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ESE 2021

Preliminary Examination

Detailed Solutions of

Electronics & Telecommunication Engineering

Set-B

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Expected Cutoff of ESE 2021 Prelims Exam (Out of 500 Marks)				
Branch	Gen	OBC	SC	ST
CE	260-270	250-260	220-230	220-230
ME	280-290	270-280	230-240	220-230
EE	250-260	240-250	210-220	200-210
E&T	270-280	260-270	220-230	210-220

Actual Cutoff of ESE 2020 Prelims Exam (Out of 500 Marks)				
Branch	Gen	OBC	SC	ST
CE	238	238	202	227
ME	262	250	214	202
EE	238	229	187	194
E&T	245	245	205	202

Electronics & Telecom Engg. Paper Analysis of ESE 2021 Preliminary Examination

Sl.	Subjects	Number of Questions
1	Materials Science	13
2	Electronic Devices and Circuits	6
3	Analog Circuits	11
4	Network Theory	22
5	Control Systems	5
6	Electromagnetic Theory	14
7	Measurements	11
8	Communication Systems	12
9	Advance Communications	14
10	Advance Electronics	4
11	Basic Electrical Engineering	4
12	Computer Organization	9
13	Signals and Systems	12
14	Digital Circuits	7
15	Microprocessors & Microcontrollers	6

UPSC ESE/IES Prelims Exam 2021
E&T analysis and expected cutoff
by MADE EASY faculties

https://www.youtube.com/watch?v=1zEnTCRIbho

Q.1 Which one of the following traffics can adjust, over wide ranges, to changes in delay and throughput across in internet and still meet the needs of its applications?

(a) Elastic traffic
(b) Inelastic traffic
(c) Internet traffic
(d) Service traffic

Ans. (a)

End of Solution

Q.2 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

Ans. (d)

$$\text{Data Rate} = \frac{4800\ \text{bits}}{10\ \text{ms}} = 480\ \text{kbps}$$

$$\text{Total delay} = 10\ \text{ms} + (10 \times 1\ \text{ms}) = 20\ \text{ms}$$

End of Solution

Q.3 Consider the following statements regarding the OSI mode :

1. Application layer provides the control structure for communication between applications; establishes, manages and terminates connections between cooperating applications.
2. Data link layer provide for the reliable transfer of information across the physical link.
3. Transport layer provide 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

Ans. (d)

Session layer establishes, manages and terminate connections.

End of Solution

Q.4 Consider the following statement regarding the TCP/IP protocol :

1. TELNET is an application of TCP protocol.
2. SMTP provides a basic electronic mail facility and makes use of 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

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Ans. (d)

TELNET uses the TCP.

End of Solution

Q.5 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) $\dfrac{S}{\sum_{i=1}^{P} I_P}$

(b) $\dfrac{2\times S}{\sum_{i=1}^{P} I_P}$

(c) $\dfrac{\sum_{i=1}^{P} I_P}{S}$

(d) $\dfrac{S}{I_P}$

Ans. (a)

$$\text{SINR} = \frac{S}{I_1 + I_2 + \ldots I_P} = \frac{S}{\sum_{i=1}^{P} I_P}$$

End of Solution

Q.6 Which one of the following provides a reliable connection for the transfer of data between applications?

(a) TCP
(b) UDP
(c) FTP
(d) SMTP

Ans. (a)

TCP offers reliable connection oriented transmission for upper layer protocols like FTP and SMTP.

UDP offers unreliable connectionless transmission.

End of Solution

Q.7 For a GEO satellite, what is the free space loss (L_{db}) at the equator in terms of carrier wavelength (λ)?

(a) 20log(λ) + 21.98
(b) –20log(λ) + 173.07
(c) 20log(λ) – 173.07
(d) –20log(λ) + 21.98

Ans. (b)

$$L_s = \left(\frac{4\pi d}{\lambda}\right)^2$$

$$L_S(\text{dB}) = 10\log_{10}\left(\frac{4\pi d}{\lambda}\right)^2$$

$$= 20\log_{10}\left(\frac{4\pi d}{\lambda}\right)$$

d = distance in meters = 36000 × 1000 meters

$= 20\log_{10}(4\pi \times 36000 \times 1000) = 20\log_{10}(\lambda)$

$= 173.07 - 20\log_{10}(\lambda)$

End of Solution

Q.8 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?

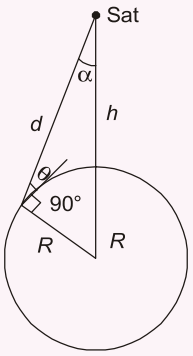
(a) $\frac{R}{R+h} = \frac{\cos(\beta+\theta)}{\cos(\theta)}$

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

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

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

Ans. (a)



$$\sin\alpha = \frac{R}{d}$$

$$\sin(90^\circ + \theta) = \frac{R+h}{d}$$

$$\frac{\sin\alpha}{\sin(90^\circ+\theta)} = \frac{R}{R+h}$$

$$\frac{R}{R+h} = \frac{\sin\left(\frac{\pi}{2} - \beta - \theta\right)}{\sin\left(\theta + \frac{\pi}{2}\right)} = \frac{\cos(\beta+\theta)}{\cos(\theta)}$$

End of Solution

Q.9 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

Ans. (b)

A switching in centre that directly supports subscribers is known as endoffice.

End of Solution

Q.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 nonblocking.

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

Ans. (b)

FDMA system, the capacity of a cell is more compared to the number of frequency channels.

If $L > N$, then the system is blocking.

End of Solution

Q.11 The fundamental parameters 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.

Ans. (a)

In single made fibre the core diameter is always small.

End of Solution

Q.12 Consider the following statements regarding the advantages of optical fibre 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

Ans. (d)

End of Solution

Q.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) $AB\bar{C} + A\bar{B}C + \bar{A}\bar{B}C$

Ans. (c)

	$\bar{B}\bar{C}$	$\bar{B}C$	BC	$B\bar{C}$
$\bar{A}$		1		
A	1	1	1	1

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

End of Solution

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

1. The maximum drain current, I_{DSS} occurs when gate-to-source voltage $V_{GS} = 0$ V 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 0 A.
3. For all levels of V_{GS} between 0 V and the pinch-off level, the current I_D will range between I_{DSS} and 0 A, respectively.

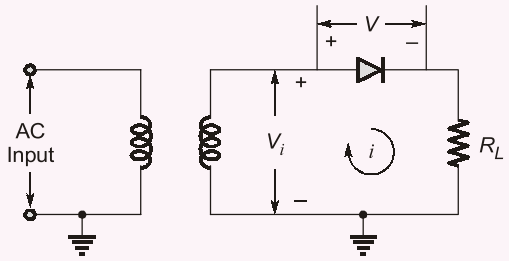
Which of the above statements are correct?

