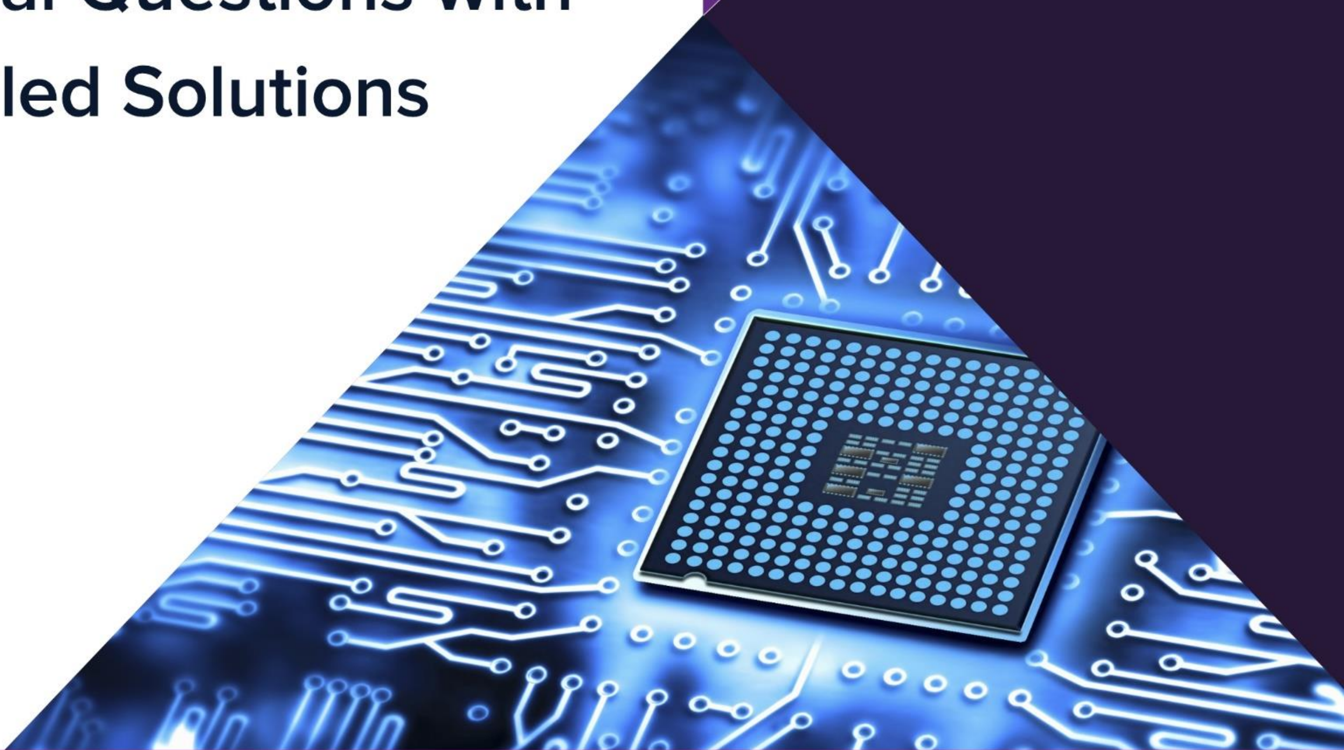
BYJU'S EXAM PREP

ESE 2023 Prelims

Electronics Engineering

Paper-2 (Set-B)

Official Questions with Detailed Solutions



ESE EC 2023 Prelims Paper-2 : Major Highlights

- **Overall Difficulty Level:** Easy to Moderate
- **Subject wise difficulty level:** Maximum Qs came from Electromagetics
- **Theoretical & Numerical:** Equal Weightage of Theory & Numerical
- **Assertion/Reason -** 6
- **Comparison from last year:** Same as last year
- **Good Score:** 130+

ESE EE 2023 Prelims Paper-2 : Subject-wise Weightage Distribution

S. No.	Subjects	Total Questions	Difficulty Level
1.	**Network Theory**	15	Easy
2.	**Basic Electronics Engineering**	17	Easy
3.	**Analog Circuits**	5	Moderate
4.	**Digital Circuits**	8	Easy
5.	**Material Science**	2	Easy
6.	**Electronic Measurements and Instrumentation**	8	Moderate
7.	**Basic Electrical Engineering**	13	Easy
8.	**Control Systems**	13	Easy
9.	**Electromagnetics**	23	Easy
10.	**Computer Organization and Architecture**	12	Easy
11.	**Microprocessor and Microcontrollers**	7	Easy
12.	**Analog and Digital Communication Systems**	15	Easy
13.	**Advanced Communication**	3	Easy
14.	**Advanced Electronics**	9	Moderate
	Total	**150**	

ESE EC 2023 Prelims Paper-2 : Comparison with Last 3 Years' Data

S. No.	Subjects	2023	2022	2021	2020
1.	Control Systems	15	12	14	17
2.	Electromagnetics	17	9	12	3
3.	Computer Organization and Architecture	5	1	8	9
4.	Microprocessor and Microcontrollers	8	15	5	9
5.	Analog and Digital Communication Systems	2	14	14	11
6.	Advanced Communication	8	12	10	12
7.	Advanced Electronics	13	10	8	13
8.	Control Systems	13	14	7	11
9.	Electromagnetics	23	13	13	8
10.	Computer Organization and Architecture	12	11	11	16
11.	Microprocessor and Microcontrollers	7	4	4	4
12.	Analog and Digital Communication Systems	15	11	12	14
13.	Advanced Communication	3	16	15	10
14.	Advanced Electronics	9	8	17	13
	Total	150	150	150	150

ELECTRONICS ENGINEERING

1. Vector potential is a vector

A. Whose curl is equal to the magnetic flux density

B. whose curl is equal to the electric field intensity

C. whose divergence is equal to the electric potential

D. which is equal to the vector product E × H

Ans. A

Sol. $\vec{B} = \vec{\nabla} \times \vec{A}$

Therefore, Vector potential is a vector whose curl is equal to the magnetic flux density.

Option A is correct.

2. If the magnetic vector potential $A = -\frac{\rho^2}{4} a_z$ Wb/m, what is the total magnetic flux crossing the surface $\phi = \frac{\pi}{2}, 1 \le \rho \le 2$ m, $0 \le z \le 5$m ?

