrt{3}}\sin\left(\dfrac{\pi n}{3}\right), & 0 \leq n \leq 5 \\ 0 & , \text{ eslsewhere} \end{cases}$

By substituting the value of 'n'

$x(n) = \{0, 1, 1, 0, -1, -1\}$

Given $h(n) = \{\underset{\uparrow}{1}, 2, 3, 2, 1\}$

$y(n) = x(n)*h(n)$

$y(n) = \sum_{k=-\infty}^{\infty} x(k)h(n-k)$

$y(5) = \sum_{k=-\infty}^{\infty} x(k)h(5-k)$

$h(k) = \{\underset{\uparrow}{1}, 2, 3, 2, 1\}$

$h(k+5) = \{1, 2, 3, 2, 1, \underset{\uparrow}{0}\}$

$h(-k+5) = \{\underset{\uparrow}{0}, 1, 2, 3, 2, 1\}$

and $x(k) = \{\underset{\uparrow}{0}, 1, 1, 0, -1, -1\}$

$\sum_{k=-\infty}^{\infty} x(k)h(5-k) = 1 + 2 - 2 - 1 = 0$

So, $y(f5) = 0$

128. By using the 3-point DFT of the sequence $h(n) = a^{-n}, 0 \leq n \leq 2$ for $a = 1.369$, what is the relationship between the output sequences?

(a) $H(0) + H(1) + H(2) = 4$

(b) $H(0) + H(1) = H(2)$

(c) $H(1) = H(2)$

(d) $H(2) = H^*(1)$

128. Ans: (d)

Sol: Given $h(n) = (a)^{-n}, 0 \leq n \leq 2$ and $a = 1.369$

$h(n) = (1.369)^{-n}, 0 \leq n \leq 2$

Here, h(n) is real

So, from conjugate property

$H(k) = H^*(N-k)$

Given $N = 3$

$H(k) = H^*(3-k)$

$k = 2 \Rightarrow H(2) = H^*(1)$

129. If $X(s) = L\{x(t)\}$, what is the initial value $x(0)$ and the final value $x(\infty)$ respectively, for the given signal $X(s) = \dfrac{7s+6}{s(3s+5)}$, using initial value and final value theorems?

   (a) $\dfrac{6}{5}, \dfrac{7}{3}$ (b) $2, \dfrac{7}{3}$

   (c) $\dfrac{7}{3}, 2$ (d) $\dfrac{7}{3}, \dfrac{6}{5}$

129. Ans: (d)

Sol: Given $X(s) = \dfrac{7s+6}{s(3s+5)}$

From Initial value theorem $x(0) = \underset{s\to\infty}{Lt}\, sX(s)$

$x(0) = \underset{s\to\infty}{Lt}\dfrac{7s+6}{5s+5} = \underset{s\to\infty}{Lt}\dfrac{7+6/s}{3+5/s}$

$x(0) = \dfrac{7}{3}$

From final value theorem, $x(\infty) = \underset{s\to 0}{Lt}\,sX(s)$

$= \underset{s\to 0}{Lt}\dfrac{7s+6}{3s+5} = \dfrac{6}{5}$

130. If $X(s) = L\{x(t)\}$, what is the inverse Laplace transform of the signal $X(s) = \dfrac{2}{s(s+1)(s+2)^2}$?

   (a) $x(t) = (0.5 - 2e^{-t} + te^{-2t} + 1.5e^{-2t})u(t)$

   (b) $x(t) = (0.5 - 2e^{-t} + te^{-2t} + 2e^{-2t})\,u(t)$

   (c) $x(t) = (0.5 - e^{-t} + te^{-2t} + 2e^{-2t})\,u(t)$

   (d) $x(t) = (1 - e^{-t} + te^{-2t})\,u(t)$

130. Ans: (a)

Sol: $X(s) = \dfrac{2}{s(s+1)(s+2)^2}$

$X(s) = \dfrac{A}{s} + \dfrac{B}{s+1} + \dfrac{C}{(s+2)} + \dfrac{D}{(s+2)^2}$

$X(s) = \dfrac{\frac{1}{2}}{s} - \dfrac{2}{s+1} + \dfrac{\frac{3}{2}}{s+2} + \dfrac{1}{(s+2)^2}$

Apply ILT

$x(t) = \dfrac{1}{2}u(t) - 2e^{-t}u(t) + \dfrac{3}{2}e^{-2t}u(t) + te^{-2t}u(t)$

$x(t) = [0.5 - 2e^{-t} + 1.5e^{-2t} + te^{-2t}]u(t)$

131. What is the DC gain (zero frequency) for a system which has a transfer function of $G(s) = (s+2)/[(s+1)(s+3)(s+4)]$?