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

Ans. (c)

End of Solution

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



(a) –28.54 V
(b) –38.54 V
(c) –48.54 V
(d) –58.54 V

Ans. (c)

$$V_{\text{diode, DC}} \cong \frac{-V_m}{\pi} = \frac{-110\sqrt{2}}{\pi} \cong -49\ \text{V}$$

(or)
$$V_{\text{Diode, DC}} = \frac{-I_m R_L}{\pi} = \frac{-152.5\ \text{m} \times 1\text{k}}{\pi} = -48.5\ \text{V}$$

where,
$$I_m = \frac{V_m}{R_F + R_L} = \frac{110\sqrt{2}}{1020} = 152.5\ \text{mA}$$

End of Solution

Q.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

Ans. (b)

End of Solution

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

(a) 72 mW
(b) 144 mW
(c) 158 mW
(d) 316 mW

Ans. (b)

$$H = 5 \times 10^{-6}\ \text{(A/m)}$$

$$\theta = \frac{\pi}{2}$$

$$r = 2\ \text{km air}$$

$$R_{\text{rad}} = 73\ \Omega$$

$$H_{\phi s} = \frac{jI_o e^{-j\beta r}\cos(\pi/2\cos\theta)}{2\pi r\sin\theta}$$

$$(H_{\phi s}) = \frac{I_o\cos(\pi/2\cos\theta)}{2\pi r\sin\theta}$$

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

$$I_o = \frac{(5\times10^{-6})\,2\pi(2\times10^{3})\sin(98)}{\cos\left(\frac{\pi}{2}\cos 90^\circ\right)} = 20\pi\times10^{-3}$$

$$P_{rad} = \frac{1}{2}I_o^2\,P_{rad} = \frac{1}{2}(20\pi)^2\,(10^{-6})\,(73)\text{ Watt}$$

$$P_{rad} = 0.143950.16 = 143.450\text{ mW} \simeq 144\text{ mW}$$

End of Solution

Q.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

Ans. (c)

End of Solution

Q.19 Consider the following statements for Poly-Si depositions :

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

Ans. (d)

End of Solution

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Q.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 minterms are ORed through the programmable switches which can be made ON or OFF to select a particular minterms. The programmable switches can be implemented by either bipolar, CMOS, nMOS or pMOS technologies.
4. Mask-programed 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
(c) 1, 2 and 4 only
(d) 2, 3 and 4 only

Ans. **(c)**

ROM is a non-volatile memory which means it keeps its data even if the power is turned off.

End of Solution

Q.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) $(0.1)^{16}$

Ans. **(b)**

All the cores must work, therefore, the yields is $(0.9)^{16}$.

End of Solution

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

(a) sin10
(b) –sin10
(c) 1
(d) 0

Ans. **(d)**

$$y(n) = \sum_{n=-5}^{5} \sin(2n)\delta(n+7)$$

$$y(n) = -\sin(14) \sum_{n=-5}^{5} \delta(n+7)$$

$$y(n) = 0$$

Alternate Solution:

$$y(n) = \sum_{n=-5}^{5} \sin 2n \cdot \delta(n+7) = \sum_{n=-5}^{5} \sin[2(-7)\,\delta(n+7)]$$

$$= \sum_{n=-5}^{5} \sin(-14) \cdot \delta(n+7) = 0$$

$$f(x) \cdot \delta(n + n_o) = f(-n_o) \cdot \delta(n + n_o)$$

End of Solution

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

(a) $\frac{1}{16}$ (b) $\frac{1}{36}$

(c) $\frac{5}{3}$ (d) $\frac{25}{4}$

Ans. (*)

$$x(n) = (0.4)^n u(n)$$

$$\text{Energy, } E = \sum_{n=-\infty}^{\infty} |x(n)|^2$$

$$= (0.4)^0 + (0.4)^2 + (0.4)^4 + \ldots$$

$$= \frac{1}{1-(0.4)^2} = \frac{1}{1-0.16}$$

$$= \frac{1}{0.84} = \frac{25}{21}$$

Alternate

$$x(n) = (-0.4)^n u(n)$$

Energy of $x(n)$:

$$E = \sum_{x=-\infty}^{\infty} |x(n)|^2$$

$$= \sum_{x=0}^{\infty} (0.4)^{2n} = \sum_{x=0}^{\infty} (0.16)^n$$

$$= \frac{1}{1-0.16} = \frac{1}{0.84} = \frac{100}{84} = \frac{25}{21}$$

All options are wrong.

End of Solution

Q.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

Ans. (d)

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

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

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

$$= x_1(n)\sum_{k=-\infty}^{\infty}\delta(n-3k) + x_2(n)\sum_{k=-\infty}^{\infty}\delta(n-3k)$$

$$= y_1(n) + y_2(n)$$

Hence, the system is linear.

$$y_0(n) = \sum_{k=-\infty}^{\infty} x(n)\cdot\delta(n-3k)$$

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

$y(n)$ independent of future values of $x(n)$. Hence, the system is causal.

Alternate

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

- Linear because it will satisfy low of superposition.
- Causal because output is independent of future values of input.

End of Solution

Q.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) $y_{Zi}(n) = (1)^{n+1} + (-4)^{n+2}, n \geq 0$

Ans. (c)

$y[n] - 3y[n-1] - 4y[n-2] = 0$

auxiliary equation is:

$\lambda^n - 3\lambda^{n-1} - 4\lambda^{n-2} = 0$

$\Rightarrow \quad \lambda^2 - 3\lambda - 4 = 0$

$\Rightarrow \quad (\lambda - 4)(\lambda + 1) = 0$

$\Rightarrow \quad \lambda = 4, -1$

Hence, $y[n] = C_1(4)^n + C_2(-1)^n;\ n \geq 0$

Using given conditions, $y[-2] = 0$ and $y[-1] = 5$

$$0 = \frac{C_1}{16} + C_2$$

and $$5 = \frac{C_1}{4} - C_2$$

On solving we get, $C_1 = 16$ and $C_2 = -1$

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

Alternate

Given difference equation

$y(n) - 3y(n-1) - 4y(n-2) = 0$ ...(i)

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

By applying unilateral Z-transform on equation (i)

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

$$\Rightarrow \quad Y(z) - 3\left[z^{-1}Y(z) + 5\right] - 4\left[z^{-2}Y(z) + 5z^{-1} + 0\right] = 0$$

$$\Rightarrow \quad Y(z)\left[1 - z^{-1} - 4z^{-2}\right] = 15 + 20z^{-1}$$

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

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

By taking inverse,

$$y(n) = -1(-1)^n\, u(n) + 16(4)^n\, u(n)$$
$$= \left[(-1)^{n+1} + (4)^{n+2}\right] u(n)$$
$$= \left[(-1)^{n+1} + (4)^{n+2}\right],\ n \geq 0$$

End of Solution

Q.26 Consider the following statements regarding Epitaxial Growth :

1. Thin 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

Ans. (b)

Chemical vapour deposition is also called vapour phase epitaxy.

End of Solution

Q.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.

Ans. (d)

When $h(n) = -h(m - 1 - n)$ and M is even, $H(0) = 0$. Thus, it is not used in the design of a low pass linear phase FIR filter.

Alternate

$$\text{Order} = \text{Even integer}$$
$$\text{Length} = \text{Order} + 1 = \text{Odd integer}$$

Impulse response is anti-symmetric.

So, the above filter is type-III linear phase FIR filter.

Type-III FIR filters introduce phase shift of $\pi/2$. So they are not suitable to design frequency selective filter. They are used to design Hilbert transforms and differentiators.

End of Solution

Q.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)

Ans. (d)

End of Solution

Q.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

Ans. (a)

A = 80H ; B = 8FH

[A] + [B] = 80H + 8FH =1 0FH

But accumulator is 8-bit register

∴ Accumulator = 0FH

Carry flag = 1

End of Solution

Q.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 $x[n]$

Ans. (d)

Folding and time delaying of signals are not commutative.

End of Solution

Q.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

Ans. (a)

For $x(n - n_o)$ as input,

System output $y'(n) = x(n - n_o) - x(n - n_o - 1)$

Now, delayed output

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

Since, $y'(n) = y(n - n_o)$

So, the system is time invariant.

System output is independent of future values of input. So, the system is causal.