A. 3.25 Wb

B. 3.50 Wb

C. 3.75 Wb

D. 4.00 Wb

Ans. C

Sol. $A = \frac{-\rho^2}{4} a_z$

$1 \le \rho \le 2, \; 0 \le z \le 5$

Since, $\vec{B} = \vec{\nabla} \times \vec{A}$

$$\vec{B} = \frac{1}{\rho}\begin{vmatrix} a_\rho & \rho\hat{a}_\phi & a_z \\ \frac{\partial}{\partial\rho} & \frac{\partial}{\partial\phi} & \frac{\partial}{\partial z} \\ 0 & \rho \times 0 & \frac{-\rho^2}{4} \end{vmatrix}$$

$$\vec{B} = \frac{1}{\rho}\left[-\rho a_\phi\left(\frac{-2\rho}{4}\right)\right]$$

$$\vec{B} = \frac{\rho}{2} a_\phi$$

$$\psi = \int\int \vec{B} \cdot \vec{ds} = \int\int \frac{\rho}{2} a_\phi \cdot d\rho dz a_\phi$$

$$\psi = \int_1^2\int_0^5 \frac{\rho}{2} d\rho\, dz$$

$$\psi = \left[\frac{\rho^2}{4}\right]_1^2 [z]_0^5$$

$$\psi = \left(\frac{4-1}{4}\right) \times 5 = \frac{15}{4} = 3.75 \text{ Wb}$$

3. A vector $\vec{P}$ is given by $\vec{P} = x^3\vec{a_x} - x^2y^2\vec{a_y} - x^2yz\vec{a_z}$. Which one of the following statements is correct?

A. $\vec{P}$ is solenoidal, but not irrotational.

B. $\vec{P}$ is irrotational, but not solenoidal.

C. $\vec{P}$ is neither solenoidal nor irrotational.

D. $\vec{P}$ is both solenoidal and irrotational.

Ans. C

Sol. $\vec{P} = x^3\vec{a}_x - x^2y^2\vec{a}_y - x^2yz\,\vec{a}_z$

$$\text{Div}\,\vec{P} = \frac{\partial}{\partial x}(x^3) - \frac{\partial}{\partial y}(x^2y^2) - \frac{\partial}{\partial z}(x^2yz)$$

$$= 3x^2 - 2x^2y - x^2y$$

$$= 3x^2 - 3x^2y \neq 0$$

$$\text{Curl}\,\vec{P} - = \begin{vmatrix} \hat{a}_x & \hat{a}_y & \hat{a}_z \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ x^3 & -x^2y^2 & -x^2yz \end{vmatrix}$$

$$= \hat{a}_x(-x^2z - 0) - \hat{a}_y(-2xyz - 0) + \hat{a}_z(-2xy^2 - 0)$$

$$\neq 0$$

$\vec{P}$ is Neither solenoidal nor irrotational option C is correct.

4. The electric field on the surface of a perfect conductor is 2 V/m. The conductor is immersed in water with $\varepsilon = 80\varepsilon_0$. The surface charge density on the conductor is

A. 0 C/m^2

B. 2 C/m^2

C. 1.8×10^{-11} C/m^2

D. 1.41×10^{-9} C/m^2

Ans. D

Sol. $\vec{D} = \in \vec{E}$

$$|\vec{D}| = |\in \vec{E}|$$

$$= 80 \in_0 (2)$$

$$= 160 \in_0$$

$$= 160 \times 8.854 \times 10^{-12}$$

$$\simeq 1.41 \times 10^{-9}$$

Option D is correct.

5. If the electric field intensity if given by $\bar{E} = (xu_x + yu_y + zu_z)$ V/m, the potential difference between X(2, 0, 0) and Y(1, 2, 3) is

A. +1 V

B. −1 V

C. +5 V

D. +6 V

Ans. C

Sol. $\vec{E} = xu_x + yu_y + xu_z$

X(2, 0, 0)   Y(1, 2, 3)

$$V_{yx} = -\int_Y^X \vec{E} \cdot d\ell$$

$$= -\int_{(1,2,3)}^{(2,0,0)} xdx + ydy + zdz$$

$$= -\left[\frac{x^2 + y^2 + z^2}{z}\right]_{(1,2,3)}^{(2,0,0)}$$

= +5 V

6. The radiation pattern of an antenna in spherical coordinates is given by F(θ) = $\cos^4$ (θ), $0 \le \theta \le \frac{\pi}{2}$. The directivity of the antenna is

A. 16.42

B. 18.02

C. 20.42

D. 22.02

Ans. B

Sol. $P_{rad} = \int\int \cos^8\theta \sin\theta \, d\theta d\phi$

$$P_{rad} = \int_{\theta=0}^{\pi/2} \cos^8\theta \sin\theta \, d\theta \int_0^{2\pi} d\phi$$

$$P_{rad} = \left[\frac{(7\times5\times3\times1)(1)}{9\times7\times5\times3\times1}\right][2\pi]$$

$$P_{rad} = \frac{2\pi}{9}$$

$$(G_d) = \frac{\cos^8\theta}{\frac{P_{rad}}{4\pi}} = \frac{\cos^8\theta}{\frac{2\pi}{9}\times\frac{1}{4\pi}} = 18\cos^8\theta$$

$D = G_{d\,max} = 18 \times 1 = 18$

7. The directive gain $G_d(\theta, \phi)$ depends on antenna pattern. For the Hertzian dipole, P_{avg} is maximum at $\theta = \frac{\pi}{2}$ and minimum at θ = 0 or π. For an isotropic antenna, $G_d(\theta, \varphi) = 1$. The directive gain $G_d(\theta, \phi)$ can be defined as

A. the measure of the concentration of the radiated power in a particular direction

B. the total radiated power divided by 4π

C. the ratio of the maximum radiation intensity to the average radiation intensity

D. the ratio of total power divided by array factor

Ans. A

Sol. Directive gain is the measure of the concentration of the radiated power in a particular direction.

8. Consider a parallel-plate capacitor, each of the plates has an area S and they are separated by a distance d. Assume that plates 1 and 2 carry charges +Q and −Q uniformly distributed on them. The energy stored in the capacitor is

A. $-\frac{Q}{\varepsilon S}a_x$

B. $\frac{Qd}{\varepsilon S}$

C. $\frac{1}{2C}Q^2$

D. $\frac{1}{2}Q\cdot C$

Ans. C

Sol. Energy stored in capacitor $= \frac{1}{2}CV^2 = \frac{1}{2}C\left(\frac{Q}{C}\right)^2$

$$= \frac{1}{2C}Q^2$$

9. Two dipoles with dipole moments $-5a_z$ nC-m and $9a_z$ nC-m are located at points (0, 0, −2) and (0, 0, 3), respectively. What is the potential at the origin ?

A. −24.25 V

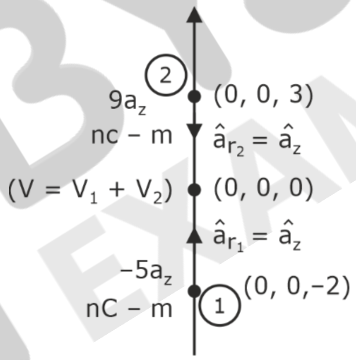
B. −22.25 V

C. −20.25 V

D. −18.25V

Ans. C

Sol.



