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# ESE-2021

## PRELIMINARY EXAMINATION

## QUESTIONS WITH DETAILED SOLUTIONS

# ELECTRONICS & TELECOMMUNICATION ENGINEERING

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# ESE - 2021 Prelims Examination

## Electronics & Telecommunication Engineering

## Subject Wise Weightage

| Subjects | No. of Questions |
|---|---|
| Basic Electrical Engineering | 3 |
| Materials Science | 14 |
| Electronic Measurements and Instrumentation | 12 |
| Network Theory | 21 |
| Control Systems | 6 |
| Computer Organization and Architecture | 11 |
| Digital Electronic Circuits & Microprocessors | 9 |
| Electro Magnetics | 14 |
| Signals & Systems | 13 |
| Advanced Electronics | 2 |
| Analog and Digital Communication Systems | 12 |
| Advanced Communication | 14 |
| Analog Electronic Circuits | 11 |
| Basic Electronics Engineering | 8 |
| **Total** | **150** |

01. Which one of the following traffics can adjust, over wide ranges, to changes in delay and throughput across an internet and still meet the needs of its applications?

(a) Elastic traffic (b) Inelastic traffic

(c) Internet traffic (d) Service traffic

**01. Ans: (a)**

**Sol:** "Elastic traffic can adjust, over wide ranges, to changes in delay and throughput across an internet and still meet the needs of its applications. Inelastic traffic does not easily adapt, if at all, to changes in delay and throughput across an internet. The prime example is real-time traffic, such as voice and video."

02. A data message of 10 ms duration having 4800 bits crosses 9 nodes (10 hops) to reach its destination. The data rate and total delay for circuit switched connection (assuming node delays as 1 ms) are respectively,

(a) 240 kbps, 20 ms (b) 240 kbps, 21 ms

(c) 120 kbps, 21 ms (d) 480 kbps, 20 ms

**02. Ans: (d)**

**Sol:** According to the question, within 10 ms, we need to transfer 4800 bits.

So, then bit rate = 4800/10ms = 480Kbps.

03. Consider the following statements regarding the OSI model:

1. Application layer provides the control structure for communication between applications; establishes, manages and terminates connections between cooperating applications.
2. Data link layer provides for the reliable transfer of information across the physical link.
3. Transport layer provides end-to-end error recovery and flow control of data.

Which of the above statements are correct?

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

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

**03. Ans: (d)**

**Sol:** The Data Link layer provides reliable transit of data across a physical network link. The Data Link layer translates messages from the Network layer into bits for the Physical layer to transmit.

The transport layer provides transparent transfer of data between hosts. It is responsible for end-to-end error recovery and flow control. It ensures complete data transfer.

04. Consider the following statements regarding the TCP/IP protocol:

1. TELNET is an application of TCP protocol.
2. SMTP provides a basic electronic mail facility and makes use to TCP to send message to an SMTP module on another host.
3. The Internet Protocol is used at internet layer to provide the routing function across multiple networks.

Which of the above statements are correct?

(a) 1 and 2 only

(b) 1 and 3 only

(c) 1, 2 and 3

(d) 2 and 3 only

**04. Ans: (d)**

**Sol:** (1) Is FALSE. TELNET is an application protocol that allows a user at one site to access another user at a remote system. This is done as though the remote system were locally attached. TELNET uses the Transmission Control Protocol/Internet Protocol (TCP/IP) to connect to a remote system. TELNET uses TCP as an application layer Protocol.

(2) Is TRUE. SMTP is an application layer protocol which uses TCP as transport protocol. SMTP uses TCP port no. 25.

(3) Is TRUE. The Internet Protocol (IP) is responsible for routing data by indicating where data packets come from and what their destination is IP makes network-to-network communications possible. Hence, IP is considered as network layer (layer 3) protocol.

05. If a cellular system has p number of co-channel interfering cells, S is the desired signal power from serving base station and $I_p$ is interference power from $p^{th}$ interfering co-channel cell base station, then what is the signal to interference ratio for a mobile receiver in the functioning cell?

(a) $\frac{S}{\sum_{i=1}^{p} I_P}$ (b) $\frac{2\times S}{\sum_{i=1}^{p} I_P}$

(c) $\frac{\sum_{i=1}^{p} I_P}{S}$ (d) $\frac{S}{I_P}$

**05. Ans: (a)**

**Sol:** Signal power = S

Noise from interference cells

$$\frac{S}{I} = \frac{S}{\sum_{i=1}^{p} I_P}$$

P = Number of interference cells

$I_P$ = Interference power

06. Which one of the following provides a reliable connection for the transfer of data between applications?

(a) TCP (b) UDP

(c) FTP (d) SMTP

**06. Ans: (a)**

**Sol:** TCP enables data to be transferred between applications and devices on a network and is used in the TCP/IP model.

07. For a GEO satellite, what is the free space loss ($L_{db}$) at the equator in terms of carrier wavelength ($\lambda$)?

(a) 20 log($\lambda$) + 21.98 (b) –20 log($\lambda$) + 173.07

(c) 20 log($\lambda$) – 173.07 (d) –20 log($\lambda$) + 21.98

**07. Ans: (b)**

**Sol:** Space Loss ($L_P$) = $10\log\left(\frac{4\pi R}{\lambda}\right)^2$

R = 36000 km, GEO satellite

$L_P = 20\log\left(\frac{4\pi\times 36000\times 10^3}{\lambda}\right)$

$L_P = -20\log\lambda + 173.11$

08. If R = Earth's radius, h = orbit height, β = coverage angle, and θ = minimum elevation angle, then which one of the following relations is correct?

(a) $\frac{R}{R+h} = \frac{\cos(\beta+\theta)}{\cos(\theta)}$ (b) $\frac{R}{h} = \frac{\cos(\beta)}{\cos(\theta)}$

(c) $\frac{h}{R} = \frac{\cos(\beta+\theta)}{\cos(\beta)}$ (d) $\frac{R+h}{h} = \cos(\beta+\theta) - \cos(\theta)$

**08. Ans: (a)**

09. Consider the following statements for public circuit-switching network:

1. Private branch exchange (PBX) is an application of circuit switching.
2. A switching centre that directly supports subscribers is known as digital PBX.
3. The link between the subscriber and the network, is also referred to as the local loop.

Which of the above statements are correct?

(a) 1 and 2 only

(b) 1 and 3 only

(c) 1, 2 and 3

(d) 2 and 3 only

**09. Ans: (b)**

**Sol:** PBX uses circuit switching.

The link between subscribers and the network is called as loop.

10. Consider the following statements regarding the cellular system/network:

1. Cellular systems use open-loop power control and closed-loop power control.
2. For FDMA system, the capacity of a cell is more as compared to the number of frequency channels allocated to it.
3. A cell has L potential subscribers and is able to handle N simultaneous users. If L > N, then the system is referred to as non-blocking.

Which of the above statements are not correct?

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

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

**10. Ans: (b)**

**Sol:** Only (ii) is TRUE.

In cellular systems, Let T = total number of duplex channels

K cells = size of cell cluster (typically 4, 7, 12, 21)

N = T/K = number of channels per cell.

11. The fundamental parameter of a single-mode fiber is

(a) the core diameter and cladding diameter. (b) the mode-field diameter.

(c) the cladding diameter. (d) the buffer coating diameter.

**11. Ans: (b)**

**Sol:** The performance of a single mode fiber depends on mode field diameter.

12. Consider the following statements regarding the advantages of optical fiber communication:

1. Enormous potential bandwidth.
2. Electrical isolation.
3. Immunity to interference and crosstalk.
4. System reliability and ease of maintenance.

Which of the above statements are correct?

(a) 1 and 4 only (b) 2, 3 and 4 only

(c) 1, 2 and 3 only (d) 1, 2, 3 and 4 only

**12. Ans: (d)**

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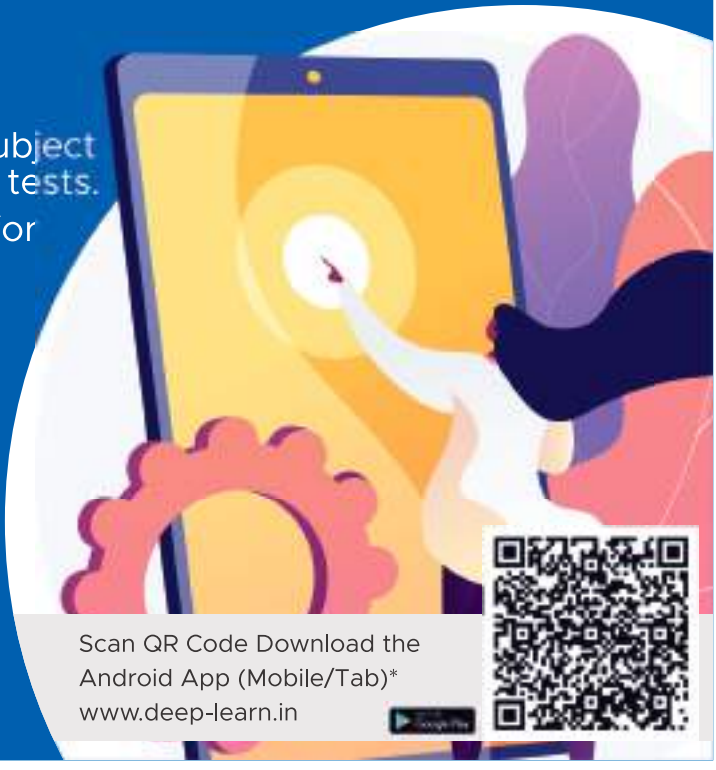

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13. Express the Boolean function $F = A + \bar{B}C$ as a sum of minterms?

(a) $ABC + \bar{A}\bar{B}C$ (b) $A\bar{B}C + \bar{A}\bar{B}C + A\bar{B}\bar{C}$

(c) $ABC + AB\bar{C} + A\bar{B}C + A\bar{B}\bar{C} + \bar{A}\bar{B}C$ (d) $AB\bar{C} + A\bar{B}C + \bar{A}\bar{B}\bar{C}$

**13. Ans: (c)**

**Sol:** $F = A + \bar{B}C = A(B+\bar{B})(C+\bar{C}) + (A+\bar{A})\bar{B}C$

$= ABC + AB\bar{C} + A\bar{B}C + A\bar{B}\bar{C} + A\bar{B}C + \bar{A}\bar{B}C$

$F = ABC + AB\bar{C} + A\bar{B}C + A\bar{B}\bar{C} + \bar{A}\bar{B}C$

14. Consider the following statements regarding n-channel JFET:

1. The maximum drain current $I_{DSS}$ occurs when gate-to-source voltage $V_{GS}$ = 0V and drain-to-source voltage $V_{DS} \geq |V_p|$, ($V_p$ is pinch-off voltage)
2. For gate-to-source voltage $V_{GS}$ less than the pinch-off level, the drain current is 0A.
3. For all levels of $V_{GS}$ between 0V and the pinch-off level, the current $I_D$ will range between $I_{DSS}$ and 0A, respectively.

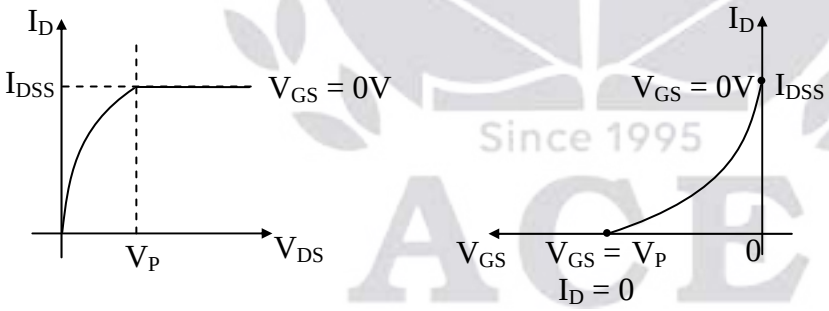
Which of the above statements are correct?

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

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

**14. Ans: (b)**

**Sol:**




**Drain Characteristics** **Transfer Characteristics**

→ The maximum possible drain current in JFET is $I_{DSS}$.

For $V_{GS}$ = 0V and $V_{DS} \geq |V_P|$, $I_D = I_{DSS}$

So, statement 1 is correct.

→ $V_{GS}$ less than pinch-off level means, $|V_{GS}| < |V_P|$ and $I_D \neq 0$.

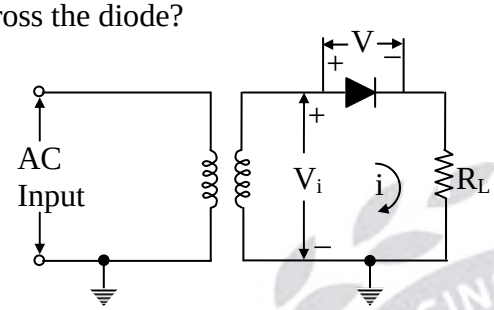
So, statement 2 is wrong.

→ $V_{GS}$ between 0V and the pinch-off level means $0 \le |V_{GS}| \le |V_P|$

At $V_{GS} = 0 \Rightarrow I_D = I_{DSS}$ and $V_{GS} = V_P \Rightarrow I_D = 0$

So, statement 3 is correct.

15. The circuit given below is a half wave rectifier. The internal resistance of a diode $R_f$ is 20Ω and load resistance $R_L$ is 1 kΩ. The input AC source with rms voltage is 110 V. That is the DC voltage across the diode?

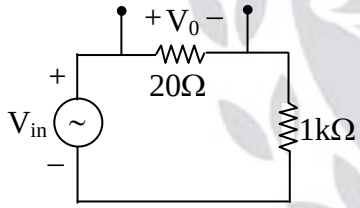



(a) –28.54 V (b) –38.54 V

(c) –48.54 V (d) –58.54V

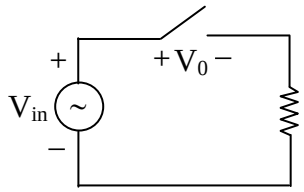
**15. Ans: (c)**

**Sol:** During positive cycle

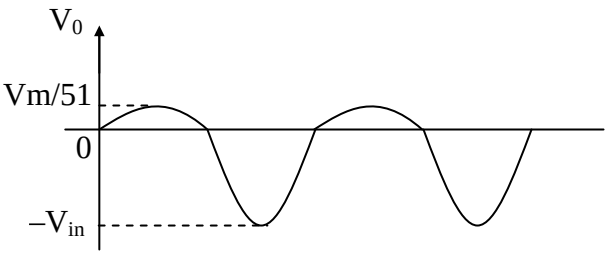



$$V_0 = \frac{V_{in}(20)}{1k + 20} = \frac{V_{in}}{51}$$

During negative cycle




$\therefore V_0 = V_{in}$




Given $\frac{V_m}{\sqrt{2}} = V_{rms} = 110V \rightarrow V_m = \sqrt{2}(110)$

$$V_{0_{avg}} = \frac{\frac{V_m}{51}}{\pi} - \frac{V_m}{\pi} = \frac{\sqrt{2}(110)}{51(\pi)} - \frac{\sqrt{2}(110)}{\pi} = -48.546$$

16. At the higher frequencies, which one of the following becomes more confined to the region between the micro-strip and ground plane?

(a) Electric field (b) Magnetic field

(c) Dispersion (d) Skin effect

**16. Ans: (a)**

**Sol:** As frequency approaches higher values, effective permittivity decreases, as a result characteristics impedance increases which suggest that electric field is more concentrated in the dielectric in case of microstrip line.