End of Solution

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

(a) 1

(b) 0

(c) infinity

(d) 0.5

Ans. (b)

For V_1 and V_2 to be orthogonal, $V_1 \cdot V_2 = 0$.

End of Solution

Q.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.

Ans. **(a)**

For the system to be causal, ROC should be right-sided and since, ROC is bounded by the poles and cannot include any poles, therefore, the ROC should be the exterior of a circle outside the outermost pole.

End of Solution

Q.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

Ans. **(c)**

The close loop transfer function is

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

for third order system to be stable,

$$5(9 - k) > k$$
$$(45 - 5k) > k$$
$$6k < 45$$
$$k < 7.5$$

End of Solution

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

(a) 0 (b) $\frac{1}{2}$

(c) 1 (d) ∞

Ans. **(d)**

For type 1 system, the steady-state error due to parabolic input is infinite.

End of Solution

Q.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.

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Ans. (b)

End of Solution

Q.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

Ans. (a)

For coherent-binary PSK

$$\Rightarrow \quad \text{BER} = Q\left(\sqrt{\frac{2E_b}{N_o}}\right)$$

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

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

End of Solution

Q.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 zeros cancelled by the close] proximity of higher-order closed-loop poles are far removed from the closed-loop second-order zero pair.

Ans. (c)

End of Solution

Q.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 branches 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 branches 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

Ans. (c)

End of Solution

Q.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

Ans. (d)
RISC CPU contain smaller instruction set compared to CISC CPU.

End of Solution

Q.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

Ans. (c)
In the stack CPU. ALU operations are performed only on a stack data. So no need of an operand addresses. Opcode without address is called as 0-address instruction.

End of Solution

Q.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.

Ans. (b)
(n-bit) * (n-bit) = $2n$-bit
Final product is in $2n$-bit format.

End of Solution

Q.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

Ans. (a)

Direct mapping function is [K mod $N = i$ (line number)]

Set associative function is [K mod $S = i$ (set number)].

End of Solution

Q.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

Ans. (a)

Mask-programmed ROMs are permanent and once programmed cannot be modified.

End of Solution

Q.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 electromechanical 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.

Ans. (a)

Mechanical I/O devices are purely slower than electronic devices. So, CPU often idle when the data is accessed from the mechanical I/O.

End of Solution

Q.46 A white noise of magnitude 0.001 μW/Hz is applied to an RC low-pass filter of R = 1 kΩ 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

Ans. (c)

$$\text{Output noise power} = \frac{N_o}{4RC}$$

$$N_o = 0.001\ \mu\text{W/Hz}$$

$$R = 1\ \text{k}\Omega,\ C = 0.1\ \mu\text{F}$$

$$\text{Noise power} = \frac{0.001\times 10^{-6}}{4\times(10^3)\times(0.1\times 10^{-6})} = 2.5\,\mu\text{W}$$

End of Solution

Q.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

Ans. **(a)**

If cov(X, Y) = 0 ; then X and Y are said to be uncorrelated.

End of Solution

Q.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 $V(t) = 1.4 \sin(2\pi \times 500t)$ with modulation index 0.8?

(a) 3.2 A (b) 7.2 A

(c) 9.2 A (d) 11.2 A

Ans. **(c)**

$$I_t = I_c\sqrt{1+\frac{\mu^2}{2}} = 8\sqrt{1+\frac{(0.8)^2}{2}}$$

$$= 9.2 \text{ Amp}$$

End of Solution

Q.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

Ans. **(b)**

$$\text{Modulation index } (\beta) = \frac{\Delta f}{f_m}$$

$$= \frac{75\,\text{kHz}}{300\,\text{kHz}} = 0.25 <<< 1$$

$\because \beta <<< 1 \Rightarrow$ Given is NBFm

$$\text{BW} \simeq 2f_m \simeq 600 \text{ kHz}$$

End of Solution

Q.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.
5. 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

Ans. (a)

End of Solution

Q.51 What 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

Ans. (b)

$$H = \sum_{i=1}^{6} P_i \cdot \log_2 \frac{1}{P_i}$$

$$= \left[\frac{1}{8}\log_2 8\right] \times 4 + \left[\frac{1}{4}\log_2 4\right] \times 2$$

$$H = 2.5 \text{ bits/message}$$

End of Solution

Q.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

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Ans. (c)

$[Q_e]_{max} \le 0.1\%\ A_m$.

Where A_m is the peak amplitude of the signal.

$$\frac{\Delta}{2} = \frac{1}{2}\left[\frac{2A_m}{2^n}\right] \le \frac{0.1}{100} \times A_m$$

$$2^n \ge 1000$$

$$n \ge 10$$

$$n_{min} = 10$$

End of Solution

Q.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

Ans. (a)

Given : $N = 6$ and $f_m = 4$ kHz

Signalling rate (or) bitrate $(R_b) = Nnf_s$

Default $n = 1$ bit/sample

f_s = N.R. $= 2f_m = 8$ kHz

$R_b = 6 \times 1 \times 8\ k = 48$ kbps

$$\text{Min transmission BW} = \frac{R_b}{2} = 24\ \text{kHz}$$

End of Solution

Q.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

Ans. (b)

$R_b = 2000$ bps

$f_H - f_L = 4000$ Hz

For FSK; Min bandwidth $= (f_H - f_L) + R_b$

$= 4\ k + 2k = 6$ kHz

End of Solution

Q.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

Ans. (d)

The voice activity interference reduction factor: $G_f = 2.5$

The antenna sectorization gain factor: $G_A = 2.5$

The interference increase factor: $\rho = 1.6$

The performance improvement factor in CDMA P_f is given by

$$P_f = \frac{G_f \times G_A}{\rho} = \frac{2.5 \times 2.5}{1.6} = 3.9$$

End of Solution

Q.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

Ans. (b)

$[Q_e]_{max} \le 1\%\ V_{p-p}$

$\because$ Dynamic range = Peak to peak amplitude of the signal

$$\frac{\Delta}{2} = \frac{1}{2}\left[\frac{V_{p-p}}{L}\right] \le \frac{1}{100} \times V_{p-p}$$

$$L \ge 50$$

$$L_{min} = 50$$

End of Solution

Q.57 A multimode step index fibre 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 fibre is

(a) 37.9 (b) 75.8

(c) 151.6 (d) 303.2

Ans. (b)

Given that, $2a = 80\ \mu m$

$\Rightarrow$ $\Delta = 1.5\% = \frac{1.5}{100}$

$\lambda = 0.85\ \mu m$

$n_1 = 1.48$

$v = ?$

$$v = \frac{2\pi a}{\lambda} NA = \frac{2\pi a}{\lambda} n\sqrt{2\Delta}$$

$$v = \frac{2\pi \times \frac{80}{2} \times 10^{-6}}{0.85 \times 10^{-6}} \times 1.48 \times \sqrt{2 \times \frac{1.5}{100}}$$

$$v = 75.79 \simeq 75.8$$

End of Solution

Q.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 $-\sinh 2t \cos t$

Ans. (d)

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

$$\Rightarrow \quad \text{Even}[x(t)] = \frac{x(t)+x(-t)}{2} = \frac{e^{-2t}\cos t + e^{2t}\cos(-t)}{2}$$

$$= \cos t\left[\frac{e^{-2t}+e^{2t}}{2}\right] = \cos t \cdot \cosh 2t$$

$$\text{Odd}[x(t)] = \frac{x(t)-x(-t)}{2} = \frac{e^{-2t}\cos t - e^{2t}\cos(-t)}{2}$$

$$= \cos t\left[\frac{e^{-2t}-e^{2t}}{2}\right] = -\cos t\left[\frac{e^{2t}-e^{-2t}}{2}\right] = -\cos t \cdot \sinh 2t$$