Potential (V) = $\frac{K\vec{P}\cdot a_r}{r^2}$

Where, $K = \frac{1}{4\pi \epsilon_0} = 9\times10^9$

$$V_1 = \frac{9\times10^9\times\left(-5a_z\times10^{-9}\right)\cdot a_z}{2^2}$$

$$V_1 = -\frac{45}{4}$$

$$V_2 = \frac{9\times10^9\times\left(9a_z\times10^{-9}\right)\cdot\left(-a_z\right)}{3^2}$$

$$V_2 = -9$$

$$V = V_1 + V_2 = -\frac{45}{4} - 9 = -20.25V$$

10. If ∇.D = ε∇.E and ∇.J = σ∇.E in a given material, the material is said to be

A. linear and isotropic
B. linear and homogeneous
C. isotropic and homogeneous
D. homogeneous and dielectric

Ans. C

Sol.

$\nabla \cdot (\varepsilon E)$

$\nabla \cdot D = \varepsilon \nabla \cdot E$ .... (i)

$\nabla \cdot (\sigma E)$

$\nabla \cdot J = \sigma \nabla \cdot E$ .... (ii)

In equation (i), ε comes out means it is a constant term and it should not be vector so homogeneous material.

σ is also constant and not vector quantity.

Hence, option C is correct.

11. The frequency range for the broadcast satellite service is

A. 2 GHz to 4 GHz
B. 4 GHz to 8 GHz
C. 8 GHz to 12.5 GHz
D. 12.5 GHz to 26.5 GHz

Ans. D

Sol. Ku-band (12–18 GHz)

Used for satellite communications. option D is correct.

12. In an advance mobile phone system (AMPS), which of the following separate channels in a link is/are used?

A. TDMA only
B. FDMA only
C. SDMA only
D. Both TDMA and FDMA

Ans. B

Sol. One of the earliest standards developed for wireless and cellular telephony, the Advanced Mobile Phone Service (AMPS), is based on frequency division multiple access (FDMA).

13. In op-amp, the effect of asymmetries between the internal circuits driven by inputs can be reduced by

A. adding resistor at the input to V_{CC}^{+} side.

B. driven by an AC voltage source.

C. connecting a Zener diode at the input side.

D. connecting the slider of the potentiometer to V_{CC}^{-}.

Ans. *

14. By considering standard notations, the line width of the spontaneous emission is approximately

A. $\Delta\lambda = 2\lambda_{peak}^{3/2} \cdot kT$
B. $\Delta\lambda = 1.45\lambda_{peak}^{3} \cdot kT$
C. $\Delta\lambda = 2\lambda_{peak}^{1/4} \cdot kT$
D. $\Delta\lambda = 1.45\lambda_{peak}^{2} \cdot kT$

Ans. D

15. As per the Wien's displacement law, the spectral distribution of the energy emitted at a given temperature has

A. a defined minimum and this minimum shifts to longer wavelengths as the temperature decreases

B. a defined minimum and this minimum shifts to shorter wavelengths as the temperature increases

C. a defined maximum and this maximum shifts to shorter wavelengths as the temperature decreases

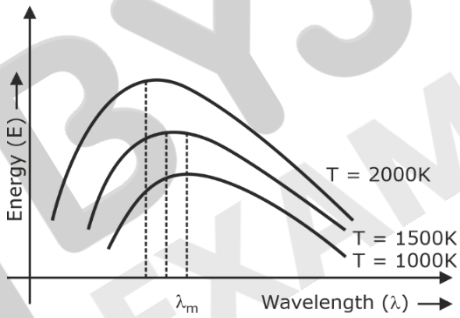
D. a definite maximum and this maximum shifts to shorter wavelengths as the temperature increases

Ans. D

Sol. Wein's displacement law:

The wavelength (λ_m) Corresponding to maximum energy emitted by a black body is inversely proportional to its absolute temperature. i.e. $\lambda_m \propto \left(\frac{1}{T}\right)$ or $\lambda_m T = b$. where b is a constant, called Wein's constant. The radiation emitted by a black body is called black body radiation. The distribution of energy of black body radiation at different temperatures is as shown in the figure.

The energy distribution is not uniform. There is a particular wavelength λ_m at which the energy emitted is maximum. The wavelength λ_m for which the intensity is maximum decreases with an increase in temperature.



16. The VSWR can have any value between

A. 0 and 1

B. −1 and 1

C. 1 and ∞

D. 0 and ∞

Ans. C

Sol. Range of VSWR is given by

$1 \leq S \leq \infty$

17. Which of the following modes has the solution of $H_z = 0$, but $E_z \neq 0$?

A. TEM only

B. TE only

C. TM only

D. Both TE and TM

Ans. C

Sol. Given,

$H_z = 0, E_z \neq 0$

T.E mode: Transverse electric mode does not have z component in the direction of wave propagation.

i.e., $E_z = 0, H_z \neq 0$

TM mode: Magnetic field does not exist in the direction of wave propagation i.e., $H_z = 0, E_z \neq 0$

18. Consider the following statements regarding impedance matching:

1. The single-stub tuner (matching) consists of an open or shorted section of transmission line of length d connected in parallel with the main line at some distance l from the load.

2. An open-circuited stub radiates some energy at high frequencies.

3. Double-stub matching allows for the adjustment of the load impedance.

4. At very high frequencies, lumped inductances and capacitances can be used as circuit elements.

Which of the above statements are correct?

A. 1 and 2 only B. 1, 2 and 3

C. 2, 3 and 4 D. 1, 2 and 4

Ans. B

Sol. From the given statements 1, 2 and 3 are correct.

Hence option B is correct.

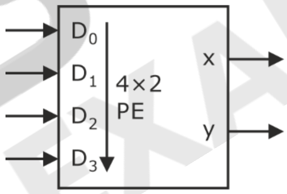
19. What is a four-line to two-line priority encoder with active HIGH inputs and outputs, with priority assigned to the higher-order data input line?

A. $X = D_2 + D_3$ and $Y = D_1\bar{D}_2 + D_3$ B. $X = D_1 + D_3$ and $Y = D_1\bar{D}_2 + D_3$

C. $X = D_2 + \bar{D}_3$ and $Y = D_1\bar{D}_2 + \bar{D}_3$ D. $X = \bar{D}_2 + D_3$ and $Y = \bar{D}_1\bar{D}_2 + D_3$

Ans. A

Sol.