17. A magnetic field strength of 5 μA/m is required at a point on $\theta = \frac{\pi}{2}$, which is 2 km from a half-wave dipole antenna in air. If the radiation resistance of the half-wave dipole antenna is 73Ω, then the power radiated by this antenna (neglecting the ohmic loss) is

(a) 72 mW (b) 144 mW

(c) 158 mW (d) 316 mW

**17. Ans: (b)**

**Sol:** Given: H = 5μA/m, r = 2km, $R_r$ = 73Ω

Magnetic field intensity of half wave dipole antenna is

$$H_\phi = \frac{jI_0}{2\pi r}\frac{\cos\left(\frac{\pi}{2}\cos\theta\right)}{\sin\theta}$$

$$\left|H_\phi\right|\Big|_{\text{at }\theta=\pi/2} = \frac{I_0}{2\pi r}$$

$$I_0 = 2\pi r\left(H_\phi\right) = 2\pi\times 2\times 10^3\times 5\times 10^{-6} = 2\pi\times 10^{-2}$$

$$I_{rms} = \frac{I_0}{\sqrt{2}}$$

Power radiated by the half wave dipole is

$$P_{rad} = I_{rms}^2 R_r = \left(\frac{2\pi\times 10^{-2}}{\sqrt{2}}\right)^2\times 73 = 144mW$$

18. Consider the following statements regarding the waveguides:

1. Cut-off frequency is the operating frequency below which attenuation occurs and above which propagation takes place.
2. The dominant mode is the mode with the lowest cut-off wavelength.
3. The dominant mode in the rectangular waveguide (for a > b) will be $TE_{01}$.

Which of the above statements is/are not correct?

(a) 1 and 2 only

(b) 1 and 3 only

(c) 2 and 3 only

(d) 3 only

**18. Ans: (c)**

**Sol:** Cut off frequency is the frequency, below which waves are attenuated and above which wave propagation takes place.

A mode which is having lowest cut off frequency or highest cut off wavelength is called dominant mode.

$TE_{10}$ mode is the dominant mode in rectangular waveguide.

So, statement 2 and 3 are not correct.

19. Consider the following statements for Poly-Si deposition:

1. Poly-Si layer is used for gate electrode of MOSFET because it has similar lattice constants with $SiO_2$.
2. Poly-Si layer used for gate electrode of MOSFET for the better mechanical stability due to different thermal expansion coefficients.
3. In VLSI circuits, interconnects can be completed in one or two metal levels.
4. Poly-Si is used for short interconnects.

Which of the above statements are correct?

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

(c) 1 and 4 only (d) 2, 3 and 4 only

**19. Ans: (d)**

20. Consider the following statements regarding the Read Only Memory (ROM):

1. The stored data is lost if the power is removed
2. It consists of an address decoder with n input lines and a programmable OR array with n output lines.
3. The min terms are ORed through the programmable switches which can be made ON or OFF to select a particular minterms. The programmable switches can be CMOS, nMOS or pMOS technologies.
4. Mask-programmed ROMs are used in the applications where the system requires data to be stored and to be changed during the operation.

Which of the above statements are not correct?

(a) 1 and 2 only (b) 1,3 and 4 only

(c) 1,2 and 4 only (d) 2,3 and 4 only

**20. Ans: (c)**

**Sol:** ROM consists of Decoder followed by programmable OR gates.

21. If each core in a 16-core processor has a yield of 90% and nothing else on the chip fails, what is the yield of the chip?

(a) $(0.9)^8$ (b) $(0.9)^{16}$

(c) $(0.1)^8$ (d) $(0.1)^{16}$

**21. Ans: (b)**

**Sol:** Since, there is no failure rate of the chip and as it is 16-core processor with 90% efficiency, the yield of the chip is $(0.9)^{16}$.

22. What is the simplified value of y(n), if $y(n)=\sum_{n=-5}^{5}\sin(2n)\delta(n+7)$?

(a) sin 10 (b) –sin 10

(c) 1 (d) 0

**22. Ans: (d)**

**Sol:** The value $y(n)=\sum_{n=-5}^{5}\sin(2n)\delta(n+7)$

sin(2n) covers the index in the range $-5 \le n \le 5$

But discrete impulse is at n = –7

So, the product of sin(2n) and δ(n+ 7) for the given range is 0.

23. The energy of the signal $x(n) = (-0.4)^n u(n)$ is

(a) 1/16 (b) 1/36

(c) 5/3 (d) 25/4

**23. Ans: (*)**

**Sol:** $x(n) = (-0.4)^n u(n)$

$$E_{x(n)} = \sum_{n=-\infty}^{+\infty}|x(n)|^2 = \sum_{n=0}^{\infty}\left|(-0.4)^n\right|^2$$

$$= \sum_{n=0}^{\infty}(0.16)^n$$

$$= 1 + (0.16) + (0.16)^2 + \ldots\ldots$$

$$= \frac{1}{1-0.16} = \frac{1}{1-\frac{16}{100}} = \frac{100}{84} = \frac{25}{21}$$

No option Correct.

24. Consider the following statements for a system given by $y(n) = x(n)\sum_{k=-\infty}^{\infty}\delta(n-3k)$.

1. The system is linear.
2. The system is non-linear.
3. The system is causal.
4. The system is non-causal.

Which of the above statements is/are correct?

(a) 1 only (b) 2 only

(c) 2 and 4 only (d) 1 and 3 only

**24. Ans: (d)**

**Sol:** $y(n) = x(n)\sum_{k=-\infty}^{\infty}\delta(n-3k)$

From product property of impulse signal

$$y(n) = \sum_{k=-\infty}^{\infty} x(3k)\delta(n-3k)$$

(i) $y_1(n) = \sum_{k=-\infty}^{\infty} x_1(3k)\delta(n-3k)$

$$y_2(n) = \sum_{k=-\infty}^{\infty} x_2(3k)\delta(n-3k)$$

$$y_3(n) = \sum_{k=-\infty}^{\infty} [\alpha x_1(3k) + \beta x_2(3k)]\delta(n-3k)$$

$y_3(n) = \alpha\, y_1(n) + \beta\, y_2(n)$

So, system is linear.

(ii) Present output depends on present input.

So, system is causal system.

25. Which one of the following is the zero-input response of the system $y(n) - 3y(n-1) - 4y(n-2) = 0$ Described by the homogeneous second-order difference equation if $y(-2) = 0$ and $y(-1) = 5$?

(a) $y_{zi}(n) = (-1)^{n+1} + (-4)^{n+2}$, $n \geq 0$ (b) $y_{zi}(n) = (1)^{n+1} + (4)^{n+2}$, $n \geq 0$

(c) $y_{zi}(n) = (-1)^{n+1} + (4)^{n+2}$, $n \geq 0$ (d) $y_{zi}(n) = (1)^{n+1} + (-4)^{n+2}$, $n \geq 0$

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**25. Ans: (c)**

**Sol:** $y(n) - 3y(n-1) - 4y(n-2) = 0$

Applying z- transform

$(y(-2) = 0 \ , \ y(-1) = 5)$

$$y(n-1) \xleftrightarrow{Z.T} z^{-1}Y(z) + y(-1)$$

$$y(n-2) \xleftrightarrow{Z.T} z^{-2}Y(z) + z^{-1}y(-1) + y(-2)$$

Solve for zero input response

$$Y(z) - 3[z^{-1}Y(z) + y(-1)] - 4[z^{-2}Y(z) + z^{-1}y(-1) + y(-2)] = 0$$

$$Y(z) - 3[z^{-1}Y(z) + 5] - 4[z^{-2}Y(z) + 5z^{-1}] = 0$$

$$Y(z)\ [1 - 3z^{-1} - 4z^{-2}] - 15 - 20z^{-1} = 0$$

$$Y(z) = \frac{15 + 20z^{-1}}{1 - 3z^{-1} - 4z^{-2}} = \frac{15 + 20z^{-1}}{(1 - 4z^{-1})(1 + z^{-1})} = \frac{A}{1 - 4z^{-1}} + \frac{B}{1 + z^{-1}}$$

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

$$= \frac{16}{1 - 4z^{-1}} - \frac{1}{1 + z^{-1}}$$

Applying inverse z-transform

$$y_{zi}(n) = 16(4)^n u(n) - (-1)^n u(n)$$

$$= (4)^{n+2} + (-1)^{n+1} \ ; \ n \geq 0$$

26. Consider the following statements regarding Epitaxial Growth:

1. The layers are grown on a substrate wafer, this technique is known as epitaxial growth.
2. Physical vapour deposition is also called vapour phase epitaxy.
3. OMCVD is a technique to grow epitaxial layers from metalorganic compounds.
4. High throughout and slow deposition rate are the disadvantages of the CVD technique.

Which of the above statements are correct?

(a) 2 and 3 only

(b) 1 and 3 only

(c) 1, 2 and 3 only

(d) 1, 3 and 4 only

**26. Ans: (b)**

**Sol:**

→ Epitaxial layer is a thin layer grown on a substrate wafer called epitaxial growth

→ Physical vapor deposition is vaporization technique and is in some respect similar to chemical vapor deposition except in PVD the material to be deposited start out in solid form where as in CVD it is in gaseous form

→ OMCVD (Orgonometalic Chemical Vapor Deposition) is advance technique which allow the formation of metal thin films (platinum) as a fine dispersion of metal particles

→ CVD has fast deposition rate.

Statement (I) and (III) is correct

Option (b)

27. FIR filter having anti-symmetrical impulse response with even filter order can be used to design

(a) low-pass, high-pass, band-pass and band-stop.

(b) low-pass and band-pass only.

(c) high-pass and band-stop only.

(d) differentiator and Hilbert transformer

**27. Ans: (d)**

**Sol:** FIR filters with anti-symmetric I.R with even filter order used to design differentiator and Hilbert Transformer.

28. An IIR filter having numerator order M and denominator order N is to be realized using direct form II structure, How much total number of multiplications, additions and memory locations are required respectively?

(a) M+N, M+N and M+N

(b) M+N, M+N and maximum of [M, N]

(c) M+N+1, M+N+1 and M+N

(d) M+N+1, M+N and maximum of [M,N]

**28. Ans: (d)**

**Sol:** IIR filter having numerator order M and denominator order N is to be realized using direct form II structure.

Total no. of Multiplications = (M+N+1)

Additions = (M+N)

Memory locations = Maximum [M, N]

(unit delays)

29. In 8051, the accumulator register contains 80H and B register contains 8FH. The content of the accumulator and status of the carry flag after the addition operation are respectively,

(a) 0FH, 1 (b) 10FH, 0

(c) FFH, 1 (d) 10FH, 1

**29. Ans: (*)**

**Sol:** B-register can not be used for addition, it is used only for multiplication and division.

30. Which one of the following operations is **not** commutative?

(a) Scaling and reversal of a signal x(n)

(b) Scaling and folding of a signal x(n)

(c) Folding and time reversal of a signal x(n)

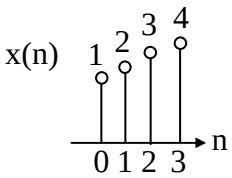
(d) Folding and time delaying of a signal x(n)

**30. Ans: (d)**

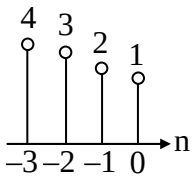
**Sol:** Folding and time delaying of a signal

**Ex:**

x(n) = {1,2,3,4}



$x(-n) = \{4,3,2,\underset{\uparrow}{1}\}$

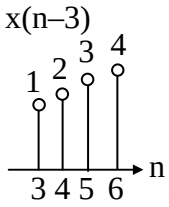



Delay x(–n) by 3 samples

$n \rightarrow 0\ 1\ 2\ 3$

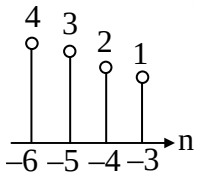
$y_1(n) = x(-(n-3)) = \{4,3,2,1\}$

Delay x(n) by 3 samples




Time reverse this signal

x(–n – 3)




Folding and time delaying of a signal x(n) operation is not commutative

31. Which one of the following is correct for the given system?

$y(n) = x(n) - x(n-1)$

(a) Time invariant and causal

(b) Time variant and non-causal

(c) Time variant and causal

(d) Time invariant and non-causal

**31. Ans: (a)**

**Sol:** Given $y(n) = x(n) - x(n-1)$

(i) Delay the input by 'k' units, then output is

$$y_1(n) = x(n-k) - x(n-k-1)$$

Delay the output by k units, then output is

$y(n-k) = x(n-k) - x(n-k-1)$

$y_1(n) = y(n-k)$

So, time invariant system.

$y(n) = x(n) - x(n-1)$

(ii) Present output depends on present input, past inputs.

So, system is causal system.

32. Two vectors $V_1$ and $V_2$ are orthogonal if their dot product is

(a) 1 (b) 0

(c) infinity (d) 0.5

**32. Ans: (b)**

**Sol:** 2 Vectors $V_1$ and $V_2$ are orthogonal if their dot product is 0

$\overrightarrow{V_1}.\overrightarrow{V_2} = 0$

33. A discrete-time LTI system with rational system function H(z) is causal if and only if

(a) the ROC is the exterior of a circle outside the outermost pole.

(b) the ROC is the interior of a circle outside the outermost pole.

(c) the ROC is the exterior of a circle outside the innermost pole.

(d) the ROC is the interior of a circle outside the innermost pole.

**33. Ans: (a)**

**Sol:** A D.T LTI system with rational system function H(z) is causal if and only if ROC is the exterior of a circle outside the outermost pole.

34. A feedback system has an open-loop transfer function of

$$G(s)H(s)=\frac{K(1-s)}{s(s^2+5s+9)}$$

By using the Routh criterion, the maximum value of K for the closed-loop system to be stable is

(a) 2.5 (b) 5

(c) 7.5 (d) 9

**34. Ans: (c)**

**Sol:** CE $\rightarrow$ $1 + G(s)\,H(s) = 0$

$$s^3 + 5s^2 + 9s + K - Ks = 0$$

$$s^3 + 5s^2 + s(9 - K) + K = 0$$

| | | |
|---|---|---|
| $s^3$ | 1 | $9 - K$ |
| $s^2$ | 5 | $K$ |
| $s^1$ | $\left(\frac{45-5K-K}{5}\right) > 0$ | |
| $s^0$ | $K > 0$ | |

$6K < 45$

$$K < \frac{45}{6}$$

$K < 7.5$

Maximum value of K for stability is 7.5

35. The steady-state error of type 1 system with input $r(t)=\frac{t^2}{2}$, $t \geq 0$; is

(a) 0 (b) 1/2

(c) 1 (d) $\infty$

**35. Ans: (d)**

**Sol:** Type-1 System for parabolic I/P, the $e_{ss}$ is $\infty$

**Ex:** $G(s)=\dfrac{K(1+s\tau_1)}{s(1+s\tau_a)},\ H(s)=1$

$$K_a=\underset{S\to0}{Lt}\,s^2G(s)=\underset{S\to0}{Lt}\,s^2\left(\frac{K(1+s\tau_1)}{s(1+s\tau_a)}\right)=0$$

$$e_{ss}=\frac{1}{K_a}=\frac{1}{0}=\infty$$

36. Which one of the following statements is correct regarding constant N circles?

(a) The locus of constant, closed-loop magnitude frequency response for unity feedback systems.

(b) The locus of constant, closed-loop phase frequency response for unity feedback systems.

(c) A subsystem inserted into the forward or feedback path for the purpose of improving the transient response or steady-state error.

(d) A system that monitors its output and corrects for disturbances. It is characterized by feedback paths from the output.

**36. Ans: (b)**

**Sol:** Consider closed loop frequency response

$$M(j\omega)=\frac{C(j\omega)}{R(j\omega)}=\frac{G(j\omega)}{1+G(j\omega)}=\frac{(x+jy)}{(1+x+jy)}$$

$$\alpha=\tan^{-1}\left(\frac{y}{x}\right)-\tan^{-1}\left(\frac{y}{1+x}\right)$$

$$N=\tan\alpha=\frac{y}{x^2+x+y^2}$$

For a constant value of $\alpha$, $N = \tan\alpha$ is constant.

Constant N circles give the phase curves of closed loop frequency response.

37. Which one of the following digital modulation schemes has the bit error rate as $\frac{1}{2}\text{erfc}\left(\sqrt{\frac{E_b}{N_0}}\right)$?