End of Solution

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

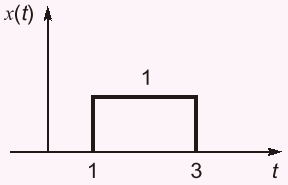
(c) $c(t) = \begin{cases} 0, & t<1 \\ 5-t, & 1\le t<4 \\ 0, & t\ge 4 \end{cases}$

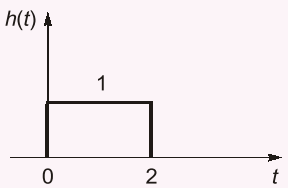
(d) $c(t) = \begin{cases} 2, & 1\le t\le 2 \\ 1, & 3\le t\le 5 \\ 0, & \text{otherwise} \end{cases}$

Ans. (a)

$$\Rightarrow \quad x(t) = u(t-1) - u(t-3)$$

$$\Rightarrow \quad h(t) = u(t) - u(t-2)$$



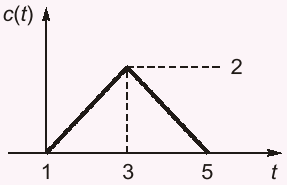


$\Rightarrow$ $c(t) = x(t) * h(t)$

$= [u(t-1) - u(t-3)] * [u(t) - u(t-2)]$

$= r(t-1) - r(t-3) - r(t-3) + r(t-5)$

$= r(t-1) - 2r(t-3) + r(t-5)$



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

End of Solution

Q.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

Ans. **(b)**

S/g : $u(t)$

$$\text{Power} = \frac{1}{2},\ E = \text{Infinite}$$

End of Solution

Q.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

Ans. **(a)**

Virtual memory system provides a mechanism for translating the logical address into a physical address.

End of Solution

Q.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

Ans. (d)
All statements are correct.

End of Solution

Q.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

Ans. (a)
Mach maps the address space containing the senders message into the receiver address space. Therefore, the message itself is never actually copied.

End of Solution

Q.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

Ans. (b)
Application program is always stored in the secondary memory (Hard Disk) later OS transfer the program from the secondary memory to main memory, to execute.

End of Solution

Q.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 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

Ans. (d)
Complier may not perform inlining, if a function contains a loop, function is recursive, function contain switch goto statements.

End of Solution

Q.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

Ans. (b)
Assembler directives are hints given to assembler by programmer while writing assembly language program. They are not converted machine codes.
Example: END, DB, DW etc.

End of Solution

Q.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) $0.4444\hat{a}_x - 0.2222\hat{a}_y + 0.4444\hat{a}_z$

Ans. (d)

$$\vec{P} = 2\hat{a}_x - \hat{a}_z$$
$$\vec{Q} = 2\hat{a}_x - \hat{a}_y + 2\hat{a}_z$$
$$\hat{a}_Q = \frac{2\hat{a}_x - \hat{a}_y + 2\hat{a}_z}{\sqrt{2^2 + 1 + 2^2}} = \frac{2}{3}\hat{a}_x - \frac{1}{3}\hat{a}_y + \frac{2}{3}\hat{a}_z$$

Component of $\vec{P}$ along $\vec{Q}$ is $= (\vec{P}\cdot\vec{Q})\,\hat{a}_Q$

$$= \left[(2\hat{a}_x - \hat{a}_z)\cdot\left(\frac{2}{3}\hat{a}_r - \frac{1}{3}\hat{a}_y + \frac{2}{3}\hat{a}_z\right)\right]\left[\frac{2}{3}\hat{a}_x - \frac{1}{3}\hat{a}_x + \frac{2}{3}\hat{a}_y\right]$$
$$= \left(\frac{4}{3} - \frac{2}{3}\right)\left(\frac{2}{3}\hat{a}_x - \frac{1}{3}\hat{a}_y + \frac{2}{3}\hat{a}_z\right)$$
$$= 0.444\hat{a}_x - 0.222\hat{a}_y + 0.444\hat{a}_z$$

End of Solution

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

1. $\oint D_s \cdot dS = \int \rho_{vs}\, dv$
2. $\oint E_s \cdot dl = -j\omega B_s$
3. $\oint B_s \cdot dS = 0$
4. $\oint H_s \cdot dS = \int (J_s + j\omega D_s)\, dl$

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

Ans. (b)

End of Solution

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

(a) 6.750 (b) 4.941

(c) 0.732 (d) 1.765

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Ans. (b)

If $\vec{A} = \rho\cos\phi\hat{a}_\rho + \sin\phi\hat{a}_\phi$

$$30° < \phi < 60°$$
$$2 \le \rho \le 5$$
$$\overrightarrow{ds} = \rho d\rho d\phi \hat{a}_z$$
$$\vec{\nabla}\times\vec{A} = \left[\frac{1}{\rho}\sin\phi + \sin\phi\right]\hat{a}_\phi \qquad \text{(we need } z\text{-component only)}$$

$$\iint(\vec{\nabla}\times\vec{A})\cdot\overrightarrow{ds} = \iint\frac{1}{\rho}\sin\phi\rho d\rho d\phi + \iint\sin\phi d\rho d\phi$$

$$= \int_{\rho=2}^{5} d\rho \int_{\phi=\frac{\pi}{6}}^{\pi/3}\sin\phi d\phi + \int_{\rho=2}^{5}\rho d\rho \int_{\phi=\frac{\pi}{6}}^{\pi/3}\sin\phi d\phi$$

$$= (\rho)_2^5(-\cos\phi)_{\phi=\frac{\pi}{6}}^{\pi/3} + \left(\frac{\rho^2}{2}\right)_{\rho=2}^{5}(-\cos\phi)_{\pi/6}^{\pi/3}$$

$$= (5-2)\left[-\left(\frac{1}{2}-\frac{\sqrt{3}}{2}\right)\right] + \left(\frac{5^2-2^2}{2}\right)\left[-\left(\frac{1}{2}-\frac{\sqrt{3}}{2}\right)\right]$$

$$= \left(\frac{\sqrt{3}}{2}-\frac{1}{2}\right)\left[3+\frac{(25-4)}{2}\right] = \left(\frac{\sqrt{3}-1}{2}\right)\left[3+\frac{21}{2}\right]$$

$$= \left(\frac{\sqrt{3}-1}{2}\right)(13.5) = 4.941$$

End of Solution

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.