   (a) 1/6   (b) 2/3
   (c) 1/3   (d) 1/2

131. Ans: (a)

Sol: $G(s) = \dfrac{(s+2)}{(s+1)(s+3)(s+4)}$

For DC gain substitute $s = 0$ in the TF

$G(s)\big|_{s=0} = \dfrac{2}{1\times 3\times 4} = \dfrac{1}{6}$

132. Match the following Lists:

   List-I (Input function)
   P. $\delta(t)$
   Q. $u(t)$
   R. $\sin \omega t$
   S. $(1/2)t^2 u(t)$

   List-II (Use)
   1. Steady-state error
   2. Transient response
   3. Transient response steady-state error
   4. Transient response modeling steady-state error

   Select the correct answer using the code given below.

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AIR 1 E&T — Utkarsh Pathak
AIR 1 EE — Rajan Kumar
AIR 1 ME — Nimesh Chandra

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AIR 10 CE — PUSHPENDRA K R
AIR 10 EE — AKSHIT PARASHARI
AIR 10 ME — AMIT KUMAR SINGH

Total 36 Ranks in Top-10 (E&T:10 | EE: 09 | CE:07 | ME: 10)

Codes:

	P	Q	R	S
(a)	1	2	3	4
(b)	2	3	4	1
(c)	4	2	3	1
(d)	2	4	3	1

132. Ans: (b)

Sol: $\delta(t) \rightarrow$ Impulse response is used to determine the systems transient response.

$u(t) \rightarrow$ step response reveals both the transient response and steady state error

$\sin\omega t \rightarrow$ sinusoidal inputs for frequency response analysis, which involves understanding the transient response

$\frac{1}{2}t^2 u(t) \rightarrow$ parabolic input to determine steady state error.

133. Consider the following steps regarding multiple-node electrical networks:

1. Replace passive elements' values with their admittance
2. Replace all sources and time variables with their Laplace transform
3. Replace transformed voltage sources with transformed current sources

Which of the above steps are correct?

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

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

133. Ans: (d)

Sol: Multiple Nodes, KCL $\rightarrow$ [Y] Bus (or) y-parameters

$1 \rightarrow$ Correct (admittance form)

$2 \rightarrow$ Correct

$3 \rightarrow$ Correct

134. What is the transfer function T(s) from the state-space input matrix $\dot{x} = [A]x + [B]u$ and output matrix $y = [C]x$, where $T(s) = Y(s)/U(s)$, while $U(s)$ is input and $Y(s)$ is output?

$$\dot{x} = \begin{bmatrix} 0 & 1 & 1 \\ 0 & 0 & 1 \\ -1 & -2 & -3 \end{bmatrix} x + \begin{bmatrix} 10 \\ 0 \\ 0 \end{bmatrix} u \; ; \; y = [1 \; 0 \; 0]x$$

(a) $T(s) = \dfrac{10(s^2 + 3s + 2)}{s^3 + 3s^2 + 2s + 1}$

(b) $T(s) = \dfrac{10(s^2 + 3s + 2)}{s^3 + 3s^2 + 3s + 1}$

(c) $T(s) = \dfrac{10(s^2 + 3s + 2)}{s^3 + 6s^2 + 5s + 1}$

(d) $T(s) = \dfrac{10(s^2 + 3s + 2)}{s^3 + 2s^2 + 3s + 1}$

134. Ans: (b)

Sol: $TF = C[sI - A]^{-1}B + D$

$$TF = \frac{CAdj[sI - A]B}{[sI - A]} + D$$

In the four options, Numerators are the same

Check the denominator.

$$|sI - A| = \begin{vmatrix} s & -1 & -1 \\ 0 & s & -1 \\ +1 & +2 & s+3 \end{vmatrix}$$

$= s[s(s + 3) + 2] - (-1)[0 - (-1)] + (-1)[0 - s]$

$= s[s^2 + 3s + 2] + 1 + s$

$= s^3 + 3s^2 + 3s + 1$

135. Consider the following statements regarding first-order systems:

1. The time constant of the system can be described as the time for e^{-at} to decay to 63% of initial value or it is the time taken for the

step response to rise to 37% of its final value.

2. Rise time is found to be the time for waveform to go from 0.1 to 0.9 of its final value.

3. Settling time is defined as the time for the response to reach and stay within 4% of its final value.

Which of the above statements is/are not correct?