(a) Coherent binary PSK

(b) Coherent binary FSK

(c) DPSK

(d) Noncoherent binary FSK

**37. Ans: (a)**

**Sol:** $\frac{1}{2}\text{erfc}\left(\frac{x}{\sqrt{2}}\right) = Q(x)$

$$\frac{1}{2}\text{erfc}\left(\sqrt{\frac{E_b}{N_0}}\right) = Q\left(\sqrt{\frac{2E_b}{N_0}}\right)$$

$$E_b = \frac{A_c^2 T_b}{2}$$

$$Q\left(\sqrt{\frac{2E_b}{N_0}}\right) = Q\left(\sqrt{\frac{A_c^2 T_b}{N_0}}\right) = P_e \text{ (B-PSK coherent scheme)}$$

38. Which one of the following conditions is justifying a second-order approximation?

(a) Closed-loop zeros near the closed-loop second-order pole pair are nearly cancelled by the close proximity of higher-order closed-loop poles.

(b) Closed-loop zeros cancelled by the close proximity of higher-order closed-loop poles are far removed from the closed-loop second-order pole pair.

(c) Closed-loop zeros near the closed-loop second-order pole pair are not cancelled by the close proximity of higher-order closed-loop poles.

(d) Closed-loop zero cancelled by the close proximity of higher-order closed-loop poles are far removed from the closed-loop second-order zero pair.

**38. Ans: (a)**

**Sol:** For a second order approximation, the closed-loop zeros near the closed-loop second order pole pair are nearly cancelled by the close proximity of higher-order closed loop poles.

39. Consider the following statements regarding the disadvantages of a passive lead network over an active PD controller:

1. No additional power supplies are required.
2. Noise due to differentiation is reduced.
3. Additional pole does not reduce the number of branched of the root locus that cross the imaginary axis into the right half-plane.
4. Addition of the single zero of the PD controller tends to reduce the number of branched of the root locus that cross into the right half-plane.

Which of the above statements is/are correct?

(a) 1 only (b) 2 only

(c) 3 and 4 only (d) 1,2 and 4 only

**39. Ans: (c)**

**Sol:** Lead compensator adds one finite zero and finite pole. Hence the number of root locus branches which are moving right side are not reduce.

PD controller add one finite zero. Hence the number of root locus branches which are moving right side are reduced.

40. Which one of the following characteristics is correct regarding RISC processor?

(a) Relatively very large addressing modes

(b) Multi-cycle instruction execution

(c) All operations are not done within the registers of the CPU

(d) Relatively few instructions

**40. Ans: (d)**

**Sol:** RISC processor

1. Executes instructions in one cycle
2. It has few Instructions
3. It has few Addressing modes
4. All operations are done in CPU registers

41. Which one of the following instructions in a stack computer consists of an operation code only with no address field?

(a) PUSH X (b) POP X

(c) ADD (d) LOAD A

**41. Ans: (c)**

**Sol:** In a stack computer, the Arithmetic and logical operations are done on top of the stack values. Hence the Address field is not required.

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42. Which one of the following statements is correct regarding arithmetic and logical operations?

(a) When two 3-bit unsigned numbers are multiplied, the result is an 8-bit product that must be stored in three memory words.

(b) When two 16-bit unsigned numbers are multiplied, the result is a 32-bit product that must be stored in two memory words.

(c) Operations that are implemented in a computer with one machine instruction are said to be implemented by software.

(d) Operations implemented by a set of instructions that constitute a program are said to be implemented by hardware.

**42. Ans: (b)**

**Sol:** After multiplying 2 no. of 16 bit numbers, the longest result size is 32 bit, hence it requires two memory locations for storing the result.

43. Which one of the following techniques inherits the simplicity of the direct mapping technique in terms of determining the target set?

(a) Set-associative-mapping technique

(b) Set-associative-direct mapping technique

(c) Direct mapping set technique

(d) Indirect mapping set technique

**43. Ans: (a)**

**Sol:** In set associative mapping, the principles of both direct mapping and Associative mapping are implemented. To decide the set we use direct mapping.

44. Which one of the following memories is primarily used to store machine microcode, desktop bootstrap loaders, and video game cartridges?

(a) Mask-programmed ROM (b) Static-RAM

(c) Dynamic-RAM (d) Non-Programmed ROM

**44. Ans: (a)**

**Sol:** In all systems, Programmable ROM is used to store the system programs, boot strap loader and micro code.

45. In which one of the following situations is the CPU often idle?

(a) The speeds of the mechanical I/O devices are intrinsically slower than those of electronic devices.

(b) The speeds of the electomechanical I/O devices are intrinsically faster than those of electronic devices.

(c) The speeds of the electrical I/O devices are intrinsically slower than those of electronic devices.

(d) The speeds of the electrical I/O devices are intrinsically faster than those of electronic devices.

**45. Ans: (a)**

**Sol:** In a computer CPU and memory are electronic devices. I/O devices are electromechanical and electromagnetic devices, which are slower than CPU.

46. A white noise of magnitude 0.001 μW/Hz is applied to an RC low-pass filter of R = 1kΩ and C = 0.1 μF. The output noise power of the RC low-pass filter is

(a) 0.5 μW (b) 1.5 μW

(c) 2.5 μW (d) 3.5 μW

**46. Ans: (c)**

**Sol:** If single sided power spectral density is considered, then output noise power

$$N_0 = \frac{N_0}{4RC} = \frac{0.001\times10^{-6}}{4\times10^{3}\times0.1\times10^{-6}} = \frac{10^{-5}}{4} = 2.5\mu W$$

**NOTE:** By default, noise is considered as two sided PSD i.e., $\frac{N_0}{2} = 0.001 W/Hz$, in that case, o/p noise power is 5 μW.

47. The two random variables X and Y are uncorrelated if and only if their covariance is

(a) 0 (b) 1

(c) –1 (d) infinity

**47. Ans: (a)**

**Sol:** X, Y are uncorrelated if and only if $\rho_{XY} = 0$

Where $\rho_{XY}$ defined as, $\rho_{xy} = \frac{Cov(X,Y)}{E(X)E(Y)}$

$\therefore$ If $Cov(X, Y) = 0 \Rightarrow \rho_{XY} = 0 \Rightarrow$ uncorrelated

48. The antenna current of an AM transmitter is 8 A when only the carrier signal is transmitted. What is the antenna current when the carrier signal is modulated by sinusoidal signal V(t) = 1.4 sin(2π × 500t) with modulation index 0.8?

(a) 3.2 A (b) 7.2 A

(c) 9.2 A (d) 11.2 A

**48. Ans: (c)**

**Sol:** $I_t = I_c\sqrt{1+\frac{\mu^2}{2}}$

$I_t = 8\sqrt{1+\frac{0.64}{2}}$

$I_t = 8\sqrt{1.32} = 9.19\,A \approx 9.2\,A$

49. A 10 MHz carrier signal is frequency-modulated by analog-modulating signal. The maximum frequency deviation is 75 kHz. If the frequency of the modulating signal is 300 kHz, then the modulation index and the approximate transmission bandwidth of the FM signal are respectively,

(a) 0.25, 750 kHz (b) 0.25, 600 kHz

(c) 0.75, 750 kHz (d) 0.75, 450 kHz

**49. Ans: (b)**

**Sol:** $\Delta f_{max} = 75\,kHz$

$f_{max} = 300\,kHz$

$\beta = \frac{\Delta f_{max}}{f_{max}} = \frac{75}{300} = \frac{1}{4} = 0.25$

$BW_{NBFM} = 2f_{max} = 600\,kHz$

50. Consider the following statements for baseband transmission model:

1. Channel signal-to-noise ratio is defined as the ratio of the average power of the modulated signal to the average power of noise in the message bandwidth, both measured at the receiver input.
2. Channel signal-to-noise ratio is defined as the ratio of the average power of the modulated signal to the average power of noise in the message bandwidth, both measured at the receiver output.

3. Figure of merit = $\frac{(SNR)_o}{(SNR)_c}$, where o stands for output and c stands for channel.

4. Figure of merit = $\frac{(SNR)_c}{(SNR)_o}$, where o stands for output and c stands for channel.

Which of the above statements are correct?

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

(c) 1 and 4 only (d) 2 and 4 only

**50. Ans: (a)**

**Sol:**

$\left(\frac{S}{N}\right)_c$ — Rx — $\left(\frac{S}{N}\right)_o$

$$\left(\frac{S}{N}\right)_C = \frac{\text{Signal Power [modulated]}}{\text{Noise Power in message BW}}$$

$$\text{Figure of Merit} = \frac{\left(\frac{S}{N}\right)_O}{\left(\frac{S}{N}\right)_C}$$

51. Which is the entropy of a communication system that consists of six messages with probabilities 1/8, 1/8, 1/8, 1/8, 1/4 and 1/4 respectively?

(a) 1 bit/message

(b) 2.5 bits/message

(c) 3 bits/message

(d) 4.5 bits/message

**51. Ans: (b)**

**Sol:** Entropy, $H = -\sum P\log_2 P = -\sum P\log_2 \frac{1}{P}$

$$H = \frac{1}{8}\log_2 8 + \frac{1}{8}\log_2 8 + \frac{1}{8}\log_2 8 + \frac{1}{8}\log_2 8 + \frac{1}{4}\log_2 4 + \frac{1}{4}\log_2 4$$

$$H = 4\times\frac{3}{8} + 2\times\frac{2}{4} = \frac{12}{8} + 1 = 2.5 \text{ bits/message}$$

52. Discrete samples of an analog signal are uniformly quantized to PCM. If the maximum value of analog sample is to be represented within 0.1% accuracy, then the minimum number of binary digits required per sample is

(a) 4 (b) 8

(c) 10 (d) 12

**52. Ans: (c)**

**Sol:** $Q_e = \frac{0.1}{100} \times A_m$

$$\frac{1}{2}\left[\frac{2A_m}{L}\right] = \frac{0.1}{100} \times A_m$$

$$\frac{1}{L} = \frac{1}{1000}$$

$$L = 1000 = 2^n \approx 2^{10}$$

$$n = 10$$

53. Six analog information signals, each band-limited to 4 kHz, are required to be time-division multiplexed and transmitted by a TDM system. The minimum transmission bandwidth and the signalling rate of the PAM/TDM channel are respectively,

(a) 24 kHz and 48 kbps (b) 24 kHz and 8 kbps

(c) 48 kHz and 48 kbps (d) 48 kHz and 16 kbps

**53. Ans: (a)**

**Sol:** $N = 6$

$f_m = 4k$

$B_T = N.f_m = 24\,kHz$

Signalling rate = $\frac{r_b}{n} = N.f_s = 6 \times 2 \times 4k = 48\,kbps$

54. A 2000 bps binary information data signal is required to be transmitted in half-duplex mode using BFSK digital modulation technique. If the separation between two carrier frequencies is 4000 Hz, then the minimum bandwidth of the BFSK signal is

(a) 4 kHz (b) 6 kHz

(c) 8 kHz (d) 12 kHz

**54. Ans: (b)**

**Sol:** Bit rate $r_b = 2000$

$f_1 - f_2 = 4000\,\text{Hz}$

When Rectangular pulses are used,

$\text{BW}_{\text{(B-FSK)}} = f_1 - f_2 + 2r_b = 4000 + 2 \times 2000 = 8000\,\text{Hz} = 8\text{kHz}$

$\text{BW}_{\text{(B-FSK) (min)}} = \dfrac{4}{T_b} = 8\,\text{kHz}$

When Nyquist sampling pulses are used,

$\text{BW}_{\text{(B-FSK)}} = f_1 - f_2 + \dfrac{1}{T_b} = f_1 - f_2 + r_b = 4000 + 2000 = 6\,\text{kHz}$

55. If voice activity interference reduction factor is 2.5, antenna sectorization gain factor is 2.5 and interference increase factor is 1.6, then the performance improvement factor in CDMA digital cellular system is

(a) 1.2 (b) 2.5

(c) 3.1 (d) 3.9

**55. Ans: (d)**

**Sol:** Voice interference reduction factor, $G_V = 2.5$

Antenna sectorization factor, $G_S = 2.5$

Interference increase factor = P = 1.6

Performance improvement factor = $\dfrac{G_V G_A}{P} = \dfrac{2.5 \times 2.5}{1.6} = 3.9$

56. The temperature at a particular place varies between 14°C and 34°C. For the purpose of transmitting the temperature record of that place using PCM, the record is sampled at an appropriate sampling rate and the samples are quantized. If the error in representation of the samples due to quantization is not to exceed ±1% of the dynamic range, what is the minimum number of quantization levels that can be used?

(a) 100 (b) 50

(c) 30 (d) 15

**56. Ans: (b)**

**Sol:** Dynamic Range, DR = 34 – 14 = 20

$$\Delta = \frac{DR}{L} = \frac{20}{L}$$

$$\frac{\Delta}{2} = \frac{1}{100} \times DR$$

$$\frac{20/L}{2} = \frac{1}{100} \times 20$$

$$\frac{1}{2L} = \frac{1}{100}$$

$$2L = 100$$

$$L = 50$$

57. A multimode step index fiber with a core diameter of 80 μm and a relative index difference of 1.5% is operating at a wavelength of 0.85 μm. If the core refractive index is 1.48, then the normalized frequency for the fiber is

(a) 37.9 (b) 75.8

(c) 151.6 (d) 303.2

**57. Ans: (b)**

**Sol:** V = Normalized frequency = $\frac{2\pi a}{\lambda}.NA$

Core radius = a = $40\times10^{-6}$

$$\lambda = 0.85\times10^{-6}$$

$$NA = \sqrt{n_1^2 - n_2^2}$$

$$n_1 = 1.48,\ \Delta = 1.5\% = 0.015$$

$$\frac{n_1 - n_2}{n_1} = 0.015 \Rightarrow \frac{1.48 - n_2}{1.48} = 0.015$$

$$n_2 = 1.458$$

$$NA = \sqrt{n_1^2 - n_2^2} = 0.254$$

$$V = \frac{2\pi \times 40\times10^{-6}}{0.85\times10^{-6}} \times 0.254 = 75.10$$

58. The even and odd components of the signal $x(t) = e^{-2t}\cos t$ are respectively,

(a) cos 2t cos t and – sin 2t cos t

(b) sinh 2t sin t and – cosh 2t cos t

(c) cos 2t sin t and –sin 2t cos t

(d) cosh 2t cos t and – sinh 2t cos t

**58. Ans: (d)**

**Sol:** Given $x(t) = e^{-2t}\cos(t)$

$$x_e(t) = \frac{x(t) + x(-t)}{2} = \frac{e^{-2t}\cos(t) + e^{2t}\cos(t)}{2}$$

$$x_e(t) = \frac{1}{2}\cos(t)\left[e^{-2t} + e^{2t}\right] = \cos(t).\cosh(2t)$$

$$x_0(t) = \frac{x(t) - x(-t)}{2} = \frac{e^{-2t}\cos(t) - e^{2t}\cos(t)}{2}$$

$$x_0(t) = \frac{1}{2}\cos(t)\left[e^{-2t} - e^{2t}\right]$$

$x_0(t) = -\cos(t)\sinh(2t)$

59. What is the convolution integral c(t) for a system with input x(t) and impulse response h(t), where $x(t) = u(t-1) - u(t-3)$ and $h(t) = u(t) - u(t-2)$?