Ans. (d)

End of Solution

71. A uniform plane wave propagating in a medium has

$\vec{E} = 2e^{-\alpha z}\sin\left(10^8 t - \beta z\right)\hat{a}_y$ V/m,

If the medium is characterized by $\varepsilon_r = 1$, $\mu_r = 20$ and $\sigma = 3$ S/m. The value of α and β 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

Ans. (b)

$$\vec{E} = 2e^{-\alpha z}\sin(10^8 t - \beta z)\,\hat{a}_y$$

$$\epsilon_r = 1\ ;\ \mu_r = 20\ ;\ \sigma = 3\ ;\ \alpha,\ \beta$$

$$\frac{\sigma}{\omega\epsilon_o} = \frac{3}{(10^8)\left(\frac{1}{36\pi}\times 10^{-9}\right)} = 3\times 36\pi\times 10 = 3391.2$$

$$\frac{\sigma}{\omega\epsilon_o} >> 1$$

$$\alpha = \beta = \sqrt{\frac{\omega\mu\sigma}{2}} = \sqrt{\pi f\mu\sigma} = \sqrt{\pi\left(\frac{10^8}{2\pi}\right)(4\pi\times 10^{-7})(20)\,(3)}$$

$$\alpha = \beta = \sqrt{2\pi\times 20\times 3\times 10} = \sqrt{3768} = 61.384$$

End of Solution

72. A distortionless 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 pF/m
(c) 2.4 Ω/m, 333 nH/m, 333 μS/m, 92.59 pF/m
(d) 2.4 Ω/m, 111 H/m, 333 μS/m, 92.59 pF/m

Ans. (a)

$Z_o = 60\ \Omega$; $v_p = 0.6 \times 3 \times 10^8$; $\alpha = 20 \times 10^{-3}$ (NP/m)
$f = 100$ MHz distortionless transmission line

$$Z_o = \sqrt{\frac{L}{C}} \qquad ...(1)$$

$$\alpha = \sqrt{RG} \qquad ...(2)$$

$$v_p = \frac{1}{\sqrt{LC}} \qquad ...(3)$$

$$\beta = \omega\sqrt{LC}$$

$$Z_o\, v_p = \sqrt{\frac{L}{C}}\,\frac{1}{\sqrt{LC}}$$

$$\Rightarrow \quad C = \frac{1}{Z_o v_p} = \frac{1}{60\,(0.6\times 3\times 10^8)}$$

$$C = \frac{1}{10.8}\,10^{-9}$$

$$C = 92.59 \times 10^{-12} = 92.59 \times 10^{-12}\ \text{F} \qquad ...(4)$$

$$Z_o^2 = \frac{L}{C}$$

$$\Rightarrow \quad L = Z_o^2 C$$

$$L = (60)^2 \times 92.59 \times 10^{-12} = 333.324 \times 10^{-9}$$

$$= 333.324\ \text{nH/m} \qquad ...(5)$$

$$Z_o = \sqrt{\frac{R}{G}}$$

$$\alpha Z_o = \sqrt{\frac{R}{G}}\,\sqrt{RG}$$

$$\alpha Z_o = R$$

$$R = 20 \times 10^{-3}\,(60) = 1.2\ \Omega \qquad ...(6)$$

$$\frac{\alpha}{Z_o} = \sqrt{RG}\,\sqrt{\frac{G}{R}}$$

$$\Rightarrow \quad G = \frac{\alpha}{Z_o}$$

$$G = \frac{20\times 10^{-3}}{60}$$

$$\Rightarrow \quad G = 333.3 \times 10^{-6}\ (\text{℧/m}) \qquad ...(7)$$

End of Solution

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. λ distance on the line corresponds to a 720° movements 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

Ans. (a)

End of Solution

Q.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 Ω load to a 75 Ω line, the quarter-wave transformer must have a characteristic impedance of 190 Ω.
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

Ans. (a)

End of Solution

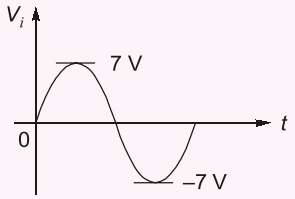
Q.75 Which of the following antennas are used directly as radiators aboard satellites to illuminate comparatively large areas of the Earth and they are widely used as primary feeds for reflector-type antennas both in transmitting and receiving modes?

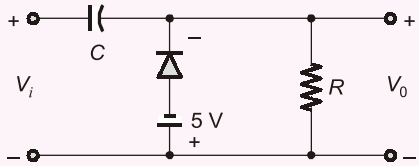
(a) Dipole antennas (b) End fire-array antennas
(c) Microstrip antennas (d) Horn antennas

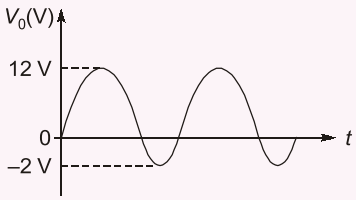
Ans. (d)

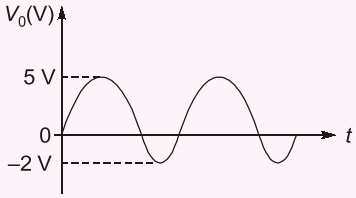
End of Solution

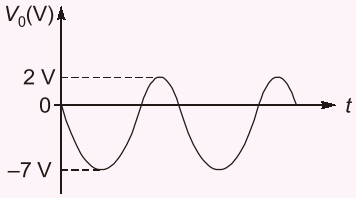
Q.76 A sinusoidal input is given to the network shown below. The output waveform is

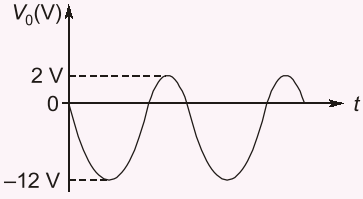




(a)


(b)


(c)


(d)


Ans. (*)

Positive clamper

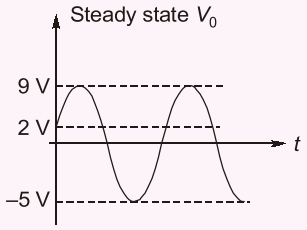
If $V_i < -5$ V, capacitor charges through diode upto $-7 - (-5)$ i.e., -2 V

In steady state $V_C = -2$ V

Now, $V_0 = V_i - V_C = V_i + 2$

If $V_i = +7$ V $\Rightarrow$ $V_0 = 9$ V

If $V_i = -7$ V $\Rightarrow$ $V_0 = -5$ V



*All options are incorrect.

End of Solution

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

Ans. (b)

$$I_{DS} = k(V_{GS} - V_T)^2 \Rightarrow k = 0.278 \text{ mA/V}^2$$

End of Solution

Q.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 voltages are sampled.

Ans. (b)

Shunt Mixing $\Rightarrow$ Currents are mixed or compared

Series sampling $\Rightarrow$ Current sampling

End of Solution

Q.79 A Hartley oscillator uses $L_1 = 2$ mH and $L_2 = 1.5$ mH. 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

Ans. (a)

In Hartley oscillator,

$$f_0 = \frac{1}{2\pi\sqrt{(L_1 + L_2)C}}$$

$$C = \frac{1}{4\pi^2 f_0^2 (L_1 + L_2)}$$

If $f_0 = 1000$ kHz $\Rightarrow$ $C = 7.2$ pF

If $f_0 = 2000$ kHz $\Rightarrow$ $C = 1.8$ pF

(or) $$\frac{C_2}{C_1} = \left(\frac{f_{01}}{f_{02}}\right)^2 = \frac{1}{4}$$

$\Rightarrow$ $$\frac{C_{max}}{C_{min}} = 4$$

This ratio matches with option (a).

End of Solution

Q.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.