(a) 1 only   (b) 2

(c) 3 only   (d) 1 and 3

135. Ans: (d)

Sol: At t = T, the step rise to 63% of its final value.

136. Consider the following characteristics regarding ideal operational amplifier:

1. An infinite output impedance and zero input impedance

2. The Op-Amp must have an extremely high inherent voltage gain

3. Zero slew rate

Which of the above characteristics is/are correct?

(a) 1 and 3   (b) 3 only

(c) 2 only   (d) 1 and 2

136. Ans: (c)

Sol: OP-Amp has high gain, high R_{in}, low R_0 and high slew rate.

137. An inverting amplifier using the 741C must have a flat response up to 40 kHz. The gain of the amplifier is 10. What maximum peak-to-peak input signal can be applied without distorting the output?

(a) 0.398 V   (b) 3.98 V

(c) 30.98 V   (d) 0.0398 V

137. Ans: (a)

Sol: 741C has a slew rate of 0.5V/μs

$$\therefore \text{ SR} = 2\pi f_m V_m$$

$$\frac{0.5V}{10^{-6}S} = 2\pi \times 40 \times 10^3 \times V_{0(\text{peak})}$$

$$V_{0(\text{peak})} = 1.989 \text{ V}$$

$$V_{0(\text{P-P})} = 3.9788 \text{ V}$$

$$V_{\text{in(P-P)}} = \frac{V_{0(\text{P-P})}}{\text{Gain}} = \frac{3.9788}{10} = 0.39788$$

138. Consider the following statements regarding bistable multivibrator:

1. The bistable multivibrator is used as memory elements in shift registers, counters.

2. It is used to generate sine wave by sending regular triggering pulse to the input.

3. It can also be used as a frequency divider.

Which of the above statements is/are correct?

(a) 1 and 3   (b) 3 only

(c) 2 only   (d) 1 and 2

138. Ans: (a)

Sol: A Bistable multivibrator is used as a flip-flop. It is used for frequency division particularly divide by 2 circuits.

139. What is the percentage of resolution of the eight-bit DAC?

(a) 0.0244%   (b) 0.392%

(c) 0.568%   (d) 0.0148%

139. Ans: (b)

Sol: %Resolution $= \dfrac{1}{2^n - 1} \times 100$

$$= \frac{1}{2^8 - 1} \times 100$$

$$= \frac{100}{255} = 0.392\%$$

ESE - 2026
Preliminary Examination

Questions with Detailed Solutions

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ELECTRICAL ENGINEERING

140. What is the value of the capacitance to a use in a capacitor filter connected to a full-wave rectifier operating at a standard aircraft power frequency of 400 Hz, if the ripple factor is 10% for a load of 500 Ω?

(a) 72.2 µF (b) 87.6 µF
(c) 25.2 µF (d) 102.4 µF

140. Ans: (a)

Sol: Ripple factor = $\dfrac{1}{4\sqrt{3}\,fCR}$

$\dfrac{10}{100} = \dfrac{1}{4\sqrt{3} \times 400 \times 500 \times C}$

$C = \dfrac{10}{4\sqrt{3} \times 400 \times 500} = 7.2\ \mu F$

Note: Examiner given wrong position of decimals

141. Match the following Lists regarding R-C filter circuit:

List-I [Component]
P. Low-pass filter
Q. R-C circuit as integrator
R. High-pass filter
S. R-C circuit as differentiator

List-II [Output voltage (V_{out})]

1. $\dfrac{1}{RC}\displaystyle\int_0^t V_{in}\,dt$

2. $V_{in}\,\dfrac{\omega RC}{\sqrt{1 + \omega RC)^2}}$

3. $RC\,\dfrac{dV_{in}}{dt}$

4. $V_{in}\,\dfrac{1}{\sqrt{1 + (\omega RC)^2}}$

Select the correct answer using the code given below.

Codes:

	P	Q	R	S
(a)	4	3	2	1
(b)	1	3	2	4
(c)	4	1	2	3
(d)	2	1	4	3

141. Ans: (c)

Sol: LPF has a TF of $\dfrac{K}{1 + SRC}$

RC differentiator has $V_0 = RC\dfrac{dV_n}{dt}$

∴ P-4 and S-3

142. Match the following Lists:

List-I (Name of the flag)
P. Auxiliary carry flag
Q. Parity flag
R. Zero flag
S. Carry flag

List-II (Bit position in flag register)
1. D_0
2. D_2
3. D_4
4. D_6

Select the correct answer using the code given below.