(a) $c(t) = \begin{cases} 0, & t < 1 \\ t-1, & 1 \le t < 3 \\ 5-t, & 3 \le t < 5 \\ 0, & t \ge 5 \end{cases}$

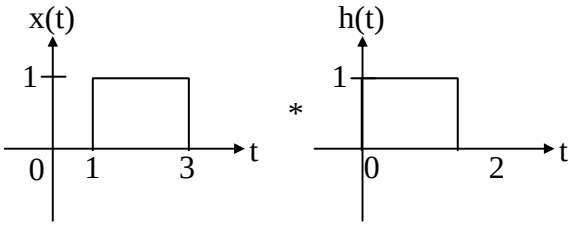
(b) $c(t) = \begin{cases} 0, & t < 1 \\ t - \frac{1}{2}, & 1 \le t < 2 \\ \frac{3}{2} - t, & 2 \le t < 5 \\ 0, & t \ge 5 \end{cases}$

(c) $c(t) = \begin{cases} 0, & t < 1 \\ 5-t, & 1 \le t < 4 \\ 0, & t \ge 4 \end{cases}$

(d) $c(t) = \begin{cases} 2, & 1 \le t \le 2 \\ 1, & 3 \le t \le 5 \\ 0, & \text{otherwise} \end{cases}$

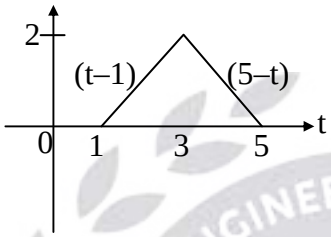
**59. Ans: (a)**

**Sol:** x(t) = u(t – 1) – u(t – 3) and h(t) = u(t) – u(t – 2)




Convolution of 2 equal length rectangles is Triangle.

$u(t) * u(t) = r(t)$




y(t) = x(t)*h(t)

= [u(t –1) –u(t–3)]*[u(t) – u(t–2)]

= r(t–1) – r(t–3) – r(t–3) + r(t–5)

= r(t–1) – 2r(t–3) + r(t–5)

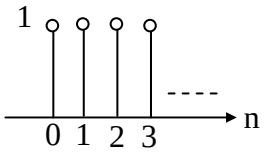
60. The power and energy of the unit step sequence are respectively,

(a) 1/2 and 0 (b) 1/2 and infinity

(c) 2 and 0 (d) 2 and infinity

**60. Ans: (b)**

**Sol:** x(n) = u(n)




$$\text{Power in } x(n) = \lim_{N\to\infty} \frac{1}{2N+1} \sum_{n=-N}^{+N} |x(n)|^2$$

$$= \lim_{N\to\infty} \frac{1}{2N+1} \sum_{n=0}^{N} (1)^2$$

$$= \lim_{N\to\infty} \frac{N+1}{2N+1} = \lim_{N\to\infty} \frac{N\left(1+\frac{1}{N}\right)}{N\left(2+\frac{1}{N}\right)}$$

$$= \frac{1}{2}$$

For a power signal, Energy = ∞

61. Which one of the following systems provides a mechanism for translating program-generated addresses into correct main memory locations?

(a) Virtual memory system

(b) Main memory system

(c) Physical addresses system

(d) Memory space system

**61. Ans: (a)**

**Sol:** A virtual memory system provides a mechanism for translating program-generated addresses into correct main memory locations. This is done dynamically, while programs are being executed in the CPU. The translation or mapping is handled automatically by the hardware by means of a mapping table.

62. Consider the following statements regarding memory:

1. Integrated circuit RAM chips are available in both static and dynamic modes.
2. The dynamic RAM stores the binary information in the form of electric charges that are applied to capacitors.
3. The static RAM is easier to use and has shorter read and write cycles.
4. RAM and ROM chips are available in a variety of sizes.

Which of the above statements are correct?

(a) 1 and 2 only

(b) 1,3 and 4 only

(c) 2,3 and 4 only

(d) 1,2,3 and 4

**62. Ans: (d)**

**Sol:** All statements are True.

Static and Dynamic RAM's are designed with electronic chips of different sizes 1GB, 2 GB, 4GB.

⇒ In Dynamic RAM, capacitor is used to store bit voltage.

⇒ Static RAM is faster hence it executes the program in shortest time

⇒ RAM and ROM chips are designed with different sizes likes 64KB, 128KB, 1MB, 1GB, 4GB, etc.

63. Which one of the following messaging systems attempts to avoid double copy operations by using virtual-memory management techniques?

(a) Mach message system

(b) Duplex message system

(c) Packet message system

(d) Data message system

**63. Ans: (a)**

**Sol:** If we copy the same file from one drive to another drive on the same disk, it is treated as "double copy operation". It leads to memory wastage of memory. To avoid this we use Mach messaging system.

64. Which one of the following storage devices used is when the operating system abstracts from the physical properties of its storage devices to define a logical storage unit?

(a) Volatile storage devices

(b) Non-volatile devices

(c) Flash storages

(d) Cache storage devices

**64. Ans: (b)**

**Sol:** If OS is trying to access some program that is part of virtual memory (which is part of Secondary memory (Hard Disk which is non - volatile)).

65. Which one of the following is not correct when we define either a class that does not implement either a mathematical entity like a matrix or a complex number or a low-level type such as a linked list?

(a) Don't use global data (use members)

(b) Don't use local functions

(c) Don't use public data members

(d) Don't use inline functions, except as a significant optimization

**65. Ans: (b)**

**Sol:** Assuming, here local functions means functions that are members of a class i.e. member functions then the answer would be (b).

Since all the operations are best handled by member functions as it enables abstraction and prevents external entities from handling private data.

Therefore, we must use member functions. Hence option (b) is right here.

66. Which one of the following is also called as pseudo instructions that are not directly translated into machine language instructions?

(a) Macro expansions

(b) Assembly directives

(c) Micro expansions

(d) Labels

**66. Ans: (b)**

**Sol:** Assembly Directives are called as "Pseudo Instructions". They are not converted into machine Instructions.

67. The component of $\vec{P} = 2\hat{a}_x - \hat{a}_z$ along

$\vec{Q} = 2\hat{a}_x - \hat{a}_y + 2\hat{a}_z$ is

(a) $0.745\hat{a}_x + 0.298\hat{a}_y - 0.596\hat{a}_z$

(b) $4\hat{a}_x - 2\hat{a}_y + 4\hat{a}_z$

(c) $0.2222\hat{a}_x - 0.1111\hat{a}_y + 0.2222\hat{a}_z$

(d) $0.4444\hat{a}_x - 0.2222\hat{a}_y + 0.4444\hat{a}_z$

**67. Ans: (d)**

**Sol:** The vector projection of $\vec{P}$ along $\vec{Q}$ is given by

$$= \left(\frac{\vec{P}.\vec{Q}}{|\vec{Q}|}\right)\hat{a}_Q = \left\{\frac{[2\hat{a}_x - \hat{a}_z][2\hat{a}_x - \hat{a}_y + 2\hat{a}_z]}{\sqrt{2^2+1^2+2^2}}\right\}\left(\frac{2\hat{a}_x - \hat{a}_y + 2\hat{a}_z}{\sqrt{9}}\right)$$

$$= \left(\frac{4-2}{9}\right)(2\hat{a}_x - \hat{a}_y + 2\hat{a}_z) = 0.44\hat{a}_x - 0.22\hat{a}_y + 0.44\hat{a}_z$$

68. Consider the following equations with time factor $e^{j\omega t}$ :

1. $\oint D_s.DS = \int \rho_{vs} dv$

2. $\oint E_s.d\ell = -j\omega B_S$

3. $\oint B_s.dS = 0$

4. $\oint H_S.dS = \int (J_S + j\omega D_S)d\ell$

Which of the above Time-Harmonic Maxwell's equations are correct?

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

(c) 1,2 and 3 only (d) 3 and 4 only

**68. Ans: (b)**

**Sol:** From Gauss's law of electrostatics, $\oint_s \vec{D}.d\vec{S} = \int_{vol} \rho_v dv$

From Farady's law, $\oint_L \vec{E}.d\vec{\ell} = \int_s -\frac{\partial \vec{B}}{\partial t}.d\vec{S}$

From Ampere's law, $\oint_L \vec{H}.d\vec{\ell} = \oint_S \left(\vec{J} + \frac{\partial \vec{D}}{\partial t}\right).d\vec{S}$

From Gauss's law of magnetic field, $\oint_s \vec{B}.d\vec{S} = 0$

In phase form above equation can be written as

$\oint_s \vec{D}_s.d\vec{S} = \int_{vol} \rho_v dv$

$\oint_L \vec{E}_s.d\vec{\ell} = \int_s -j\omega\vec{B}_s.d\vec{S}$

$\oint_s \vec{B}_s.d\vec{S} = 0$

$\oint_L \vec{H}_s.d\vec{\ell} = \oint_S \left(\vec{J}_s + j\omega\vec{D}_s\right).d\vec{S}$

Therefore equation 1 and 3 are correct.

69. If $\vec{A} = \rho\cos\phi\hat{a}_\rho + \sin\phi\hat{a}_\phi$, then the surface integration of curl of $\vec{A}$ (for $30° \le \phi \le 60°$ and $2 \le \rho \le 5$) is

(a) 6.750 (b) 4.941

(c) 0.732 (d) 1.765

**69. Ans: (b)**

**Sol: Given:** $\vec{A} = \rho\cos\phi\hat{a}_\rho + \sin\phi\hat{a}_\phi$

$$\nabla\times\vec{A} = \frac{1}{\rho}\begin{vmatrix} \hat{a}_\rho & \rho\hat{a}_\phi & \hat{a}_z \\ \frac{\partial}{\partial\rho} & \frac{\partial}{\partial\phi} & \frac{\partial}{\partial z} \\ \rho\cos\phi & \rho\sin\phi & 0 \end{vmatrix}$$

$$= \frac{1}{\rho}\left[\hat{a}_\rho(0) - \rho\hat{a}_\phi(0) + \hat{a}_z(\sin\phi + \rho\sin\phi)\right]$$

$$\nabla\times\vec{A} = \frac{1}{\rho}\sin\phi(1+\rho)\hat{a}_z$$

$$d\vec{S} = \rho d\rho d\phi\hat{a}_z$$

$$I \equiv \int_s (\nabla \times \vec{A}).d\vec{S} = \int_\rho \int_\phi \frac{\sin\phi(1+\rho)}{\rho} \hat{a}_z . \rho d\rho d\phi \hat{a}_z$$

$$= \int_{\rho=2}^{5} \int_{\phi=30^\circ}^{60^\circ} \sin\phi(1+\rho) d\rho d\phi = \left[\rho + \frac{\rho^2}{2}\right]_2^5 - \cos\phi\Big|_{30^\circ}^{60^\circ}$$

$$= \left[5 + \frac{25}{2} - 2 - \frac{4}{2}\right]\left(\frac{\sqrt{3}-1}{2}\right) = (13.5)\left(\frac{0.732}{2}\right) = 4.94$$

70. Which one of the following is not the basic rule for boundary conditions at the surface between two different materials?

(a) The tangential components of electric field intensity are continuous across the boundary.

(b) The normal components of electric flux density are discontinuous at the boundary by an amount equal to the surface-charge density on the boundary.

(c) The tangential components of magnetic field intensity are discontinuous at the boundary by an amount equal to the surface-current density on the boundary.

(d) The normal components of electric field intensity are continuous across the boundary.

**70. Ans: (d)**

**Sol:** Normal components of electric field intensity are discontinuous across charged boundary (or) charge free boundary.

Therefore 'd' is not correct.

71. A uniform plane wave propagating in a medium has $\vec{E} = 2e^{-\alpha z}\sin(10^8 t - \beta z)\hat{a}_y V/m$, if the medium is characterized by $\varepsilon_r = 1$, $\mu_r = 20$ and $\sigma = 3$ S/m. The values of $\alpha$ and $\beta$ are respectively,

(a) 30.70 Np/m, 30.70 rad/m (b) 61.40 Np/m, 61.40 rad/m

(c) 122.80 Np/m, 122.80 rad/m (d) 15.35 Np/m, 15.35 rad/m

**71. Ans: (b)**

**Sol:** $\varepsilon_r = 1, \mu_r = 20, \sigma = 3S/m \text{ and } \vec{E} = 2e^{-\alpha z}\sin(10^8 t - \beta z)\hat{a}_y$

Consider $\frac{\sigma}{\omega\varepsilon} = \frac{3}{10^8 \times \frac{10^{-9}}{36\pi}} = 360\pi \times 3 >> 1$

As $\frac{\sigma}{\omega\varepsilon} >> 1$ and hence given medium is good conductor.

In good conductor, $\alpha = \beta = \sqrt{\frac{\omega\mu\sigma}{2}} = \sqrt{\frac{10^8 \times 20 \times 4\pi \times 10^{-7} \times 3}{2}} = 61.39$

72. A distortion less transmission line has the following parameters:

Characteristic impedance = 60 Ω, wave velocity = 0.6c, where c is the speed of light in a vacuum, α = 20 mNp/m. The values of transmission line parameters R,L,G and C at 100 MHz are respectively,

(a) 1.2 Ω/m, 333 nH/m, 333 μS/m, 92.59 pF/m

(b) 1.2 Ω/m, 111 H/m, 333 μS/m, 92.59 F/m

(c) 2.4 Ω/m, 333 nH/m, 333 μS/m, 92.59 F/m

(d) 2.4 Ω/m, 111 H/m, 333 S/m, 92.59 pF/m

**72. Ans: (a)**

**Sol:** Given: distortion less transmission line

$\alpha = 20mNp/m$

$Z_0 = 60\Omega$

$f = 100MHz$

$v = 0.6c = 0.6 \times 3 \times 10^8 m/\sec$

For distortion less transmission line: $\alpha = \frac{R}{Z_0} (or) GZ_0$

$R = \alpha Z_0 = 20 \times 10^{-3} \times 60 = 1.2\Omega/m$

$G = \frac{\alpha}{Z_0} = \frac{20 \times 10^{-3}}{60} = 0.333 \times 10^{-3} (or) 333\mu S/m$

$v = \frac{1}{\sqrt{LC}} or\ Z_0 = \sqrt{\frac{L}{C}}$

$vZ_0 = \frac{1}{c}$ or $c = \frac{1}{vZ_0} = \frac{1}{0.6 \times 3 \times 10^8 \times 60} = 9.25 \times 10^{-11} (OR) 92.5 pF/m$

$\frac{v}{Z_0} = \frac{1}{L} (or)\ L = \frac{Z_0}{v} = \frac{60}{0.6 \times 3 \times 10^8} = 333nH/m$

$\therefore R = 1.2\Omega/m, L = 333nH/m, G = 333\mu S/m\ and\ C = 92.5 pF/m$

73. Consider the following statements regarding the Smith's chart:

1. Smith's chart is a graphical indication of the impedance of a transmission line and of the corresponding reflection coefficient as one moves along the line.
2. $\lambda$ distance on the line corresponds to a 720° movement on the Smith's chart.
3. The admittance chart can be obtained by shifting each and every point on the impedance chart by 90°.
4. Counter-clockwise movement on the chart corresponds to moving towards the generator.

Which of the above statements are correct?

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

(c) 1,2 and 4 only (d) 2,3 and 4 only

**73. Ans: (a)**

**Sol:** Smith's chart is a graphical indication of the impedance of a transmission line and of the corresponding reflection coefficient as one moves along the line.

$\lambda$ distance on the line corresponds to a 720° movement on the Smith's chart.

So option 1 and 2 are correct.

74. Consider the following statements regarding the load matching and impedance measurements:

1. A mismatched load can be properly matched to a line by inserting prior to the load a transmission line $\lambda/4$ long.
2. For matching of 120 $\Omega$ load to a 75 $\Omega$ line, the quarter-wave transformer must have a characteristic impedance of 190 $\Omega$.
3. The main disadvantage of single-stub matching is that it is a narrow-band or frequency-sensitive device.

Which of the above statements are not correct?

(a) 1 and 2 only

(b) 2 and 3 only

(c) 1 and 3 only

(d) 1, 2 and 3

**74. Ans: (b)**

**Sol:** A mismatched load can be properly matched to a line by connecting $\frac{\lambda}{4}$ line pair to the load.

Statement 2: $Z_0' = \sqrt{Z_0 Z_R} = \sqrt{75 \times 120} = 94.8\Omega$

Statement 3 is not related to load matching and impedance.

So statement 2 and 3 are not correct.