Ans. (a)

End of Solution

Q.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

Ans. (b)

In Wien bridge oscillator,

$$f_0 = \frac{1}{2\pi RC} \Rightarrow C = \frac{1}{2\pi R f_0} = 159 \text{ pF}$$

End of Solution

Q.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 Å 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

Ans. (d)

$$C_{ox} = \frac{\epsilon_{Ox}}{T_{ox}} = \frac{4 \times 8.85 \times 10^{-14}}{500 \times 10^{-8}} = 7.08 \times 10^{-8}\ \text{F/cm}^2$$

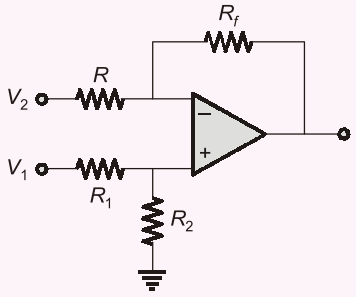
$$\Rightarrow \quad 1\ \text{cm}^2 = \frac{10^8}{645}\text{mil}^2$$

$$C_{ox} = 7.08 \times 10^{-8}\ \frac{F}{\frac{10^8}{645}\text{mil}^2} = 4.5 \times 10^{-13}\ \text{F/mil}^2$$

$$\cong 0.4\ \text{pF/mil}^2$$

End of Solution

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

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

Ans. (d)

Use virtual short circuit,

$$V^- = V^+$$

$$\frac{V_0 R + V_2 R_F}{R+R_F} = \frac{V_1 R_2}{R_1+R_2}$$

$$\Rightarrow \quad V_0 = \frac{R+R_F}{R_1+R_2} \times \frac{R_2}{R} \times V_1 - \frac{R_F}{R} \times V_2$$

End of Solution

Q.84 In a BJT switching circuit, supply voltage is V_{CC} = 9 V, 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} = 0.2 V?

(a) 1.48 V (b) 0.78 V

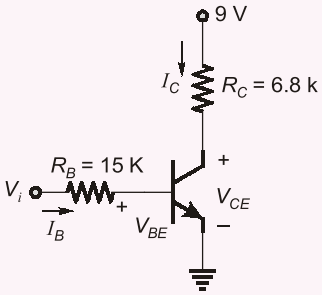
(c) 5 V (d) 2.5 V

Ans. (a)

$$I_{C\,sat} = \frac{9 - V_{CEsat}}{6.8\,K}$$

$$= 1.294\ mA$$

$$I_{Bmin} = \frac{I_{CSat}}{\beta} = 0.05176\ mA$$



$$I_B = \frac{V_i - V_{BE}}{R_B} = \frac{V_i - 0.7}{15\,k}$$

BJT operates in saturation if $I_B \geq I_{Bmin}$

$$\frac{V_i - 0.7}{15\,k\Omega} \geq 0.05176$$

$$\Rightarrow \quad V_i \geq 1.48\ V$$

End of Solution

Q.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.

Ans. (a)

End of Solution

Q.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.

Ans. (b)

End of Solution

Q.87 **Statements (I):** Metals are extremely good conductors of electricity and heat, and are not transparent to visible light.
Statements (II): Ceramics are compounds between metallic and non-metallic elements.

Ans. (b)

End of Solution

Q.88 **Statements (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.

Ans. (c)

End of Solution

Q.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.

Ans. (*)

End of Solution

Q.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.

Ans. (b)

End of Solution

Q.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 2 H, 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

Ans. (b)

$$e = \frac{Mdi}{dt}$$

$$e = \frac{2 \times 5}{10^{-3}} = 10^{4}\,\text{V}$$

End of Solution

Q.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) 30 Ω (d) 40 Ω

Ans. (d)

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

$$R_2 = \frac{\rho l_2}{a_2}$$

$$a_1 l = a_2(2l) \Rightarrow a_2 = \frac{a_1}{2}$$

$$R_2 = \frac{\rho(2l)}{a_1/2}$$

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

End of Solution

Q.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) –520 V (b) –640 V
(c) –725 V (d) –815 V

Ans. (b)

$N = 200$, $a = 0.16\ m^2$

Change in magnetic flux density (dB) = 0.5 – 0.1 = 0.4 Wb/m^2

$t = 0.02$ sec

Induced emf $e = \dfrac{-Nd\phi}{dt}$

$d\phi = (dB)\cdot a$

$= 0.4 \times 0.16$

$= 0.064$ wb

$$e = \frac{-200 \times (0.064)}{0.02} = -640\ V$$

End of Solution

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

(a) 35.35 V (b) 40.35 V
(c) 80.7 V (d) 70.7 V

Ans. (d)

$$V_{rms} = \frac{100}{\sqrt{2}} = 70.7V$$

End of Solution

Q.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.

Ans. (c)

End of Solution

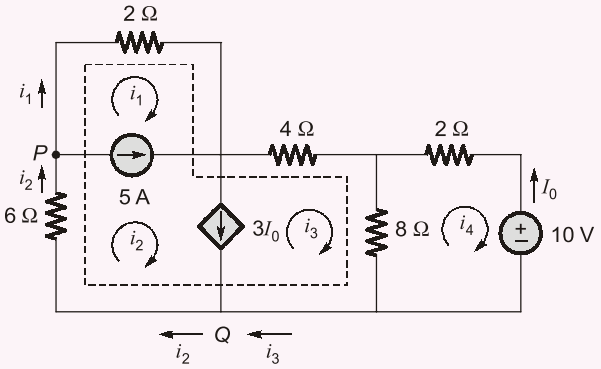
Q.96 Which one of the following is ***not*** the indication of a fully-charged cell?

(a) Intensity
(b) Gassing
(c) Voltage
(d) Specific gravity of the electrolyte

Ans. (a)

End of Solution

Q.97 For the given circuit, the current 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

Ans. (d)

Write KVL eq. in 4th loop,

$$10i_4 - 8i_3 = -10 \quad \ldots(1)$$

$$i_4 = -I_0 \quad \ldots(2)$$

$$2i_1 + 4i_3 + 8i_3 - 8i_4 + 6i_2 = 0 \quad \ldots(3)$$

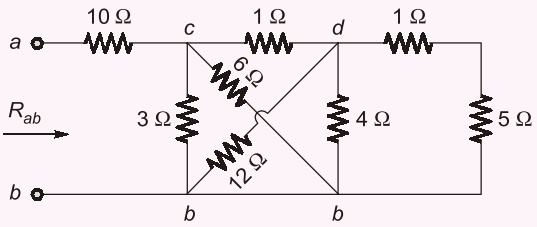
$$i_2 - i_3 = 3I_0$$

$$i_2 - i_1 = 5\text{A}$$

Solve eq. $i_1 = -7.5$; $i_3 = 3.93$ A

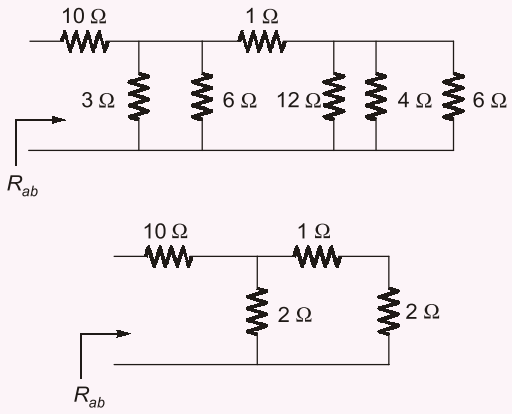
End of Solution

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



(a) 37.08 Ω
(b) 11.20 Ω
(c) 42.16 Ω
(d) 17.82 Ω

Ans. (b)



$R_{ab} = ((2 + 1) \parallel 2) + 10$

$R_{ab} = 11.2\ \Omega$

End of Solution

Q.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

Ans. (b)

End of Solution

Q.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)

Ans. (a)

$i_1 = -4 \sin (377t + 25°)$

$i_1 = 4 \cos (377t + 25° + 90°)$

$i_1 = 4 \angle 115$

$i_2 = 5 \angle -40$, i_1 leads i_2 by 155°

End of Solution

Q.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

Ans. (d)

End of Solution

Q.102 Consider the following statements regarding an ideal transformer
1. Coils have very large reactances.
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

Ans. (b)

End of Solution

Q.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.
(a) 5%
(b) 10%
(c) 15%
(d) 20%

Ans. (*)

End of Solution

Q.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

Ans. (b)

End of Solution

Q.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 7 V.
(d) Avalanche diodes have lower resistance.