D_0	D_1	D_2	D_3	H_0	H_1	H_2	H_3	x	y
1	0	0	0	1	0	0	0	0	0
X	1	0	0	0	1	0	0	0	1
X	X	1	0	0	0	1	0	1	0
X	X	X	1	0	0	0	1	1	1

$X = H_3 + H_2 = D_3 + \bar{D}_3 D_2 = D_3 + D_2$

$Y = H_1 + H_3 = \bar{D}_3 \bar{D}_2 D_1 + D_3 = D_1\bar{D}_2 + D_3$

20. How many flip-flops are required to build a binary counter that counts from 0 to 4095?

A. N = 10 B. N = 11

C. N = 12 D. N = 13

Ans. C

Sol. Number of flip flop required

2^N = mod number

$2^N = 4096$

N = 12

21. A 2-bit binary multiplier can be implemented using

A. two full adders and a two-input AND gate

B. two half adders and four numbers of two-input AND gate

C. one full adder, one half adder and one two-input AND gate

D. one full adder and one two-input AND gate

Ans. B

Sol. Two-bit binary multiplier can be implemented using two half adder and four numbers of two-input AND gate, Option (B) is correct.

22. For a binary half subtractor having two inputs A and B, the correct set of logical expressions for the outputs D(difference) and X (borrow) is

A. $D = AB + A\bar{B},\ X = A\bar{B}$

B. $D = A\bar{B} + \bar{A}B + A\bar{B},\ X = A\bar{B}$

C. $D = A\bar{B} + A\bar{B},\ X = \bar{A}B$

D. $D = AB + \bar{A}B,\ X = A\bar{B}$

Ans. C

Sol. For binary half subtractor we have the equation as

$D = \bar{A}B + A\bar{B}$

$B = \bar{A}B$

23. Which one of the following statements is correct?

A. ECL has the least propagation delay.

B. TTL has the least propagation delay.

C. CMOS has the highest power dissipation.

D. TTL has the lowest power consumption.

Ans. A

Sol. ECL has the least propagation delay.

24. Each cell of a static random-access memory contains

A. six MOS transistors

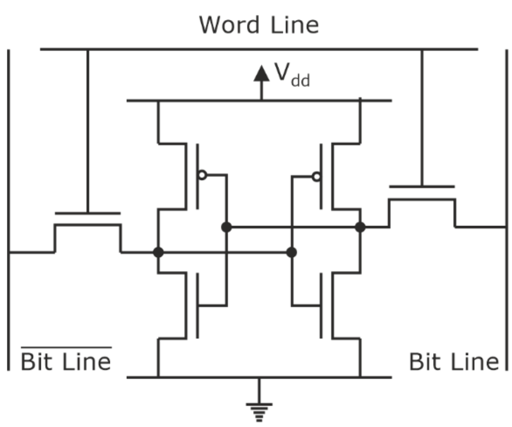
B. four MOS transistors and two capacitors

C. two MOS transistors and four capacitors

D. one MOS transistor and one capacitor

Ans. A

Sol.



25. The following sequence of instructions is executed by an 8085 microprocessor:

1000 H	LXI SP, 27FF H
1003 H	CALL 1006 H
1006 H	POP H

The contents of the stack pointer (SP) and the HL register pair on completion of execution of these instructions are

A. SP = 27FF H and HL = 1003 H

B. SP = 27FD H and HL = 1003 H

C. SP = 27FF H and HL = 1006 H

D. SP = 27FD H and HL = 1006 H

Ans. C

Sol.

1000 LX1 SP, 27FF ⇒ SP = 27FF

1003 CALL 1006 ⇒ SP = 27FF – 2

1006 POP H ⇒ SP = (27FF - 2) ×2 = 27FF

→ TOS = 1006

→ H = TOS = 1006

26. The total number of memory accesses involved when an 8085 processor execute the instruction LDA 2003 H is

A. 1

B. 2

C. 3

D. 4

Ans. D

Sol. LDA 2003

op – MR – MR - MR

27. The contents of register (B) and accumulator (A) of an 8050 microprocessor are 3C H and 89 H respectively. The contents of A and the status of carry flag (CY) and sign flag (S) after executing SUB B instructions are

A. A = C5 H, CY = 1, S = 1

B. A = 5C H, CY = 1, S = 0

C. A = C5 H, CY = 5, S = 1

D. A = 5C H, CY = 0, S = 1

Ans. *

Sol. SUB B

A = A – B = 89 – 3L

89 > 3L So, No borrow, CY = 0

and, Result is positive, S = 0

89 – 3C = 4D

28. For an 8085 microprocessor, the following program is executed:

```
        MVI A, 05 H
        MVI B, 05 H
PTR:    ADD B
        DCR B
        JNZ PTR
        ADI 03 H
          HLT
```

At the end of the program, accumulator contains.

A. 17 H B. 20 H

C. 23 H D. 05 H

Ans. A

Sol.

```
       MVI   A,05 H
       MVI   B,05 H
PTR:   ADD   B        → A = A ⇒ 0A|0E | 11|13|14
       DCR   B           B = 4|3|2|1|0
       JNZ   PTR
       ADI   03       → A = 14 + 03
       HLT                 = 17
```

29. Let $x_a(t)$ be an analog signal with bandwidth B = 6 kHz. We wish to use an $N = 2^m$ point DFT to compute the spectrum of the signal with resolution less than or equal to 200 Hz. What is the minimum length of the analog signal recorded?

A. 60 seconds B. 0.05 second

C. 0.005 second D. 6000 seconds

Ans. C

Sol. $\frac{1}{NT_s} \le 200$

$\Rightarrow NT_S \ge \frac{1}{200}$

$\Rightarrow NT_S \ge 0.005$

30. The z-transform of the impulse response of a causal LTI system is $H(z) = \frac{1}{2}\frac{z^{-1}}{z^{-2} - 4.5z^{-1} + 5}$. What is an input x(n) that would produce the output $y(n) = u(-n) + (0.5)^n u(n)$?

A. $x(n) = [0.5^n - 0.4^n]\, u(n)$

B. x(n) = 10u (n + 1) – 14u(n) + 2u(n – 1) + 3u(–n)

C. $x(n) = [0.5^n + 0.4^n]\, u(n)$

D. x(n) = 10u(n + 1) – 14u(–n) +2u(n + 1) + 3u(n)

Ans. *

Sol. $H(z) = \frac{1}{2}\frac{z^{-1}}{z^{-2} - 4.5z^{-1} + 5}$

$$H(z) = \frac{1}{2}\frac{1/z}{\left(\frac{1}{z^2} - \frac{9}{2z} + 5\right)}$$

$$H(z) = \frac{1}{2}\frac{\frac{1}{z}}{\frac{2 - 9z + 1z^2}{2z^2}}$$

$$H(z) = \frac{z}{10z^2 - 9z + 2} = \frac{z}{(2z-1)(5z-2)}$$

and, $y[n] = u[-n] + (0.5)^n.u[n]$

$$Y(z) = \frac{1}{(1-z)} + \frac{z}{(z-0.5)} = \frac{z - 0.5 + z(1-z)}{(1-z)(z-0.5)}$$