75. Which of the following antennas are used directly as radiators aboard satellites to illuminate comparatively large areas of the Earth and they are widely used as primary feeds for reflector-type antennas both in transmitting and receiving modes?

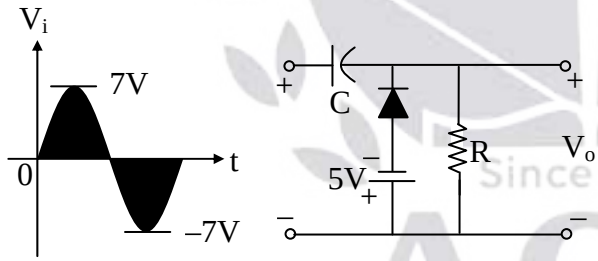
(a) Dipole antennas (b) End fire-array antennas

(c) Microstrip antennas (d) Horn antennas

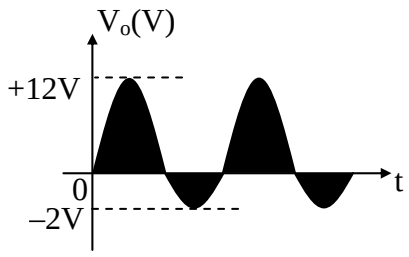
**75. Ans: (d)**

**Sol:** Horn antenna used as radiator and used as primary feeds for reflector type antenna for transmitting and receiving mode.

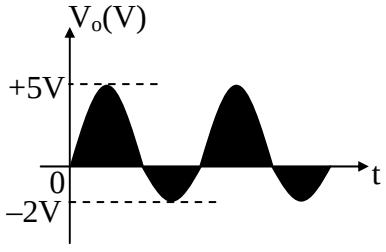
76. A sinusoidal input is given to the network shown below. The output waveform is




(a)




(b)



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## HIGHLIGHTS

- Detailed Solutions are Available.
- Video Solutions are Available for Difficult Questions.
- All India rank will be given for each test.
- Comparison with all India toppers of ACE student.

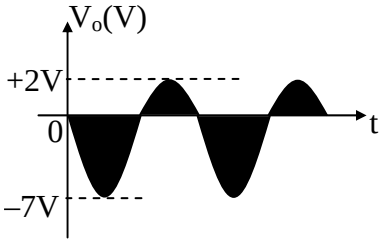
### TEST WISE STATISTICS:



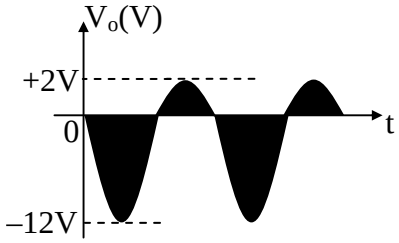

### QUESTION WISE STATISTICS:



(c)




(d)

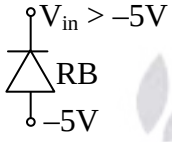



**76. Ans: (a)**

**Sol:** In a clamper circuit $V_{0(p-p)} = V_{in(p-p)} = 14V$

So option 'a' and 'd' might have the answer

In a clamper, diode should be reverse biased




So option 'a' is the closest answer

(Impact all options are wrong) the actual $V_0$ should be between –5V to +9V

77. For enhancement-type n-channel MOSFET with drain current $I_D$ = 10 mA, $V_{GS}$ = 8V and $V_T$ = 2V, the device constant k is

(a) 0.139 $mA/V^2$

(b) 0.278 $mA/V^2$

(c) 0.387 $mA/V^2$

(d) 0.556 $mA/V^2$

**77. Ans: (d)**

**Sol:** $I_D = 10mA,\ V_{GS} = 8V,\ V_T = 2V$

$$I_D = \frac{1}{2}K(V_{GS} - V_T)^2$$

$$K = \frac{2I_D}{(V_{GS} - V_T)^2} = \frac{2\times 10mA}{(8-2)^2 V^2} = 0.556\,mA/V^2$$

78. Which one of the following statements is correct regarding shunt-series feedback amplifier topology?

(a) The currents are compared and the output voltages are sampled.

(b) The currents are compared and the output currents are sampled.

(c) The voltages are compared and the output currents are sampled.

(d) The voltages are compared and the output voltage are sampled

**78. Ans: (b)**

**Sol:** Shunt-series feedback topology is implemented for current amplifier therefore the currents are compared/mixed at input and currents are sampled at output.

79. A Hartley oscillator uses $L_1$ = 2 mH and $L_2$ = 1.5mH. The range of capacitance so that the frequency of oscillation can be varied between 1000 kHz to 2000 kHz are

(a) $C_{max}$ = 7.2 pF and $C_{min}$ = 1.8 pF (b) $C_{max}$ = 9.2 pF and $C_{min}$ = 0.8 pF

(c) $C_{max}$ = 7.2 pF and $C_{min}$ = 0.8 pF (d) $C_{max}$ = 9.2 pF and $C_{min}$ = 1.8 pF

**79. Ans: (a)**

**Sol:** Frequency of oscillations in a hartley oscillator is

$$f = \frac{1}{2\pi\sqrt{(L_1 + L_2)C}} \rightarrow C = \left[\frac{1}{2\pi\sqrt{L_1 + L_2}.f}\right]^2$$

$$\text{For } f = 1000\text{kHz} \rightarrow C_{max} = \left[\frac{1}{2\pi\sqrt{3.5\text{m} \times 10^6}}\right]^2 = 7.2\text{pF}$$

$$f = 2000\text{kHz} \rightarrow C_{min} = \left[\frac{1}{2\pi\sqrt{3.5\text{m} \times 2 \times 10^6}}\right]^2 = 1.8\text{pF}$$

80. Which one of the following statements is correct regarding integrated circuit fabrication?

(a) IC offers increased reliability, improved performance, high speed and lower power consumption

(b) IC is a miniature, low cost electronic circuit fabricated on a multi crystal chip of silicon.

(c) IC is a miniature, high cost electronic circuit fabricated on a multi crystal chip of silicon.

(d) IC offers decreased reliability, improved performance, low speed and higher power consumption.

**80. Ans: (a)**

**Sol:** Integrated fabrication

→ Advantages of IC

→ IC is very small in size due to this low power consumption as the absence of parasitic and capacitance effect operating speed is high and it is more reliable.

So, option (a) is correct.

81. What is the value of capacitor of the Wien bridge oscillator operating at resonant frequency of 10 kHz with resistance of 100 kΩ?

(a) 149 pF (b) 159 pF

(c) 169 pF (d) 189 pF

**81. Ans: (b)**

**Sol:** Wien's Bridge:

$$f = \frac{1}{2\pi RC} \Rightarrow 10\times10^{3} = \frac{1}{2\times\pi\times100\times10^{3}\times C}$$

$$\therefore C = \frac{1}{2\pi\times100\times10^{3}\times10\times10^{3}}$$

$$\therefore C = 0.159\times10^{-9} = 159\,pF$$

82. A monolithic metal oxide semiconductor (MOS) non-polarized capacitor which is a parallel plate capacitor with $SiO_2$ as dielectric. A surface thin film of metal (aluminium) is the top plate. The bottom plate consists of the heavily doped $n^+$ region that is formed during emitter diffusion. What is the typical value of capacitance for an oxide thickness of 500 $\dot{A}$ of this MOS capacitor?

(a) 0.1 pF/mil$^2$ (b) 0.2 pF/mil$^2$

(c) 0.3 pF/mil$^2$ (d) 0.4 pF.mil$^2$

**82. Ans: (d)**

**Sol:** 1 mil = 25.4 μm

$$1mil = 25.4\times10^{-6}\ m$$

$$1m = \frac{10^{6}}{25.4} mil = 39370\,mil$$

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$$C_{ox} = \frac{\varepsilon_{ox}}{t_{ox}}$$

$$\varepsilon_{ox} = 4 \times 8.85 \times 10^{-12}\ \text{F/m}$$

$$\varepsilon_{ox} = 4 \times 8.85 \times 10^{-12}\ \text{F}/39370\ \text{mil} = 8.99 \times 10^{-16}\ \text{F/mil}$$

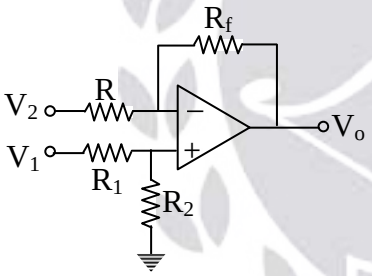
$$t_{ox} = 500 \times 10^{-10}\ \text{m} = 500 \times 10^{-10} \times 39370\ \text{mil} = 1.97 \times 10^{-3}\ \text{mil}$$

$$C_{ox} = \frac{8.99 \times 10^{-16}\ \text{F/mil}}{1.97 \times 10^{-3}\ \text{mil}} = 4.56 \times 10^{-13}\ \text{F/mil}^2$$

$$C_{ox} = 0.456 \times 10^{-12}\ \text{F/mil}^2$$

$$C_{ox} = 0.4\,\text{pF/mil}^2$$

83. For the given figure, the output voltage is




(a) $V_0 = \frac{-R_f}{R} V_2 + \left( \frac{R + R_f}{R_1 + R_2} V_1 \right)$

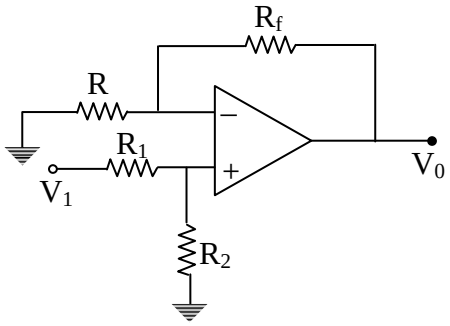
(b) $V_0 = -\frac{R}{R_f} V_2 + \left( \frac{R + R_f}{R_f} \right) \left( \frac{R_1 + R_f}{R_1 + R_2} V_1 \right)$

(c) $V_0 = -\frac{R_f}{R} V_2 + \left( \frac{R + R_f}{R} \right) \left( \frac{R_1 + R_2}{R + R_f} V_1 \right)$

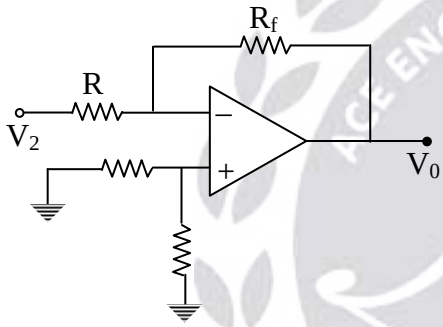
(d) $V_0 = -\frac{R_f}{R} V_2 + \left( \frac{R + R_f}{R} \right) \left( \frac{R_2}{R_1 + R_2} V_1 \right)$

**83. Ans: (d)**

**Sol:** Apply superposition




$$V_{01}=\left(1+\frac{R_F}{R}\right)V_+ =\left(1+\frac{R_F}{R}\right)\frac{V_1R_2}{R_1+R_2}$$




$$V_{02}=\left(\frac{-R_F}{R}\right)V_2$$

84. In a BJT switching circuit, supply voltage is $V_{CC}$ = 9V, biasing resistors are $R_B$ = 15 kΩ, $R_C$ = 6.8 kΩ and the transistor has an $h_{FE}$ value of 25. What is the minimum input voltage required to switch the transistor into saturation when $V_{CE}$ = 0.2V?

(a) 1.48 V

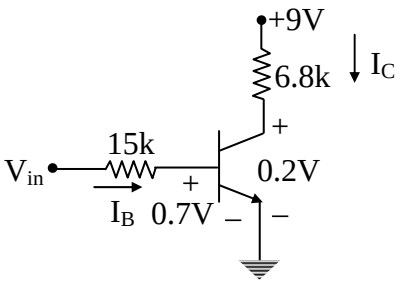
(b) 0.78 V

(c) 5V

(d) 2.5 V

**84. Ans: (a)**

**Sol:**




Given $h_{fe} = \beta = 25$

$$V_{\underset{min}{in}} = I_B(15k) + 0.7 = \frac{I_C}{25}(15k) + 0.7 = \left(\frac{9-0.2}{6.8k}\right)\left(\frac{15k}{25}\right) + 0.7$$

$= 1.476V$

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

**Codes:**

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

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

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

(d) Statement (I) is false, but Statement (II) is true.

85. **Statement (I):**

Ge and si are said to have negative temperature coefficient of resistivity.

**Statement (II):**

Ge and Si show a reduction in resistance with increase in temperature.

**85. Ans: (a)**

**Sol:** For semiconductor materials as temperature is increased, the carrier concentration increases, conductance increases and resistance decreases.

86. **Statement (I):**

A linear network which contains two or more independent sources can be analyzed to obtain the various voltages and branch currents by allowing the sources to act one at a time, then superposing the results.

**Statement (II):**

Superposition cannot be directly applied to the computation of the power.

**86. Ans: (b)**

**Sol:** Statement (I): Correct

Superposition theorem is used for only linear responses like voltages and currents

$I = I_1 + I_2 + - - - - -$ ,

$V = V_1 + V_2 + V_3 + - - - -$

Statement (II): Correct

Superposition theorem is not valid for non-linear responses like power

$P \neq P_1 + P_2 + P_3 + - - - - -$

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

87. **Statement (I):**

Metals are extremely good conductors of electricity and heat, and are not transparent to visible light.

**Statement (II):**

Ceramics are compounds between metallic and non-metallic elements.

**87. Ans: (b)**

**Sol:** Metals are good conductors of heat and electricity because of more valance electrons in it. But there are non-transparent to light.

Ex: Fe, Cu, Ag, Au, Ni.

Ceramics are compounds of both metal and non-metal with inorganic nature formed by predominantly with ionic bonds.

**Ex:** Glass, porulain, $Al_2O_3$, SiC, $Si_3N_4$.

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88. **Statement (I):**

M-ary PSK can be used to transmit digital data over a non-linear bandpass channel, whereas M-ary QAM requires the use of a linear channel.

**Statement (II):**

M-ary PSK and M-ary QAM are examples of non-linear modulation.

**88. Ans: (c)**

**Sol:** QAM is a linear method of digital Modulation.

$\therefore$ Statement II is False

Statement I is True

89. **Statement (I):**

Linear system may have multiple equilibrium states.

**Statement (II):**

If a system is BIBO stable, it must also be zero-input or asymptotically stable.

**89. Ans: (d)**

**Sol:** If the system is linear time invariant, that is if f(x, t) = AX, then there exist only one equilibrium state if A is non-singular, and there exist infinitely equilibrium states if A is singular.

BIBO stability implies Asymptotic stability.

90. **Statement (I):**

The total flux out of a closed surface is equal to the net charge enclosed within the surface.

**Statement (II):**

An electric field is completely specified by its intensity vector.

**90. Ans: (b)**

**Sol:** From Gauss law, the net electric flux leaving out of closed surface is equal to total charge enclosed within that surface.

An electric field is completely specified by its intensity vector.

Statement I and II are individually correct

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91. A current of 5 A in primary coil of a circuit is reduced to zero at a uniform rate in $10^{-3}$ seconds. If coefficient of mutual inductance is 2H, then the induced emf in the secondary coil is

(a) $10^{-4}$V (b) $10^{4}$ V

(c) $10^{-6}$ V (d) $10^{6}$ V

**91. Ans: (b)**

**Sol:** $|e_2| = M\frac{di_1}{dt} = M\frac{(i_2 - i_1)}{(t_2 - t_1)}$

$= 2\frac{(5-0)}{10^{-3}} = 10\times10^{3} = 10^{4}\,V$

92. A wire of resistor 10 Ω is drawn out so that its length is increased to twice its original length. Then the new resistance is

(a) 20 Ω (b) 5 Ω

(c) 30Ω (d) 40 Ω

**92. Ans: (d)**

**Sol:** A wire resistance = $R_1 = 10\Omega$

$$R_1 = \frac{\rho\ell_1}{a_1}$$

That wire drawn out so that its length is increased to twice its original length

$\ell_2 = 2\ell_1$ $a_2 = ?$

Volume = Constant

$V_1 = V_2$

$\ell_1 a_1 = \ell_2 a_2$

$\ell_1 a_1 = 2\ell_1 a_2 \Rightarrow a_2 = \frac{a_1}{2}$

$$R_2 = \frac{\rho\ell_2}{a_2} = \frac{\rho(2\ell_1)}{\left(\frac{a_1}{2}\right)} = 4\left(\frac{\rho\ell_1}{a_1}\right)$$

$R_2 = 4\,(R_1) = 4(10) = 40\Omega$

$R_2 = 40\Omega$

93. What is the magnitude of emf induced in a 200 turn coil with cross-sectional area of 0.16 $m^2$, if the magnetic field through the coil changes from 0.10 $Wb/m^2$ to 0.50 $Wb/m^2$ at a uniform rate over a period of 0.02 seconds ?