Ans. (c)

End of Solution

Q.106 Which one of the following has all the poles of the function lie on the $j\omega$ axis?
(a) L-C function
(b) R-L function
(c) R-C function
(d) Y function

Ans. (a)

End of Solution

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

(a) $Z(s) = \dfrac{Ks(s^2+4)}{(s^2+1)(s^2+3)}$

(b) $Z(s) = \dfrac{s^5+4s^3+5s}{3s^4+6s^2}$

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

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

Ans. (d)

End of Solution

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

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

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

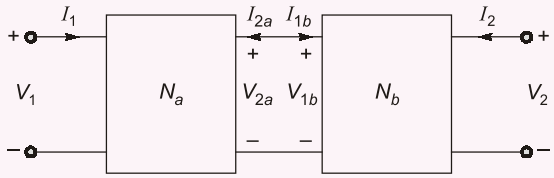
(c) The poles and zeros of a positive real function cannot be in the right half of the S plane.

(d) Only simple poles with real positive residues can exist on the $j\omega$ axis.

Ans. (a)

End of Solution

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

Ans. (b)

End of Solution

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

(a) Norton theorem

(b) Thevenin theorem

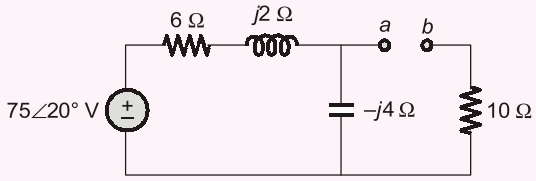
(c) Superposition theorem

(d) Maximum power transfer theorem

Ans. (c)

End of Solution

Q.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) $Z_{th} = (12.4 - j3.2)\Omega$

Ans. (d)

$$Z_{ab} = \frac{(6 + j2)(-j4)}{6 + j2 - j4} + 10$$

$$Z_{ab} = (12.4 - j3.2)\ \Omega$$

End of Solution

Q.112 Consider the following statements 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 idea 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

Ans. (b)

End of Solution

Q.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 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

Ans. (c)

End of Solution

Q.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

Ans. (d)

$$\text{Reading} = 5000000\,\mu\text{sec}$$

$$\text{Error ...(1)} = 0.005\%\ \text{of Reading} = \frac{0.005}{100}\times 5000000\,\mu\text{sec}$$

$$= 250\ \text{msec}$$

$$\text{Error ...(2)} = \pm 1\ \text{final digit}$$

$$= \pm 1\times\frac{1}{10^8} = 10^{-8} = 0.01\times 10^{-6} = 0.01\,\mu\text{sec}$$

$$\text{Total Error} = \text{Error (1)} + \text{Error (2)}$$

$$= 250\ \mu\text{sec} + 0.01\ \mu\text{sec}$$

$$= 250.01\ \mu\text{sec} \cong 250\ \mu\text{sec}$$

End of Solution

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

(a) Multimeter (b) Galvanometer
(c) Electrodynamic Wattmeter (d) Electrodynamic Voltmeter

Ans. (b)

End of Solution

Q.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) 1.23×10^{-6} m (b) 2.46×10^{-6} m
(c) 4.92×10^{-6} m (d) 9.84×10^{-6} m

Ans. (b)

$$G_f = \frac{\Delta R/R}{\Delta l/l} \Rightarrow 2.2 = \frac{0.013/240}{\Delta l/0.1} \Rightarrow \frac{\Delta l}{0.1} = 0.00024621$$

$$\Delta l = 0.0000246$$

$$= 2.46 \times 10^{-6}$$

End of Solution

Q.117 A digital frequency meter has a time base derived from a 1 MHz 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) 1.412 kHz (d) 14.12 kHz

Ans. (a)

Counting time period $\Rightarrow t_1 = \frac{1}{\delta_1} = \frac{1}{(1\,\text{mHz})/10^6} = 1\,\text{sec}$

Since we are using 6 decade counters.

$\therefore \quad \delta_{\text{measured}} = \delta_{\text{input}} \times t_1 = 1.512\ \text{kHz} \times 1\ \text{sec}$
$= 1.512\ \text{kHz}$

End of Solution

Q.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.

Ans. (*)

End of Solution

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

(a) relative error. (b) absolute error.
(c) gross error. (d) systematic error.

Ans. (b)

End of Solution

Q.120 Consider the following statements 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.

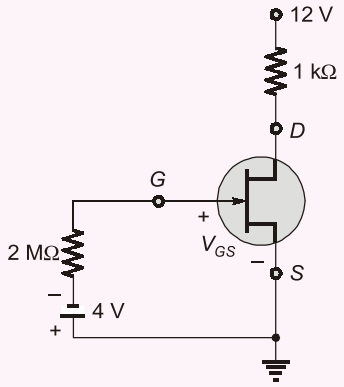
Which of the above statements are correct ?

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

Ans. (c)

End of Solution

Q.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) +4 V and 25 mA
(b) +4 V and 2.5 mA
(c) –4 V and 25 mA
(d) –4 V and 2.5 mA

Ans. (d)

$$V_{GSQ} = -4 \text{ V}$$

$$I_{DSQ} = I_{DSS}\left(1 - \frac{V_{GS}}{V_P}\right)^2$$

$$= 2.5 \text{ mA}$$

End of Solution

Q.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 statements are correct?

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

Ans. (a)

a : 1, 2 are related to JFET

c : all statements are technically correct.

End of Solution

Q.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

Ans. (d)

$$\left.\frac{dV_i}{dt}\right|_{max} = \frac{0.2\,V}{10\,\mu s} = 0.02\,V/\mu sec$$

Now $V_0 = A_{CL}V_i$

$$\left.\frac{dV_0}{dt}\right|_{max} = A_{CL} \times \left.\frac{dV_i}{dt}\right|_{max}$$

$$2\ V/\mu sec = A_{CL} \times 0.02\ V/\mu sec$$

$\Rightarrow$ $A_{CL} = 100$

End of Solution

Q.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) 2 and 3 only

Ans. (c)

For IC 555:

V_{CC} : 5 V to 18 V

Maximum output current : 200 mA

Temperature stability : 0.005% per °C

End of Solution

Q.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 impedance.

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

Ans. (c)

End of Solution

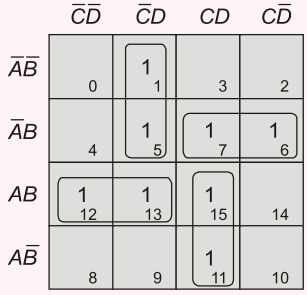
Q.126 The simplified form of the function $F(A, B, C, D) = \Sigma m(1, 5, 6, 7, 11, 12, 13, 15)$ is

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

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

Ans. (c)

$$f(ABCD) = \Sigma m(1, 5, 6, 7, 11, 12, 13, 15)$$



$$\bar{A}\bar{C}D + \bar{A}BC + ACD + AB\bar{C}$$

End of Solution

Q.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

Ans. (c)

End of Solution

Q.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) $Q_3Q_2Q_1Q_0 = 1110$

Ans. (d)

Clock	Q_0	Q_1	Q_2	Q_3
Initial	0	0	0	0
1	1	0	0	0
2	1	1	0	0
3	1	1	1	0
4	1	1	1	1
5	0	1	1	1

End of Solution

Q.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 ?