$$\because Y(z) = \frac{(2z - z^2 - 0.5)}{(1-z)(z-0.5)}$$

$$Y(z) = Y(z)\ .\ H(z)$$

$$Y(z) = \frac{Y(z)}{H(z)}$$

$$Y(z) = \frac{(2z - z^2 - 0.5)}{(1-z)(z-0.5)} = \frac{(10z^2 - 9z + 2)}{z}$$

$$X(z) = \frac{-\left(z^2 - 2z + \frac{1}{2}\right)(10z^2 - 9z + 2)}{(1-z)\left(\frac{2z-1}{2}\right)z}$$

$$= \frac{(2z^2 - 4z + 1)}{(1-z)}\frac{(2z-1)(5z-2)}{z}$$

$$X(z) = \frac{(2-5z)(2z^2 - 4z + 1)}{(z - z^2)}$$

$$X(z) = \frac{4z^2 - 8z + 2 - 10z^3 + 20z^2 - 5z}{z - z^2}$$

$$X(z) = \frac{-10z^3 + 24z^2 - 13z + 2}{z - z^2}$$

$$X(z) = \frac{10z^3 - 24z^2 + 13z - 2}{z^2 - z}$$

$$\begin{array}{r|l} z^2 - z & 10z^3 - 24z^2 + 13z - z \\ & \underline{\underset{-}{10z^3} \underset{+}{- 10z^2}} \\ & -14z^2 + 13z - 2 \\ & \underline{\underset{+}{-14z^2} \underset{-}{+ 14z}} \\ & -z - 2 \end{array}$$

$$X(z) = 10z - 14 - \frac{(z+2)}{z(z-1)}$$

$$= 10z - 14 - \frac{z}{z(z-1)} - \frac{2}{z(z-1)}$$

$$= 10z - 14 - \frac{1}{z-1} - 2\left[\frac{1}{z-1} - \frac{1}{z}\right]$$

$$= 10z - 14 - \frac{1}{(z-1)} - \frac{2}{(z-1)} + \frac{2}{z}$$

$$= 10z - 14 - \frac{3}{(z-1)} + \frac{2}{z}$$

$x[n] = 10\delta[n + 1] - 14\delta[n] + 2\delta[n - 1] - 3u[n - 1]$

31. A second-order system has a closed-loop transfer function given by $G(s) = \frac{25}{s^2 + 8s + 25}$. The settling time for 5 percentage band in tolerance error is

A. $\frac{1}{3}$ sec

B. $\frac{3}{4}$ sec

C. 2 sec

D. 4 sec

Ans. B

Sol. Standard equation is

$$\frac{\omega_n^2}{s^2 + 2\xi\omega_n s + \omega_n^2} \quad \text{............(i)}$$

given equation is

$$\frac{25}{s^2 + 8s + 25} \quad \text{............(ii)}$$

Comparing (i) and (ii) we get

$\omega_n = 5$, $\xi = 0.8$

For 5% tolerance band, settling time will be

$$T_s = \frac{3}{\xi\omega_n} = \frac{3}{0.8 \times 5} = \frac{3}{4}$$

32. The output of a standard second-order for a unit-step input is given as $y(t) = 1 - \frac{2}{\sqrt{3}} e^{-t} \cos\left(\sqrt{3}t - \frac{\pi}{6}\right)$. What is the transfer function of the system?

A. $\frac{2}{(s+2)(s+\sqrt{3})}$

B. $\frac{1}{s^2 + 2s + 1}$

C. $\frac{3}{s^2 + 2s + 3}$

D. $\frac{4}{s^2 + 2s + 4}$

Ans. D

Sol. Standard equation is

$$1-\frac{e^{-\xi\omega_n t}}{\sqrt{1-\xi^2}}\sin\left(\left(\omega_n\sqrt{1-\xi^2}t\right)+\phi\right) \text{ ....(i)}$$

Now, adjusting sin function according to question

$$\sin\left(90-90+\omega_n\sqrt{1-\xi}+\phi\right)$$

$$\sin\left(90-\left(90-\omega_n\sqrt{1-\xi^2}-\phi\right)\right)$$

$$\cos\left(90-\omega_n\sqrt{1-\xi^2}-\phi\right)$$

$$\cos\left(\omega_n\sqrt{1-\xi^2}+\phi-90\right) \text{ ....(ii)}$$

Given $\rightarrow$ $\cos\left(\sqrt{3}t-\frac{\pi}{6}\right)$

From (ii) we get

$\phi-90=-30$

$\phi=60^\circ$

Given equation is,

$$1-\frac{2}{\sqrt{3}}e^{-t}\cos\left(\sqrt{3}t-\frac{\pi}{6}\right) \text{ ....(iii)}$$

From (i) and (iii) we get

For $(\xi)\rightarrow\frac{2}{\sqrt{3}}=\frac{1}{\sqrt{1-\xi^2}}$

$$\frac{4}{3}=\frac{1}{1-\xi^2}$$

$$\xi=\sqrt{1-\frac{3}{4}}=\sqrt{\frac{1}{4}}=\frac{1}{2}$$

For $(\omega_n)\rightarrow\xi\omega_n=1$

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

Standard equation is,

$$\frac{\omega_n^2}{\xi^2+2\xi\omega_n s+\omega_n^2}$$

Finally, we get

$$\Rightarrow\frac{(2)^2}{s^2+\left(2\times\frac{1}{2}\times2\right)s+(2)^2}$$

$$\Rightarrow\frac{4}{s^2+2s+4}$$

33. Consider a causal second-order system with the transfer function $G(s) = \frac{1}{s^2 + 2s + 1}$ with a unit-step $R(s) = \frac{1}{s}$ as an input. Let c(s) be the corresponding output. The time taken by the system output c(t) to reach 94% of its steady-state value $\lim_{t\to\infty} c(t)$, rounded off to two decimal places, is

A. 5.25
B. 2.81
C. 4.50
D. 3.89

Ans. C

Sol. $G(s) = \frac{1}{(s+1)^2}$

Poles ⇒ s = −1, −1 ⇒ critically damped

→ − ω_n; ω_n

Step Response ⇒ $c(t) = 1 - e^{-\omega_n t}(1 + \omega_n t)$

$c(t) = 1 - e^{-t}(1 + t)$

$c_{SS} = \lim_{t\to\infty} c(t) = 1$

We need $c(t) = 0.94(1)$

⇒ $1 - e^{-t}(1 + t) = 0.94$

t = 4.5 by options

34. Non-minimum phase transfer function is defined as the transfer function

A. which has zeros in the right-half s-plane
B. which has poles in the left-half s-plane
C. which has poles in the negative right-half s-plane
D. which has zeros only in the left-half s-plane