(a) –520V (b) –640V

(c) –725V (d) –815V

**93. Ans: (b)**

**Sol:** N = 200

$A = 0.16\ m^2$

$B_{max} = 0.1\ Wb/m^2$ to $0.5\ Wb/m^2$

t = 0.02 sec

$$e = -N\frac{d\phi}{dt} = -200\frac{(0.4\times 0.16)}{0.02} = -640\,\text{volts}$$

94. In an AC circuit, the voltage source V is as follows: V = 100 sin (100t) volt. Then rms value of voltage is

(a) 35.35V (b) 40.35V

(c) 80.7V (d) 70.7V

**94. Ans: (d)**

**Sol:** $V = 100\sin 100t$

$V_m = 100$

$$V_{rms} = \frac{V_m}{\sqrt{2}} = \frac{100}{\sqrt{2}} = 70.7\,\text{Volts}$$

95. Which one of the following statements is not correct regarding the characteristics of ideal transformer?

(a) There is no leakage flux.

(b) There are no losses in electric circuit or in magnetic circuit.

(c) The resistance of both the windings is infinite.

(d) The permeability of the core is infinite and zero reluctance.

**95. Ans: (c)**

**Sol:** Ideal Transformer

Resistance of the winding must be zero in ideal Transformer.

96. Which one of the following is not the indication of a fully-charged cell?

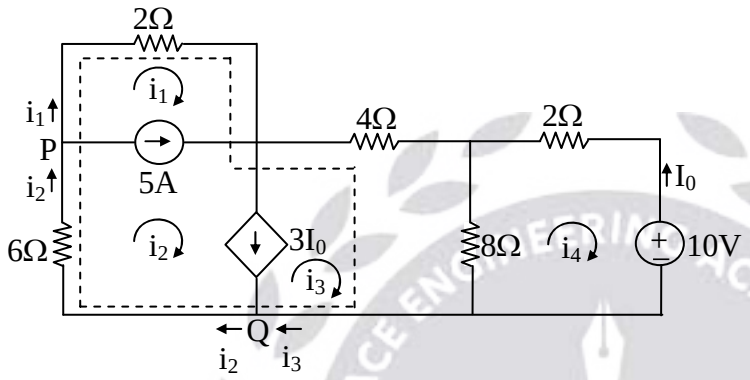
(a) Intensity (b) Gassing

(c) Voltage (d) Specific gravity of the electrolyte

**96. Ans: (b)**

**Sol:** Gassing is not the indication of a fully charged cell

97. For the given circuit, the currents $i_1$ and $i_3$ are




(a) $i_1 = -2.5$ A and $i_3 = 3.93$ A

(b) $i_1 = 7.5$ A and $i_3 = -2.5$ A

(c) $i_1 = 3.93$ A and $i_3 = 2.14$ A

(d) $i_1 = -7.5$ A and $i_3 = 3.93$ A

**97. Ans: (d)**

**Sol:** $2i_1 + 4i_3 + 8(i_3 - i_4) + 6i_2 = 0$

$i_1 + 3i_2 + 6i_3 - 4i_4 = 0$

$-i_1 + i_2 = 5$ _____(2)

$i_2 - i_3 = 3I_0$ _____(3)

$8(i_4 - i_3) + 2i_4 + 10 = 0$

$-4i_3 + 5i_4 = -5$_____(4)

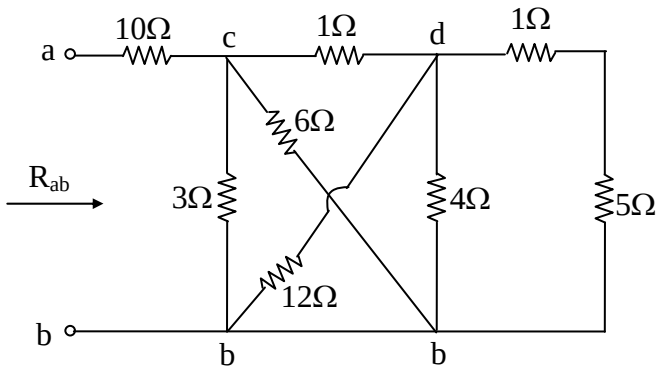
$I_0 = -i_4$ _____(5)

solve

$i_1 = -7.5$A

$i_3 = +3.93$A

98. What is the equivalent resistance $R_{ab}$ in the given circuit ?

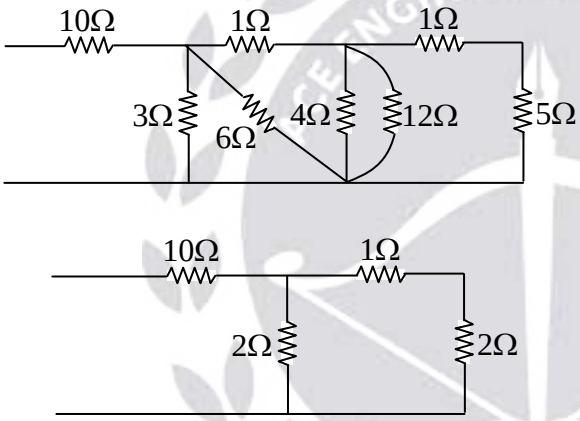



(a) 34.08Ω (b) 11.20Ω

(c) 42.16Ω (d) 17.82Ω

**98. Ans: (b)**

**Sol:**




$\Rightarrow 10 + (2//3) = 10 + \frac{6}{5} \Rightarrow 11.2\Omega$

99. Consider the following statements for inductors:

1. An inductor acts like a short circuit to DC.
2. The current through an inductor cannot change instantaneously.
3. The current through an inductor can change instantaneously
4. An inductor acts like an open circuit to DC.

Which of the above statements is/are correct?

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

(c) 2 only (d) 3 and 4 only

**99. Ans: (b)**

**Sol:** Statement I: For D.C $\rightarrow \dfrac{dI}{dt} = 0$

$$V_L = L\frac{dI}{dT} = L(0) = 0 \Rightarrow \text{Short circuit}$$

Statement II: Inductor current

$$i_L(t) = \frac{1}{L}\int_{-\infty}^{t} Vdt = \frac{1}{L}\int_{-\infty}^{0-} Vdt + \frac{1}{L}\int_{0-}^{t} Vdt$$

$$i_L(t) = i_L(0-) + \frac{1}{L}\int_{0-}^{t} Vdt$$

If $i_L(0–) = I_0$

$$i_L(t) = I_0 + \frac{1}{L}\int_{0-}^{t} Vdt$$

At t = 0+

$$i_L(0+) = I_0 + \frac{1}{L}\int_{0-}^{0+} Vdt = 0 \qquad \left[\because \frac{1}{L}\int_{0-}^{0+} Vdt \text{ tends to } 0\right]$$

$i_L(0+) = I_0 = i_L(0–)$

Inductor current don't change instanteously.

100. What is the phase angle between

$i_1 = – 4 \sin (377t + 25°)$ and

$i_2 = 5 \cos (377t – 40°)$

(a) 155° ($i_1$ leads $i_2$)

(b) 145° ($i_2$ leads $i_1$)

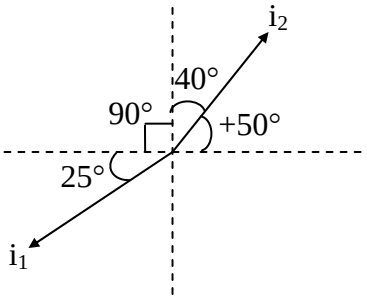
(c) 135° ($i_1$ leads $i_2$)

(d) 125° ($i_2$ leads $i_1$)

**100. Ans: (a)**

**Sol:** $i_1 = –[4\angle+25°]$

$i_2 = +[5\angle+50°]$




$i_1$ leads $i_2$ by 155°

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101. Which one of the following laws states that the line integral of the tangential component of H around a closed path is the same as the net current $I_{enc}$ enclosed by the path ?

(a) Biot-Savart's law (b) Lenz's law

(c) Gauss's law (d) Ampere's circuit law

**101. Ans: (d)**

**Sol:** Ampere's law states that the line integral of tangential component of magnetic field intensity around any closed path is equal to current enclosed by that path.

$$\oint H_t . d\vec{\ell} = I_{enc}$$

102. Consider the following statements regarding an ideal transformer:

1. Coils have very large reactance's.
2. Coupling coefficient is equal to unity
3. Primary and secondary coils are not lossless.

Which of the above statements is/are correct?

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

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

**102. Ans: (b)**

**Sol:** In ideal transformer, the co-efficient of coupling must be equal to unity

103. The total efficiency of an injection laser with a GaAs active region is 18%. The voltage applied to the device is 2.5 V and the bandgap energy for GaAs is 1.43 eV. The external power efficiency of the device is

(a) 5% (b) 10%

(c) 15% (d) 20%

**103. Ans: (b)**

**Sol:** External power efficiency

$$\eta_{ex} = \eta_T \left( \frac{E_G}{V} \right) \times 100\%$$

$$\eta_{ex} = 0.18 \times \left( \frac{1.43}{2.5} \right) \times 100\% \approx 10\%$$

104. The slope of the output characteristics of a transistor in CE configuration is higher than that in CB configuration due to which one of the following effects?

(a) Zener effect
(b) Early effect
(c) Avalanche effect
(d) Transistor effect

**104. Ans: (b)**

**Sol:** The output current ($I_C$) increase with increase in collection to emitter voltage ($V_{CE}$). This is due to the base width modulation called early effect.

105. Which one of the following statements is correct regarding the comparison between Avalanche and Zener effect?

(a) Zener effect is caused by impact ionization
(b) Zener diodes have higher resistance
(c) Avalanche effect occurs at voltages usually above 7V
(d) Avalanche diodes have lower resistance.

**105. Ans: (c)**

**Sol:** Zener effect is caused by direct rupture of covalent bonds due to high electric field at the junction and also due to tunnelling.

Zener diode is formed between heavily doped p and n type semiconductor, so resistance is less.

Avalanche diode is junction between lightly doped p and n type semiconductors. So it has high resistance.

106. Which one the following has all the poles of the function lie on the jω axis?

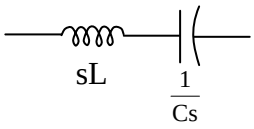
(a) L-C function
(b) R-L function
(c) R-C function
(d) Y function

**106. Ans: (a)**

**Sol:** For LC function either series, parallel and combination network function Z(s) (or) Y(s) poles and zeros are always on the jω axis

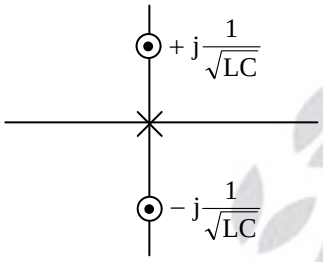
**Ex:-**

**(i)**

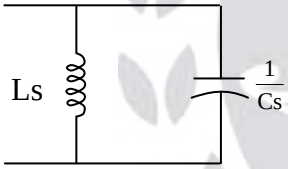



$$Z(s) = sL + \frac{1}{Cs} = \frac{LCs^2 + 1}{Cs} = \frac{LC\left(s^2 + \frac{1}{LC}\right)}{Cs}$$

Poles: s = 0, Zeros: $= \pm j \frac{1}{\sqrt{LC}}$



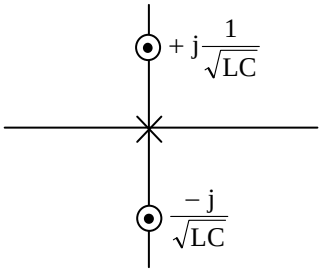

**(ii)**




$$Z(s) = Ls // \frac{1}{Cs} = \frac{Ls \times \frac{1}{Cs}}{Ls + \frac{1}{Cs}} = \frac{\frac{1}{C}s}{\left(s^2 + \frac{1}{LC}\right)}$$

Poles: $s = \pm j\frac{1}{\sqrt{LC}}$

Zeros: s = 0



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107. Which one of the following is an LC immittance function ?

(a) $Z(s)=\frac{Ks(s^2+4)}{(s^2+1)(s^2+3)}$ (b) $Z(s)=\frac{s^5+4s^3+5s}{3s^4+6s^2}$

(c) $Z(s)=\frac{K(s^2+1)(s^2+9)}{(s^2+2)(s^2+10)}$ (d) $Z(s)=\frac{2(s^2+1)(s^2+9)}{s(s^2+4)}$

**107. Ans: (d)**

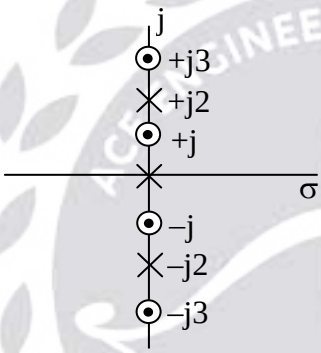
**Sol:** LC immittance function i.e., either impedance function or admittance function

**Rule:-** The location of poles and zeros are only on imaginary (or) jω axis and they are alternate. According to that property answer is (d)

$$Z(s)=\frac{2(s^2+1)(s^2+9)}{s(s^2+4)}$$

poles $\Rightarrow$ s = 0, ± j2

zero $\Rightarrow$ s = ±j, ±j3




108. Which one of the following is **not** the property of positive real function ?

(a) If F(s) is positive real, then $\frac{1}{F(s)}$ is not a positive real.

(b) The sum of positive real functions is positive real.

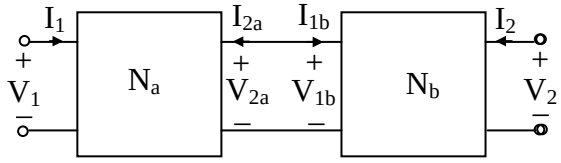
(c) The poles and zeros of a positive real function cannot be in the right half of the S plane

(d) Only simple poles with real positive residues can exists on the jω axis

**108. Ans: (a)**

**Sol:** According to the property of positive real function, if function F(s) is positive real then the reciprocal of F(s) i.e., $\frac{1}{F(s)}$ should be positive real otherwise it will not to be consider as positive real function.

109. Which one of the following is the transmission matrix equation for network $N_a$ if two networks $N_a$ and $N_b$ are cascaded as shown in the figure?




(a) $\begin{bmatrix} V_1 \\ I_1 \end{bmatrix} = \begin{bmatrix} A_a & B_a \\ C_a & D_a \end{bmatrix} \begin{bmatrix} -V_{2a} \\ I_{2a} \end{bmatrix}$

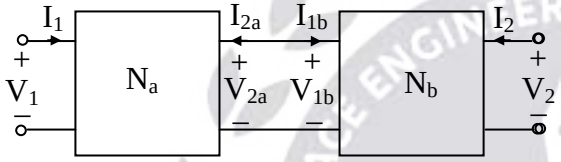
(b) $\begin{bmatrix} V_1 \\ I_1 \end{bmatrix} = \begin{bmatrix} A_a & B_a \\ C_a & D_a \end{bmatrix} \begin{bmatrix} V_{2a} \\ -I_{2a} \end{bmatrix}$

(c) $\begin{bmatrix} V_1 \\ I_1 \end{bmatrix} = \begin{bmatrix} A_a & B_a \\ C_a & -D_a \end{bmatrix} \begin{bmatrix} -V_{2a} \\ I_{2a} \end{bmatrix}$

(d) $\begin{bmatrix} V_1 \\ I_1 \end{bmatrix} = \begin{bmatrix} A_a & B_a \\ -C_a & D_a \end{bmatrix} \begin{bmatrix} V_{2a} \\ -I_{2a} \end{bmatrix}$

**109. Ans: (b)**

**Sol:**




For $N_a$ Since $I_{2a}$ is entering part, it is opposite direction for transmission parameters hence we should take negative.