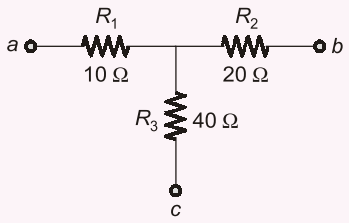
(a) 1 and 2 only (b) 1 and 3 only
(c) 1, 2 and 3 (d) 2 and 3 only

Ans. (a)

A PROM is also called as OTPROM i.e. one time programmable read only memory. So, statement 3 is wrong.

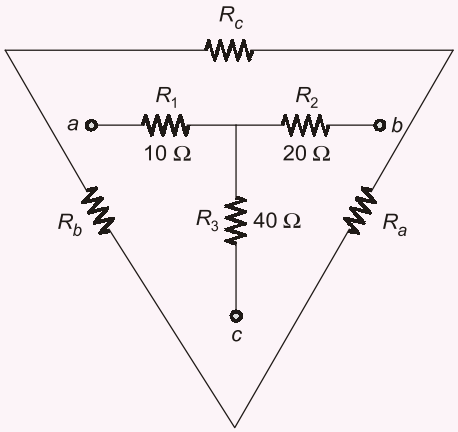
End of Solution

Q.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) 140 Ω, 70 Ω and 45 Ω (b) 70 Ω, 140 Ω and 35 Ω
(c) 140 Ω, 70 Ω and 35 Ω (d) 40 Ω, 70 Ω and 25 Ω

Ans. (c)



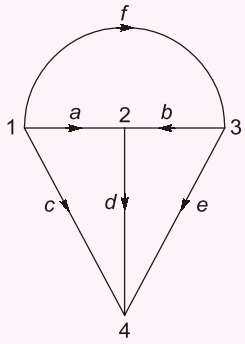
$$R_C = 10 + 20 + \frac{200}{40} = 35\ \Omega$$

$$R_b = 10 + 40 + \frac{400}{2} = 70\ \Omega$$

$$R_a = 20 + 40 + \frac{800}{10} = 140\ \Omega$$

End of Solution

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



(a) 3 (b) 4
(c) 2 (d) 5

Ans. **(a)**

A number of links (l) = $b - n + 1$
$= 6 - 4 + 1 = 3$

End of Solution

Q.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

Ans. **(a)**

End of Solution

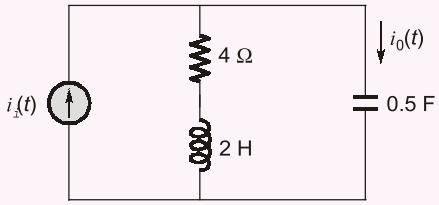
Q.133 Consider the following statements regarding duality:
1. The dual networks are obtained for both AC and DC circuits and they are based on Kirchhoff's laws.
2. Dual circuits are not obtained in planar networks.
3. Two networks are said to be dual networks if mesh equations of one network have the 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

Ans. **(b)**

End of Solution

Q.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 $s = j\omega$

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

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

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

Ans. (a)

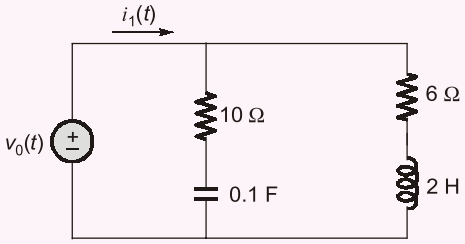
Using current division (Apply LT)

$$\frac{I_o(W)}{I_1(W)} = \frac{4+2s}{4+2s+\frac{1}{0.5s}} \Rightarrow \frac{(4+2s)0.5s}{s^2+2s+1}$$

$$\frac{I_o(W)}{I_1(W)} = \frac{s(s+2)}{s^2+2s+1}$$

End of Solution

Q.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

Ans. (a)

$$Y = \frac{1}{10+\frac{1}{0.1s}} + \frac{1}{6+2s}$$

$$Y = \frac{0.1s}{s+1} + \frac{1/2}{s+3}$$

$$Y = \frac{(s+3)(0.1s)+(s+1)(1/2)}{(s+1)(s+3)}$$

$$Z = \frac{(s+1)(s+3)}{0.1s^2+0.8s+0.5}$$

Poles : –0.683, –7.317

Zeros : –1, –3

End of Solution

Q.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 power as a percentage of the power that was originally calculated ?

(a) 118.4% (b) 109.7%

(c) 102.1% (d) 104.8%

Ans. (c)

I = 30.4 Amp, R = 0.105 Ω

Measured power = $P_m = I^2R = (30.4)^2 \times 0.105\ \Omega$ = 97.0368 Watt

Ammeter reads low by 1.2% of reading ⇒ So that true value of current

$$\Rightarrow \quad I_{true} = (30.4) + \left[\frac{1.2}{100} \times 30.4\right]$$

$$= 30.7648 \text{ Amp}$$

As resistance is marked 0.3% High ⇒ So that true value of resistance

$$\Rightarrow \quad R_{true} = (0.105) - \left[\frac{0.3}{100} \times 0.105\right]$$

$$R_{true} = 0.10468\ \Omega$$

$$\text{True power} = P_{true} = I_T^2 R_T = (30.7648)^2 \times 0.10468$$

$$P_{true} = 99.0815 \text{ Watt}$$

True power as % of measured power

$$= \frac{P_{true}}{P_{measured}} \times 100$$

$$= \frac{99.0815}{97.0768} \times 100 = 102.1\%$$

End of Solution

Q.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 ±20 mm core displacement. The spring constant is 240 N/m and the core mass is 0.05 kg. The natural frequency and maximum measurable 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

Ans. (b)

Natural frequency of oscillation $\Rightarrow$ $W_n = \sqrt{\frac{K}{M}}$

$$W_n = \sqrt{\frac{240}{0.05}} = 69.28 \text{ rad/sec}$$

Maximum acceleration $\Rightarrow$ $a_{max} = W^2A$

where $A \Rightarrow$ core displacement "mm"

$$a_{MCX} = W^2A = (69.28)^2 \times (28 \times 10^{-3} \text{ m}) = 96 \text{ m/sec}^2$$

End of Solution

Q.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) 150 V
(b) 155 V
(c) 165 V
(d) 300 V

Ans. (a)

$$V_0 = g \cdot p \cdot t = 0.05 \frac{V_{out-m}}{N} \times 2 \times 10^6 \frac{N}{m^2} \times 1.5 \times 10^{-3} \text{m}$$

$$= 150 \text{ volt}$$

End of Solution

Q.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

Ans. (b)

End of Solution

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

(a) 0.96
(b) 0.48
(c) 0.74
(d) 0.37

Ans. (c)

End of Solution

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 defects.
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

Ans. (a)

End of Solution

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

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

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

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

Ans. (c)

End of Solution

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

(a) Al_2O_3
(b) SiO_2
(c) Si_2N_4
(d) SiC

Ans. (c)

End of Solution

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 period than are metals.
2. Corrosion of ceramic materials generally involves simple chemical dissolution, in contract 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

Ans. (d)

End of Solution

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

(a) $B \cong 2\mu_o M$ (b) $B \cong \mu_o M$
(c) $B \cong \frac{\mu_o M}{2}$ (d) $B \cong \frac{\mu_o}{M}$

Ans. (b)

End of Solution

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.

Ans. (d)

End of Solution

147. Which one of the following material display the behaviour of antiferrmagnetism?

(a) Manganese oxide (b) Iron
(c) Nickel (d) Cobalt

Ans. (a)

End of Solution

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

Ans. (d)

End of Solution

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.

Ans. (c)

End of Solution

Q.150 What is the packing efficiency of diamond?

(a) 0.17
(b) 0.34
(c) 0.24
(d) 0.48

Ans. (b)

End of Solution