Ans. A

Sol. A non-minimum phase transfer function is defined as the transfer function which has zeros in the right-half of s-plane

35. A system has poles at 0.01 Hz, 1 Hz and 80 Hz; zeroes at 5 Hz, 100 Hz and 200 Hz. The approximate phase of the system response at 20 Hz is

A. −90°
B. 0°
C. 90°
D. −180°

Ans. C

Sol. Zeros ⇒ 5, 100, 200

Poles ⇒ 0.01, 1, 80

f = 20 Hz > 0.01, 1, 5

P P Z

36. The magnitude of frequency response of an underdamped second-order system is 5 at 0 rad/sec and peaks at $\frac{10}{\sqrt{3}}$ at $5\sqrt{2}$ rad/sec. The transfer function of the system is

A. $\frac{100}{s^2+10s+100}$

B. $\frac{375}{s^2+5s+100}$

C. $\frac{500}{s^2+12s+100}$

D. $\frac{1125}{s^2+12s+225}$

Ans. C

Sol. $5\left(\frac{\omega_n^2}{s^2+2\xi\omega_n s+\omega_n^2}\right)$

$$\frac{10}{\sqrt{3}} = 5\times\frac{2}{\sqrt{3}} = 5(M_r)$$

$$M_r = \frac{2}{\sqrt{3}} = \frac{1}{\sin 2\phi}$$

$$\sin 2\phi = \frac{\sqrt{3}}{2}$$

$$\phi = 30^\circ \text{ or } 60^\circ$$

Selecting $\phi = 60^\circ$

$$\xi = 105\phi = \cos 60^\circ = \frac{1}{2}$$

Given, $\omega_r = 5\sqrt{2}$

$$\omega_n\sqrt{1-2\xi^2} = 5\sqrt{2}$$

$$\omega_n = 10$$

Option C satisfies.

37. By considering standard notations, the peak value of the magnitude in the resonant peak M_r is

A. $\frac{2}{\zeta\sqrt{1-\zeta^2}}$

B. $\frac{1}{\zeta\sqrt{2-\zeta^2}}$

C. $\frac{1}{2\zeta\sqrt{2-\zeta^2}}$

D. $\frac{1}{\zeta\sqrt{1-\zeta^2}}$

Ans. C

Sol. Peak value of the magnitude in resonant peak is

$$M_r = \frac{1}{2\xi\sqrt{1-\xi^2}}$$

38. The phase margin of a system having the loop transfer function $G(s)H(s) = \frac{2\sqrt{3}}{s(s+1)}$ is

A. 45°

B. 90°

C. 30°

D. 60°

Ans. C

Sol. Finding gain cross over frequency

$$\frac{2\sqrt{3}}{\sqrt{\omega^2}\sqrt{\omega^2+1}} = 1$$

$$\frac{2\sqrt{3}}{\omega\sqrt{\omega^2+1}} = 1$$

$$12 = \omega^2(\omega^2+1)$$

$$\omega^4 + \omega^2 - 12 = 0$$

Let, $\omega^2 = x$

Now, $x^2 + x - 12 = 0$

$$= \frac{-1 \pm \sqrt{1+48}}{2}$$

$$= \frac{-1 \pm 7}{2}$$

We get, $x = 3, -4$

Here, $x = \omega^2$

So, $\omega = \sqrt{3}$ i.e. $\omega_{gc} = \sqrt{3}$

Now, $PM = 180 + \angle G(j\omega)H(j\omega)\big|_{\omega_{gc}=\sqrt{3}}$ ....(i)

$$\angle G(j\omega)H(j\omega) = -90 - \tan^{-1}\left(\frac{\omega_{gc}}{1}\right)$$

$$= 90 - \tan^{-1}\sqrt{3}$$

$$= -90 - 60 = -150°$$

From (i),

$$PM = 180 - 150 = 30°$$

39. The phase margin of a system with the open-loop transfer function $G(s)H(s) = \frac{1-s}{(s+1)(s+2)}$ is

A. 0°

B. 63.4°

C. 90°

D. ∞°

Ans. D

Sol. Finding gain crossover frequency

$$\frac{\sqrt{1+\omega^2}}{\sqrt{\omega^2+1}\sqrt{\omega^2+4}} = 1$$

$$1 + \omega^2 = (\omega^2+1)(\omega^2+4)$$

$$1 + \omega^2 = \omega^4 + 4\omega^2 + \omega^2 + 4$$

$$1 = \omega^4 + 4\omega^2 + 4$$

$$\omega^4 + 4\omega^2 + 3 = 0$$

Let, $\omega^2 = x$

Then, $x^2 + 4x + 3 = 0$

$$= \frac{-4 \pm \sqrt{16-12}}{2}$$

$= \frac{-4 \pm \sqrt{4}}{2}$

x = −1, −3

Here, ω_{gc} is imaginary,

Hence, PM will be infinite.

40. What is the overall number of Clock cycles Per Instruction (CPI) for a machine A for which the following performance measures were recorded when executing a set of benchmark programs? (Assume the clock rate of the CPU as 200 MHz and execution of 100 instructions)

Instruction category	**Percentage of occurrence**	**No. of cycles per instruction**
ALU	38	1
Load and store	15	3
Branch	42	4
Others	5	5

A. 2.76
B. 4.76
C. 6.76
D. 8.76

Ans. A

Sol.

Instruction category	**Percentage of occurrence**	**No. of cycles per instruction**
ALU	38	1
Load and store	15	3
Branch	42	4
Others	5	5
	100	

Clock cycle = 38 × 1 + 15 × 3 + 42 × 4 + 5 × 5 = 276

clock cycles per instruction = $\frac{276}{100}$ = 2.76

41. What is the number of bits in the main memory address for a memory system having the following specification?

Size of the main memory is 4K blocks, size of the cache is 128 blocks and the block size is 16 words (Assume that the system uses set-associative mapping with four blocks per set)