ABCD parameters

$V_1 = A_a V_{2a} - B_a I_{2a}$

$I_1 = C_a V_{2a} - D_a I_{2a}$

$\begin{bmatrix} V_1 \\ I_1 \end{bmatrix} = \begin{bmatrix} A_a & B_a \\ C_a & D_a \end{bmatrix} \begin{bmatrix} V_{2a} \\ -I_{2a} \end{bmatrix}$

110. Which one of the following theorems becomes important if the circuit has sources operating at different frequencies?

(a) Norton theorem

(b) Thevenin theorem

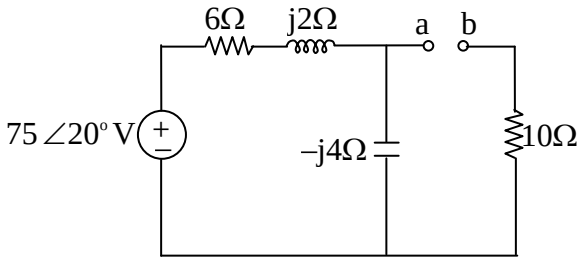
(c) Superposition theorem

(d) Maximum power transfer theorem

**110. Ans: (c)**

**Sol:** When the network is operating with different frequencies then the analysis is not possible with usual methods then definitely analysis with only one source at a time with specific frequency. So, superposition theorem only possible since the analysis in superposition theorem with only one source at a time.

111. What is the value of $Z_{th}$ at terminal a – b of the given Thevenin circuit?




(a) $Z_{th} = (8.4 – j1.2)\ \Omega$

(b) $Z_{th} = (10.3 – j2.3)\ \Omega$

(c) $Z_{th} = (11.3 – j2.9)\ \Omega$

(d) $Z_{th} = (12.4 – j3.2)\ \Omega$

**111. Ans: (d)**

**Sol:** $Z_{th} = 10 + [(–j4)//(6 + j2)]$

$= (2.4 – j\ 3.2) + 10$

$= (12.4 – j\ 3.2)$

112. Consider the following statement for accuracy of the instrument:

1. The accuracy of the instrument may be specified in terms of limits of error.
2. The specification of a point accuracy gives any information about the general accuracy of the instrument.
3. The best way to conceive the ideal of accuracy is to specify it in terms of the true value of the quantity being measured.

Which of the above statements are correct?

(a) 1 and 2 only

(b) 1 and 3 only

(c) 1, 2 and 3

(d) 2 and 3 only

**112. Ans: (b)**

**Sol:** (i) The accuracy of the instrument may be specified interms of limits of error.

(ii) Point accuracy does not give any information about general accuracy.

(iii) Accuracy can be specified interms of the true value of the quantity being measured

113. Consider the following statements for deflection and null type instruments:

1. Deflection type of instruments are more accurate than null type of instruments.
2. Deflection type of instruments can be highly sensitive as compared with the null type of instruments.
3. Null type of instruments are more suitable for measurements under dynamic for conditions than deflection type of instruments.

Which of the above statements are not correct

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

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

**113. Ans: (c)**

**Sol:** Null type instruments are highly accurate and highly sensitive than deflection type instruments.

114. A digital timer with eight readout is stated to have accuracy of 0.005 percent of reading, ±1 in the final digit. Readout is in s, ms and μs. Assuming that the instrument meets its specifications, the maximum likely errors when the reading is 05000000 μs is

(a) ±251 μs (b) ±260 μs

(c) ±261 μs (d) ±250 μs

**114. Ans: (a)**

**Sol:** $\text{Error} = \frac{0.005}{100} \times 05000000\,\mu\text{sec} + 00000001\,\mu\text{sec}$

$\text{Error} = \frac{0.005}{100} \times 05000000\,\mu\text{sec} + 1\,\mu\text{sec}$

$\text{Error} = 251\,\mu\text{sec}$

115. Which one of the following is essentially a permanent magnet moving coil instrument designed to the sensitive to extremely low current levels?

(a) Multimeter (b) Galvanometer

(c) Electrodynamic Wattmeter (d) Electrodynamic Voltmeter

**115. Ans: (b)**

**Sol:** A Galvanometer is designed to be sensitive to extremely low current levels.

116. A strain gauge is bonded to a beam 0.1 m long and has a cross-sectional area 4 $cm^2$. Young's modulus for steel is 207 $GN/m^2$. The strain gauge has an unstrained resistance of 240 Ω and a gauge factor of 2.2. When a load is applied, the resistance of gauge changes by 0.013 Ω. The change in length of the steel beam is

(a) $1.23 \times 10^{-6}$ m (b) $2.46 \times 10^{-6}$ m

(c) $4.92 \times 10^{-6}$ m (d) $9.84 \times 10^{-6}$ m

**116. Ans: (b)**

**Sol:** $\Delta R = 0.013\Omega$

$R = 240\Omega$

$G_f = 2.2$

$l = 0.1\text{m}$

$$\frac{\Delta R}{R} = G_f \varepsilon$$

$$\varepsilon = \frac{0.013}{240 \times 2.2} = 2.46 \times 10^{-5}$$

$$\frac{\Delta l}{l} = \varepsilon = 2.46 \times 10^{-5}$$

$$\Delta l = 2.46 \times 10^{-5} \times 0.1 = 2.46\mu\text{m}$$

$$\Delta l = 2.46 \times 10^{-6}\text{m}$$

117. A digital frequency meter has a time base derived from a 1MHz clock generator frequency-divided by decade counters. What is the measured frequency when a 1.512 kHz sine wave is applied and the time base uses six decade counters?

(a) 1.512 kHz (b) 15.12 kHz

(c) 1.412kHz (d) 14.12 kHz

**117. Ans: (a)**

**Sol:** Counting time period

$$t_1 = \frac{1}{f_1} = \frac{1}{1\text{MHz}/10^6} = 1\text{sec}$$

Counting cycles $n_1$

$$n_1 = f_{in} \times t_1 = 1512\,\text{cycles}$$

$$f_{measured} = 1.512\,\text{kHz}$$

118. Which of the following instruments have large scales for easy reading?

(a) Vacuum-tube voltmeter (VTVM) and a FET-input multimeter

(b) Vacuum-tube voltmeter (VTVM) and an analog electronic ammeter

(c) FET-input multimeter and an analog electronic ammeter

(d) FET-input multimeter and an analog electronic voltmeter

**118. Ans: (a)**

**Sol:** Vacuum tube voltmeter (VTVM) and a FET input multi meter have large scales for easy reading.

119. If a resistor is known to have a resistance of 500 Ω with a possible error of ±50 Ω, the ±50Ω is

(a) relative error (b) absolute error

(c) gross error (d) systematic error

**119. Ans: (b)**

**Sol:** $= 150 \pm 50\Omega$

$\downarrow$

Absolute Error

120. Consider the following statement for dynamic characteristics of a measurement system.

1. Fidelity is defined as the degree to which a measurement system indicates changes in the measured quantity without any dynamic error.
2. Dynamic error is the difference between the true value of the quantity changing with time and the value indicated by the measurement system if no static error is assumed.
3. Measuring lag is the retardation in the response of a measurement system to changes in the measured quantity.

Which of the above statements are correct?

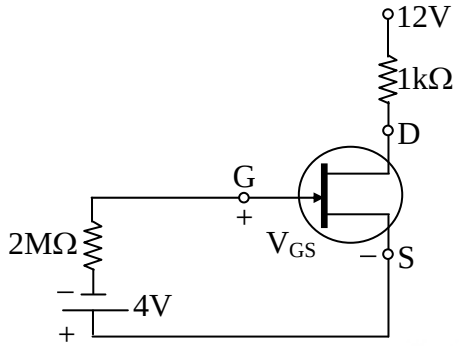
(a) 1 and 2 only (b) 1 and 3 only

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

**120. Ans: (c)**

**Sol:** All given statements are correct

121. The circuit given below is the fixed biasing of the n-channel JFET. The pinch-off voltage and the maximum drain-to-source current is –8V and 10 mA respectively. What are the values of $V_{GSQ}$ and $I_{DQ}$, respectively?



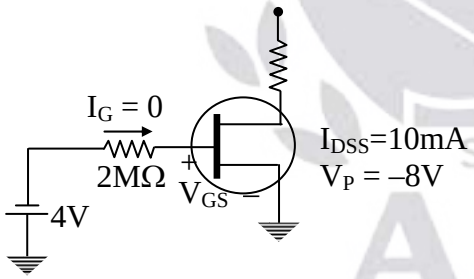

(a) +4V and 25mA (b) +4V and 2.5mA

(c) –4V and 25mA (d) –4V and 2.5 mA

**121. Ans: (d)**

**Sol:** $I_D = I_{DSS}\left[1-\frac{V_{GS}}{V_P}\right]^2$

when $V_{GS} = \frac{V_P}{2} \rightarrow I_D = \frac{I_{DSS}}{4}$




KVL

$+ 4 + I_G(2M) + V_{GS} = 0$

$V_{GS} = -4V = \frac{V_P}{2}$

$\therefore\ I_D = \frac{I_{DSS}}{4} = \frac{10m}{4} = 2.5mA$

122. Consider the following statements regarding JFET:

1. The relationship between the drain current and gate-to-source voltage of a JFET is a nonlinear.
2. The minimum current for JFET occurs at pinch-off voltage defined by $V_{GS} = V_P$.
3. A current controlled device is one in which a current defines the operating conditions of the device.

Which of the above statement are correct?

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

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

**122. Ans: (a)**

**Sol:** For a JFET

(1) $I_D = I_{DSS}\left[1 - \frac{V_{GS}}{V_P}\right]^2$ is a nonlinear relation

(2) if $V_{GS} = V_P$ then $I_D = 0$

(3) JFET is not current controlled device but voltage controlled current source

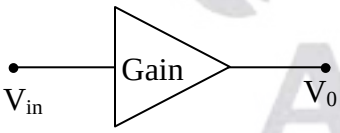
123. What is the maximum closed-loop voltage gain that can be used when the input signal varies by 0.2 V in 10 μs with slew rate of op-amp SR = 2 V/μs?

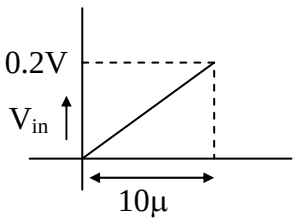
(a) 40 (b) 50

(c) 80 (d) 100

**123. Ans: (d)**

**Sol:**




Slew rate is calculated for output $SR = \frac{2V}{\mu S}$ (Given)

$$\therefore \frac{2V}{\mu} = \frac{0.2(\text{Gain})}{10\mu}$$

$$\rightarrow \text{Gain} = \frac{20}{0.2} = 100$$

124. Consider the following statements regarding 555 timer:

1. It operates on –5 V to + 18 V supply voltage in both free running and one-shot modes.
2. It has a high current output and it can source or sink 500 mA.
3. The output can drive TTL and has a temperature stability of 80 parts per million (ppm) per degree Celsius change in temperature or equivalently 0.008%/C.

Which of the above statements are not correct?

(a) 1 and 2 only

(b) 1 and 3 only

(c) 1, 2 and 3

(d) 2and 3 only

**124. Ans: (c)**

125. Consider the following statements for negative feedback:

1. It has more linear operation.
2. It has improved frequency response
3. It has better stabilized voltage gain.
4. It has higher output impendence.

Which of the above statements are correct?

(a) 1 and 2 only

(b) 2 and 3 only

(c) 1, 2 and 3 only

(d) 2, 3 and 4 only

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# GATE 2021 TOP RANKERS










and many more...

**Total 57 Ranks in Top 10**

| ME : 10 | PI : 09 | CE : 08 | EE : 4 | EC : 09 | CS : 03 | IN : 08 | XE : 06 |
|---|---|---|---|---|---|---|---|

**125. Ans: (c)**

**Sol:** (1) Negative feedback improves linearly is true

(2) Bandwidth improves by the amount of loop gain

(3) The gain are stable as the amplifier desensitizes the device parameter such that the overall gain depends only on resistors (feedback factor)

(4) improvement in output impedance is only when output is having series topology

Therefore 1, 2, 3, are correct

126. The simplified form of the function

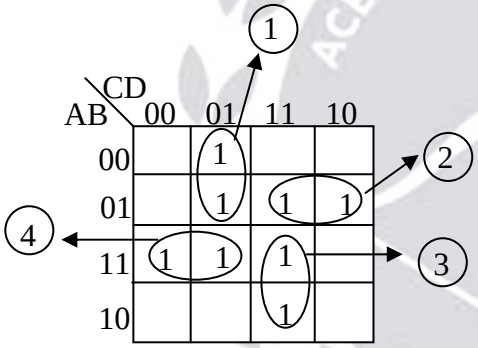
$F(A, B, C, D) = \sum m (1, 5, 6, 7, 11, 12, 13, 15)$ is

(a) $\overline{A}\,\overline{C}\,\overline{D} + \overline{A}\,\overline{B}\,\overline{C} + AB\overline{C} + A\overline{C}\,D + BD$ (b) $\overline{A}\,\overline{C}\,D + \overline{A}\,BC + AB\overline{C} + ACD + BD$

(c) $\overline{A}\,\overline{C}\,D + \overline{A}\,BC + AB\overline{C} + ACD$ (d) $\overline{A}\,\overline{C}\,D + \overline{A}\,BC + \overline{A}\,B\,\overline{C} + ACD$

**126. Ans: (c)**

**Sol:** $F(A, B, C, D) = \Sigma m (1, 5, 6, 7, 11, 12, 13, 15)$




$F = \overline{A}\,\overline{C}\,D + \overline{A}\,BC + A\,B\,\overline{C} + ACD$

127. Consider the following statements regarding the Moore and Mealy models:

1. In the Mealy circuit, the final output depends only on the present state of memory elements.
2. In the Moore circuit, output can change in between the clock edges if the external inputs change.
3. The implementation of a logic function in Mealy circuit needs more number of states than Moore circuit.

Which of the above statements are not correct?

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

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

**127. Ans: (c)**

**Sol:** In Mealy sequential circuit,

Output = F (Inputs, present state)

In Moore sequential circuit

Output = F (Present state)

And Mealy circuit requires fewer states than that of Moore sequential circuit.

128. In a Johnson's counter, all the negative triggered J-K flip-flops are used. Initially all the flip-flops are in reset condition and the outputs are $Q_3Q_2Q_1Q_0 = 0000$. What are the outputs of the flip-flops after the fifth negative going pulse?

(a) $Q_3Q_2Q_1Q_0 = 0101$

(b) $Q_3Q_2Q_1Q_0 = 1000$

(c) $Q_3Q_2Q_1Q_0 = 0010$

(d) $Q_3Q_2Q_1Q_0 = 1110$

**128. Ans: (d)**

**Sol:**

| | Serial Input | (MSB) | | | (LSB) |
|---|---|---|---|---|---|
| Clk | $\overline{Q}_3$ | $Q_0$ | $Q_1$ | $Q_2$ | $Q_3$ |
| 0 | - | 0 | 0 | 0 | 0 |
| 1 | 1 → | 1 | 0 | 0 | 0 |
| 2 | 1 → | 1 | 1 | 0 | 0 |
| 3 | 1 → | 1 | 1 | 1 | 0 |
| 4 | 1 → | 1 | 1 | 1 | 1 |
| 5 | 0 → | 0 | 1 | 1 | 1 |

After 5 Clk pulses $Q_0\,Q_1\,Q_2\,Q_3 = 0111$

i.e $Q_3\,Q_2\,Q_1\,Q_0 = 1110$

129. Consider the following statements regarding PROM/EPROM

1. The erasable programmable ROM using ultraviolet erasing is known as EPROM.
2. The ROM that makes use of the electrical voltage for erasing is known as electrically alterable ROM.
3. A PROM can be programmed many times after fabrication.