Codes:

	P	Q	R	S
(a)	4	3	2	1
(b)	1	3	2	4
(c)	2	3	4	1
(d)	3	2	4	1

142. Ans: (d)

Sol: Flag Register

S	Z	X	AC	X	P	X	CY
D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0

$P \rightarrow 3$

$Q \rightarrow 2$

$R \rightarrow 4$

$S \rightarrow 1$

143. Match the following Lists regarding interfacing the 8155 memory section:

List-I (Address lines)   **List-II (Function used for)**

P. A11 to A15   1. Don't Care

Q. A0 to A7   2. Chip Enable

R. A8 to A10   3. Register Select

Select the correct answer using the code given below.

Codes:

	P	Q	R
(a)	2	3	1
(b)	1	3	2
(c)	3	1	2
(d)	3	2	1

143. Ans: (a)

Sol: $P \rightarrow 2$

$Q \rightarrow 3$

$R \rightarrow 1$

144. The emission current of a diode is 12.5mA. What is the rms value of shot noise current for a 10 MHz bandwidth?

(a) 18.2 μA   (b) 1.3 μA

(c) 0.2 μA   (d) 2.7 μA

144. Ans: (c)

Sol: $I_{RMS} = \sqrt{2qI_{DC}B}$

Substituting all the values given

$I_{RMS} = 0.2 \ (\mu A)$

145. A transmitter supplies 10 kW power to an aerial, when unmodulated. What is the power radiated, when modulated to 30%?

(a) 3 kW   (b) 10.45kW

(c) 14.8kW   (d) 4 kW

145. Ans: (b)

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

$P_t = 10 \times 10^3 \left[1 + \dfrac{0.09}{2}\right]$

$P_t = 10.4 \ kW$

146. Consider the following statements regarding AM versus FM broadcasting:

1. The process of demodulation is complex in AM broadcasting than that of in FM broadcasting.

2. In FM broadcasting, stereophonic transmission is possible.

3. The AM broadcasting system has poor noise performance.

Which of the above statements is/are correct?

(a) 2 and 3   (b) 3 only

(c) 1 only   (d) 1 and 2

146. Ans: (a)

147. The signal voltage and noise voltage of a system are 0.923 mV and 0.267 mV respectively. What is the signal-to-noise ratio (SNR) in number?

(a) 3.45   (b) 10.77

(c) 0.29   (d) 11.95

147. Ans: (d)

Sol: $\frac{S}{N} = \frac{(0.923 \times 10^{-3})^2}{(0.267 \times 10^{-3})^2}$

$\therefore \frac{S}{N} = 11.95$

148. Match the following Lists regarding sampling techniques :

List-I (Sampling technique)

P. Natural sampling

Q. Flat-top sampling

R. Ideal sampling

List-II (Principle)

1. It uses sample-hold principle

2. It uses multiplication

3. It uses multiplication or chopping principle

Select the correct answer using the code given below.

Codes:

	P	Q	R
(a)	2	3	1
(b)	1	3	2
(c)	3	1	2
(d)	3	2	1

148. Ans: (c)

Sol: Natural sampling $\rightarrow$ It uses multiplication (or) chopping principle

Flat top sampling $\rightarrow$ It uses sample-hold principle

Ideal sampling $\rightarrow$ It uses multiplication

P-3, Q-1, R-2

149. The diode falls under which type of system?

(a) Stable only

(b) Unstable only

(c) Either stable or unstable

(d) Neither stable nor unstable

149. Ans: (a)

Sol: Diode input voltage-output current relation is

$i(t) = I_S\left[e^{\frac{V}{\eta VT_s}} - 1\right]$

Here V is the input and i(t) is the output.

For stability our requirement is bounded input must produce bounded output.

As long as 'V' is finite

$i(t) = I_S\left[e^{\frac{finite}{\eta V_T}} - 1\right]$

η, V_T are finite,

I_S = reverse saturation current

Output is stable.

150. Which of the following properties of convolution system exhibits/exhibit the result of superposition principle for unit impulse response in linear time-invariant systems?

(a) Commutativity only

(b) Distributivity only

(c) Associativity only

(d) Both distributivity and associativity

150. Ans: (b)

Sol: Commutative property:

$x(t)*h(t) = h(t)* x(t)$

Distributive property:

$x(t) * [h_1(t) + h_2(t)] = [x(t) * h_1(t)] + [x(t) * h_2(t)]$

It uses superposition principle

Associative property:

$[x(t) * h_1(t)] *h_2(t) = [x(t)] * [h_1(t) * h_2(t)]$

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