A. 18
B. 20
C. 24
D. 16

Ans. D

Sol. Size of main memory = 4K blocks

1 block size = 16 words

main memory size = $4 \times 2^{10} \times 16 = 2^{16}$ words

No. of bits in main memory address = $\log_2(2^{16})$ = 16 bits

42. Consider the following reference string of pages made by a processor:

4, 7, 5, 7, 6, 7, 10, 4, 8, 5, 8, 6, 8, 11, 4, 9, 5, 9, 6, 9, 12, 4, 7, 5, 7

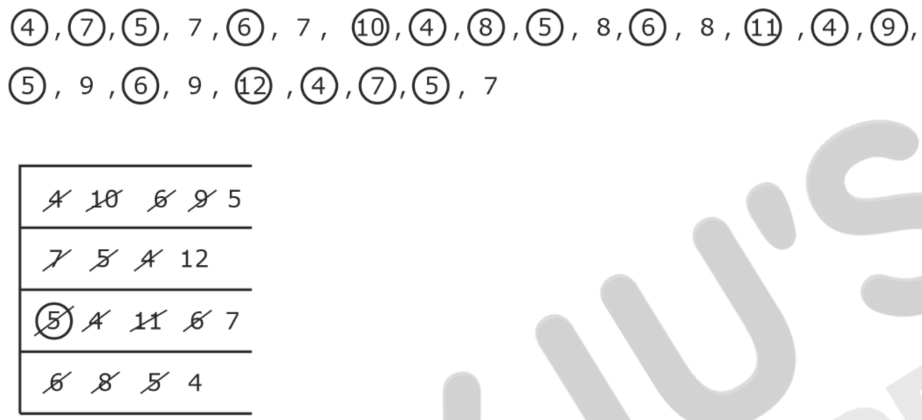
Assume that the number of page frames allocated in the main memory is four. What is the number of page faults generated using Least Recently Used (LRU) replacement technique?

A. 15 B. 17

C. 18 D. 16

Ans. C

Sol.



main memory

43. Which one of the following is correct with respect to short-term scheduling?

A. The decision as to which available process will be executed by the processor

B. The decision as to which process's pending I/O request shall be handled by an available 1/O device

C. The decision to add to the pool of processes to be executed

D. The decision to add to the number of processes that are partially or fully in main memory

Ans. A

Sol. Short term scheduler schedules the available processes from the job pool

44. Which one of the following statements is correct with respect to bounded buffer in shared memory systems?

A. The consumer may have to wait for new items, but the producer can always produce new items.

B. The consumer must wait if the buffer is empty, and the producer must wait if the buffer is full.

C. The producer and consumer must be synchronized, so that the consumer does not try to consume an item.

D. Shared memory suffers from cache coherency issues, which arise because shared data migrate among the several caches.

Ans. B

Sol. Option (b) The consumer must wait if the buffer is empty, and the producer must wait if the buffer is full.

This is the correct statement with respect to bounded buffer in shared memory systems. In a bounded buffer system, there is a fixed-size buffer that can hold a limited number of items, and multiple processes (usually a producer process and a consumer process) share the buffer. The producer process adds items to the buffer, and the consumer process removes items from the buffer.

If the buffer is empty, the consumer process cannot remove any items, so it must wait for the producer process to add new items. Conversely, if the buffer is full, the producer process cannot add any new items, so it must wait for the consumer process to remove items.

45. Which one of the following is relevant to non-preemptive kernels?

A. Kernel allows a process to be preempted while it is running in kernel mode.

B. Kernel data structure maintains a list of all open files in the system.

C. Kernel does not allow a process running in kernel mode to be preempted; a kernel-mode process will run until it exits kernel mode, blocks, yields control of the CPU.

D. Prone to possible race conditions include structures for maintaining memory allocation, for maintaining process lists and for interrupt handling.

Ans. C

Sol. Kernel does not allow a process running in kernel mode to be preempted; a kernel-mode process will run until it exits kernel mode, blocks, yields control of the CPU.

This statement is relevant to non-preemptive kernels. In a non-preemptive kernel, a process running in kernel mode cannot be preempted by another process or interrupt until it exits kernel mode. This means that a kernel-mode process will run until it completes its task, yields control of the CPU, or blocks on some event.

46. The power transmitted by an SSB transmitter is 20 kW. It is required to be replaced by standard AM transmission having modulation index of 0.4 and same power. What is the transmission efficiency?

A. 3.7%
B. 5.8%
C. 7.4%
D. 21.6%

Ans. C

Sol. P_{SSB} = 20 kW

$\mu = 0.4$

$P_{AM} = P_{SSB}$

$$\eta = \frac{\mu^2}{z+u^2} = \frac{(0.4)^2}{2+(0.4)^2} = 7.4\%$$

47. An angle modulated signal is given as $x_c(t) = 20\cos\left[200\pi t + \frac{\pi}{4}\right]$. What is the instantaneous frequency?

A. 50 Hz
B. 100 Hz
C. 200 Hz
D. 400 Hz

Ans. B

Sol. $x_c(t) = 20\cos\left(200\pi t + \frac{\pi}{4}\right)$

$$fi = fc + \frac{1}{2\pi}\frac{d\phi}{dt}$$

$$= 100 + \frac{1}{2\pi} \times \frac{d}{dt}\left(\frac{\pi}{4}\right) = 100\text{ Hz}$$

48. An FM modulator operates at carrier frequency of 250 kHz with frequency deviation sensitivity of 1.5 kHz/V. A PM modulator operates at carrier frequency of 500 kHz with phase deviation sensitivity of 1.5 rad/V. If both FM and PM modulators are modulated by the same modulating signal having peak amplitude of 5 V and modulating frequency of 5 kHz, then what is the relationship between frequency modulation index and phase modulation index?

A. PM = FM

B. PM = 2FM

C. PM = 4FM

D. PM = 5FM

Ans. D

Sol. FM: f_c = 250 kHz, K_f = 1.5 kHz/V

PM: f_c = 500 kHz, K_p = 1.5 rad/V

For Both FM and PM, A_m = 5V, f_m = 5 kHz

$$\beta_{FM} = \frac{\Delta f_{max}}{f_m} = \frac{k_f A_m}{f_m} = \frac{1.5 \times 10^3 \times 5}{5 \times 10^3} = 1.5$$

$$\beta_{FM} = \frac{\Delta f_{max}}{f_m} = \frac{K_p A_m f_m}{f_m} = 1.5 \times 5 = 7.5$$

$\beta_{PM} = 5\beta_{FM}$

49. What is the relationship between the percentage efficiency saving when the carrier wave and one of the sidebands are suppressed in an AM wave modulated to a depth of 100% modulation index?

A. $\eta_{DSB} = 2.5\eta_{AM}$

B. $\eta_{DSB} = 4\eta_{AM}$

C. $\eta_{DSB} = 5\eta_{AM}$

D. $\eta_{DSB} = 2\eta_{AM}$

Ans. A

Sol. Power efficiency is given by,

$$\eta_{AM} = \frac{m_a^2}{2 + m_a^2}$$

For m_a = 1, $\eta_{AM} = \frac{1}{3}$

When carries and one of the sidebands are suppressed, power saving is given by

$$\eta_{DSB} = \frac{1 + m_a^2}{1 + \frac{m_a^2}{2}}$$

For, m_a = 1, $\eta_{DSB} = \frac{5/4}{3/2} = \frac{5}{6}$

$$\eta_{DSB} = 2.5\,\eta_{AM}$$

50. An audio signal $s(t) = 5\cos(200\pi t)$ is quantized using 10-bit PCM. What is the signal-to-quantization noise ratio?