Which of the above statements are correct?

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

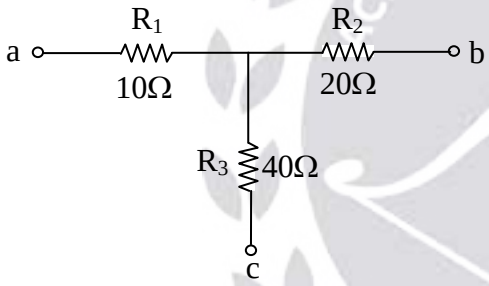
(c) 1, 2 and 3 (d) 2 and 3 only

**129. Ans: (a)**

**Sol:** EPROM, EAROM ($E^2$PROM) are erased by ultraviolet and electrically respectively.

PROM is a one time programmable ROM.

130. What are the values of $R_a$, $R_b$ and $R_c$ respectively, after transforming the Wye network shown in the figure to a delta network ?

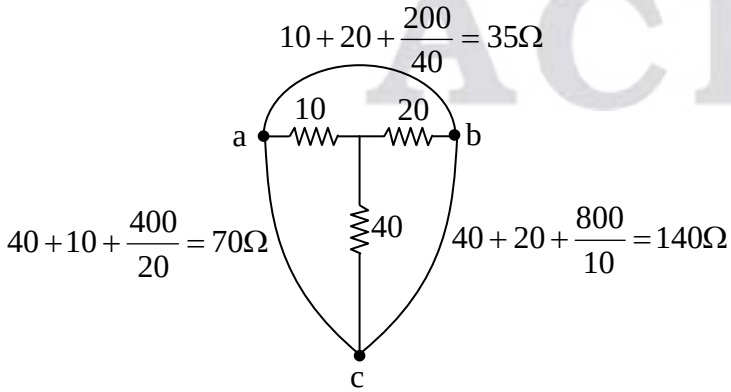



(a) 140Ω, 70 Ω and 45Ω (b) 70Ω, 140 Ω and 35Ω

(c) 140Ω, 70 Ω and 35Ω (d) 40Ω, 70 Ω and 25Ω

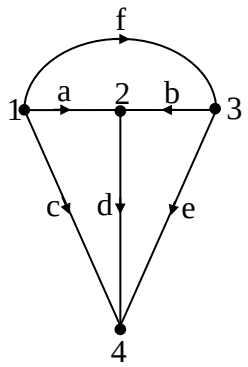
**130. Ans: (c)**

**Sol:**




In order 70Ω, 35Ω, 140Ω based on order.

131. The number of links in the graph shown in the figure is




(a) 3 (b) 4

(c) 2 (d) 5

**131. Ans: (a)**

**Sol:** Links = m = b – n + 1

= 6 – 4 + 1

= 3

132. Which one of the following contains lesser number of nodes than the original graph?

(a) Proper subgraph (b) Improper subgraph

(c) Planar graph (d) Non-planar graph

**132. Ans: (a)**

**Sol:** A subgraph is a subset of the branches and nodes of a graph. The subgraph is said to be proper if it consists of strictly less than all the branches and nodes of the graph.

133. Consider the following statements regarding duality:

1. The dual networks are obtained for both AC and DC circuits and they are based on Kirchhoff's laws.
2. Dual circuits are not obtained in planar networks
3. Two networks are said to be dual networks if mesh equations of one network have the same form as the nodal equations of the other.

Which of the above statements are correct?

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

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

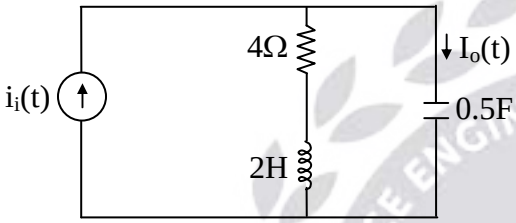
**133. Ans: (b)**

**Sol:** 1. The dual network can be obtained by using Kirchhoff's laws only.

2. Dual circuits are obtained for planar networks only.

3. If two networks are said to be in dual nature then one network mesh equations and other network nodal equations should be equal otherwise they are not in dual nature.

134. The current gain $\frac{I_0(\omega)}{I_i(\omega)}$ for the given circuit is




(a) $\frac{s(s+2)}{s^2+2s+1}$, where s = jω

(b) $\frac{s(s+1)}{s^2+s+1}$, where s = jω

(c) $\frac{s(s+2)}{s^2+2s+2}$, where s = jω

(d) $\frac{s(s+2)}{s^2+s+2}$, where s = jω

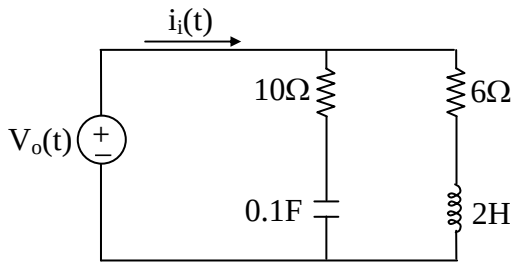
**134. Ans: (a)**

**Sol:** $I_0(s) = \frac{(4+2s)I_i(s)}{4+2s+\frac{1}{s\,0.5}}$

$\frac{I_0(s)}{I_i(s)} = \frac{s\,0.5(4+2s)}{(4+2s)(0.5\,s)+1}$

$\frac{I_0(s)}{I_i(s)} = \frac{s(2+s)}{2s+s^2+1} = \frac{s(2+s)}{s^2+2s+1}$

135. The poles and zeros of the given circuit are




(a) poles : – 0.683 and – 7.317

zeros : – 1 and – 3

(b) poles : – 0.483 and – 5.317

zeros : – 3 and – 4

(c) poles : – 0.383 and – 4.317

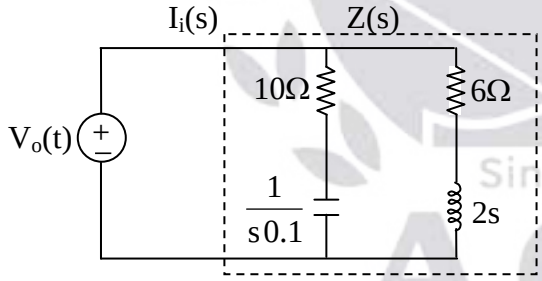
zeros : – 2 and – 3

(d) poles : – 0.583 and – 6.317

zeros : – 1 and – 4

**135. Ans: (a)**

**Sol:**




$$Z(s)=\frac{\left(10+\frac{1}{s0.1}\right)(6+2s)}{\left(10+\frac{1}{s0.1}\right)+(6+2s)}$$

$$Z(s)=\frac{(s+1)(6+2s)}{(s+1)+0.6s+0.2s^2}=\frac{(s+1)(6+2s)}{0.2s^2+1.6s+1}$$

$$V_0(s) = I_i(s)Z(s)$$

$$\frac{V_0(s)}{I_i(s)} = Z(s) = \frac{(s+1)(6+2s)}{0.2s^2+1.6s+1} = \frac{(s+1)(2s+6)}{(s+0.683)(s+7.317)}$$

Poles s = –0.683, – 7.317, zeros s = –1, –3

136. Current was measured during a test as of 30.4 A, flowing in a resistor of 0.105 Ω. It was discovered later that the ammeter reading was low by 1.2 percent and the marked resistance was high by 0.3 percent. What is the true was originally calculated?

(a) 118.4% (b) 109.7%

(c) 102.1% (d) 104.8%

**136. Ans: (c)**

**Sol:** $I_l = 30.4\,A$

$R = 0.105\,\Omega$

$$I_t = 30.4 + 30.4 \times \frac{1.2}{100} = 30.7648\,A$$

$$R_t = 0.105 - 0.105 \times \frac{0.3}{100} = 0.104685$$

$$P_m = I_m^2 R = (30.4)^2 \times (0.105) = 97.036\,W$$

$$P_t = I_t^2 R_t = (30.7648)^2 \times (0.104685) = 99.08\,W$$

$$\Rightarrow \frac{P_t}{P_m} \times 100 = \frac{99.08}{97.03} \times 100 = 102.1\%$$

137. The LVDT is used in an accelerometer to measure seismic mass displacements. The LVDT and signal conditioning outputs are 0.31 mV/mm with a ± 20mm core displacement. The spring constant is 240 N/m and the core mass is 0.05 kg. The natural frequency and maximum measureable acceleration are respectively,

(a) 69.3 rad/s and 69.3 $m/s^2$

(b) 69.3 rad/s and 96 $m/s^2$

(c) 15.59 rad/s and 96 $m/s^2$

(d) 15.59 rad/s and 31.18 $m/s^2$

**137. Ans: (b)**

**Sol:** x = ±20mm

M = 0.05 kg

K = 240 N/m

Natural Frequency $\omega_n = \sqrt{\frac{K}{M}} = \sqrt{\frac{240}{0.05}} = 69.3 \text{ rad/sec}$

Acceleration = $\omega^2 x = (69.3)^2 \times 20 \times 10^{-3} = 96 \text{ m/sec}^2$

138. A quartz piezoelectric crystal having a thickness of 1.5 mm and voltage sensitivity of 0.05 V-m/N is subjected to a pressure of 2 MN/m$^2$. The permittivity of the quartz is 40.6 × $10^{-12}$ F/m. The output voltage is

(a) 150V (b) 155V

(c) 165V (d) 300V

**138. Ans: (a)**

**Sol:** g = 0.05 Vm/N

t = 1.5 mm

p = $2 \times 10^6$ N/m$^2$

$e_0 = g\,t\,p = 0.05 \times 1.5 \times 10^{-3} \times 2 \times 10^6 = 150 \text{ V}$

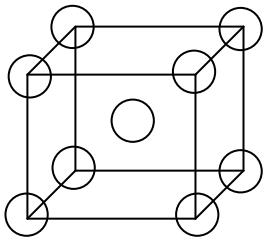
139. Which one of the following is a metallic crystal structure which has a cubic unit cell with atoms located at all eight corners and a single atom at the cube centre?

(a) Face-centred cubic crystal structure (b) Body-centred cubic crystal structure

(c) Cubic crystal structure (d) Metal crystalline structure

**139. Ans: (b)**

**Sol:** In BCC structure, 8 atoms are located at 8 corners and one atom is located at body center of unit cell



140. What is the atomic packing factor for FCC crystal structure?

(a) 0.96 (b) 0.48

(c) 0.74 (d) 0.37

**140. Ans: (c)**

**Sol:** Atomic packing factor of FCC structure = 0.74

141. Consider the following statements regarding crystal defects:

1. In metals, a self-interstitial introduces relatively large distortions in the surrounding lattice because the atom is substantially larger than the interstitial position in which it is situated.
2. All crystalline solids do not contain vacancies and, it is possible to create such a material that is free of these defect.
3. Impurity point defects are found in solid solutions, of which there are two types: substitutional and interstitial.

Which of the above statements is/are correct?

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

(c) 3 only (d) 2 only

**141. Ans: (a)**

**Sol:** The crystalline solids contain vacancies and it is not possible to create such a perfect material with free of defects.

142. Which one of the following represents the upper and lower upper bound of the elastic modulus respectively ? (E and V denote the elastic modulus and volume fraction respectively; the subscripts c, m and p represent composite, matrix and particulate phases respectively)

(a) $E_c(\mu) = \frac{E_m V_m}{E_p V_p}$ and $E_c(l) = \frac{E_m E_p}{V_m E_p + V_p E_m}$

(b) $E_c(\mu) = \frac{E_m E_p}{V_m E_p + V_p E_m}$ and $E_c(l) = E_m V_m + E_p V_p$

(c) $E_c(\mu) = E_m V_m + E_p V_p$ and $E_c(l) = \frac{E_m E_p}{V_m E_p + V_p E_m}$

(d) $E_c(\mu) = E_m V_m + E_p V_p$ and $E_c(l) = \frac{V_m E_p + V_p E_m}{E_m E_p}$

**142. Ans: (c)**

**Sol:** In a composite material the higher limit of Youngs Modulus is = $E_C = E_m V_m + E_p V_p$

Lower Limit is $\frac{1}{E_c} = \frac{V_m}{E_m} + \frac{V_p}{E_p}$

143. Which one of the following does not come under the category of ceramic material?

(a) $A1_2O_3$ (b) $SiO_2$

(c) $Si_2N_4$ (d) SiC

**143. Ans: (*)**

144. Consider the following statements regarding corrosion of ceramic material:

1. Ceramic materials are much better suited to withstand most of these environments for reasonable time periods than are metals.

2. Corrosion of ceramic materials generally involves simple chemical dissolution, in contrast to the electrochemical processes found in metals.

3. Ceramic materials are not frequently used because of their non-resistance to corrosion.

Which of the above statements is/are correct?

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

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

**144. Ans: (d)**

**Sol:** Ceramic materials have high corrosion resistance and hence these materials are frequently used for wide environment but some of ceramics may corrode due to chemical dissolution.

145. For a ferromagnetic material, which one of the following relationships is correct between magnetic flux density and magnetization?

(a) $B \cong 2\mu_0 M$

(b) $B \cong \mu_0 M$

(c) $B \cong \frac{\mu_0}{M}$

(d) $B \cong \frac{\mu_0 M}{2}$

**145. Ans: (b)**

**Sol:** magnetic flux density

$B = \mu_0(H + M)$

Here applied field $H = 0$

$B = \mu_0 M$

146. Which of the following statements is not correct regarding ferrites?

(a) Ferrites, with large magnetostrictive effects, are used in electromechanical transducers.

(b) Ferrites have very high resistivity

(c) Hard magnetic ferrites are used for the manufacture of light weight permanent magnets.

(d) Soft magnetic materials can be used for making permanent magnets.

**146. Ans: (d)**

**Sol:** Soft Magnetic materials are not used for making permanent magnets

Applications of soft magnetic material = Transformer core

147. Which one of the following materials displays the behaviour of antiferromagnetism ?

(a) Manganese oxide (b) Iron

(c) Nickel (d) Cobalt

**147. Ans: (a)**

**Sol:** Anti-ferromagnetic material = MnO, ZnO, NiO

148. Consider the following statements for superconductivity:

1. Superconducting magnets capable of generating high fields with low power consumption are currently being employed in scientific test and research equipment.
2. One of the potential applications of superconducting materials is electrical power transmission through superconducting materials – power losses would be extremely low, and the equipment would operate at low voltage levels.
3. Type II superconductors are preferred over type I for most practical applications by virtue of their higher critical temperatures and critical magnetic fields.

Which of the above statements is/are correct?

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

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

**148. Ans: (d)**

**Sol:** Super conductors are used to generate high magnetic fields with lower power consumption.

Super conductors are also used in loss less power transmission lines.

Type-II superconductor have high critical magnetic field i.e varying from 30 to 40 Tesla and hence this type is used for applications.

149. Which one of the following statements is not correct regarding the features of ceramics?

(a) Ceramics are hard, strong and dense.

(b) Ceramics are stronger in compression than in tension.

(c) Ceramics have very poor dielectric properties.

(d) Ceramics are weak in impact strength

**149. Ans: (c)**

**Sol:** Properties of Ceramics:

1. Ceramics are hard, strong & dense
2. High compressive strength & low tensile strength
3. Good dielectric materials
4. High corrosion resistance
5. Low toughness

150. What is the packing efficiency of diamond ?

(a) 0.17 (b) 0.34

(c) 0.24 (d) 0.48

**150. Ans: (b)**

**Sol:** The atomic packing factor of diamond is 0.34

*Hearty Congratulations to our*

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