A. 3.57×10^6 B. 2.57×10^6

C. 1.57×10^6 D. 0.57×10^6

Ans. C

Sol. Signal to quantization noise ratio is given by,

$$SQNR = \frac{3}{2} \times 2^{2n}$$

$$= \frac{3}{2} \times 2^{2\times 10}$$

$$= 1.57 \times 10^6$$

51. An FM audio signal with signal-tone modulation has a frequency deviation of 25kHz and a bandwidth of 75 kHz. What is the frequency of the modulating signal using Carson's rule?

A. 12.5 kHz B. 25 kHz

C. 50 kHz D. 75 kHz

Ans. A

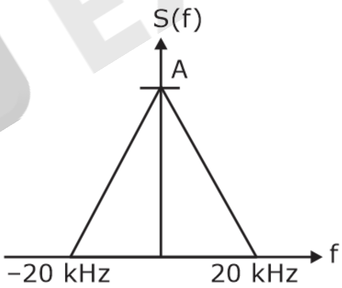
Sol. BW = 75kHz, Δf_{mix} = 25kHz

BW = $2(\Delta f_{max} + f_m)$

75 = $2(25 + f_m)$

f_m = 12.5 kHz

52. An audio signal s(t) is normalized, whose Fourier transform S(f) is shown in the figure, so that $|s(t)| \leq 1$. This signal is to be transmitted using FM the frequency deviation constant k_f = 90 kHz/V. What is the bandwidth required for transmission of the FM audio signal?



A. 140 kHz B. 180 kHz

C. 220 kHz D. 260 kHz

Ans. C

Sol. BW = $2(\Delta f_{max} + f_m) = 2(\beta + 1) f_m$

$$\beta = \frac{kA_m}{f_m} = \frac{90 \times 10^3 \times 1}{20 \times 10^3} = 4.5$$

BW = $2(\beta + 1) f_m = 2(5.5) \times 20$

= 220 kHz

53. A collector modulated class-C power amplifier is given an amplitude modulated signal of 220 W average power at the output, while operating with a collector circuit efficiency of 40%. What is the power to be supplied by the modulating amplifier when the modulating amplifier when the modulation index is 0.4?

A. 16.3 W
B. 40.75 W
C. 203.7 W
D. 220 W

Ans. B

Sol. $P_t = P_c\left(1+\frac{\mu^2}{2}\right)$

$220 = P_c\left(1+\frac{0.4^2}{2}\right)$

$P_c = 203.7$ W

$P_{SB} = P_t = P_c = 16.29$

Modulating amp. $= \frac{P_{SB}}{\mu} = \frac{16.029}{0.4} = 40.7\,W$

54. By considering standard notations, the normalized power of the AM signal is

A. $S^2(t) = \frac{1}{2}A_c^2 + \frac{1}{2}A_c^2[m^2(t)]$

B. $S^2(t) = A_c^2 + \frac{1}{2}A_c^2[m^2(t)]$

C. $S^2(t) = \frac{1}{2}A_c^2 + A_c^2[m^2(t)]$

D. $S^2(t) = \frac{1}{4}A_c^2 + \frac{1}{4}A_c^2[m^2(t)]$

Ans. A

Sol. $S(t) = A_c\,[1 + k_a m(t)] \cos\omega_c t$

Normalized power is given by,

$S^2(t) = \frac{A_c^2[1+k_a m(t)]^2}{2} = \frac{A_c^2}{2} + \frac{A_c^2\; k_a^2 m^2(t)}{2}$

If we assume $k_a = 1$, $S^2(t) = \frac{A_c^2}{2} + \frac{A_c^2}{2}m^2(t)$

55. A certain AM transmitter is radiating 125 kW when a certain audio sine wave is modulating it to a depth of 70% and 144.5 kW when a second sinusoidal audio wave also modulates it simultaneously. What is the depth of the modulation for the second audio wave?

A. $\sqrt{0.4}$
B. $\sqrt{0.3}$
C. $\sqrt{0.2}$
D. $\sqrt{0.1}$

Ans. A

Sol. $P_t = 125kW,\ m_{a_1} = 70\%$

$P_t = 144.5kW, m_{a_2} = ?$

$$P_t = P_c\left(1+\frac{m_{a_1}^2}{2}\right)$$

$$P_c = \frac{125\times10^3}{1+\frac{(0.70)^2}{2}} = 100.40\,\text{kW}$$

$$P_t = P_c\left(1+\frac{m_{a_t}^2}{2}\right) \Rightarrow 144.5\times10^3 = 100.4\times10^3\left(1+\frac{m_{a_t}^2}{2}\right)$$

$$m_{at}^2 = 0.878 \Rightarrow m_{a_t}^2 = m_{a_1}^2 + m_{a_2}^2 \Rightarrow m_{a_2} = \sqrt{0.388}$$

56. An audio signal comprising of a single sinusoidal term $s(t) = \cos(2\pi1000t)$ is quantized using DM. What is the signal-to-quantization noise ratio?

A. 120 B. 170

C. 107 D. 100

Ans. A

Sol. SQNR is given by for delta modulation,

$$\text{SQNR} = \frac{3}{8\pi^2}\left(\frac{f_s}{f_m}\right)^2 = \frac{3}{8\pi^2}\left(\frac{2\times1000}{1000}\right)^2 = \frac{3}{2\pi^2}$$

57. The number of quantization levels is increased from 4 to 64. The bandwidth required for the transmission of a PCM signal increases by a factor of

A. 1/3 B. 1/4

C.1/4 D. 1/6

Ans. A

Sol. $n_1 = \log_2 L_1 = \log_2 4 = 2$

$n_2 = \log_2 L_2 = \log_2 64 = 6$

Corresponding no. of bit increases from 2 to 6 i.e., 3 times more

$$BW = \frac{nf_s}{2}$$

Hence, BW requirement will be = $\frac{6}{2} = 3$ times more.

58. By considering standard notations, the transfer function of a tachometer is of the form

A. $K_t s$ B. $\frac{K_t}{s}$

C. $\frac{K_t}{s+1}$ D. $\frac{K_t}{s(s+1)}$

Ans. A

59. The open-loop DC gain of a unity negative feedback system with closed-loop transfer function $\frac{s+4}{s^2++7s+13}$ is

A. $\frac{4}{13}$ B. $\frac{2}{3}$

C. $\frac{1}{3}$ D. $\frac{4}{9}$

Ans. D

Sol. We can convert CLTF into OLTF

$$\text{CLTF} = \frac{N}{D} = \frac{s+4}{s^2+7s+13}$$

$$\text{OLTF} = \frac{N}{D-N} = \frac{s+4}{s^2+7s+13-s-4}$$

$$\text{OLTF} = \frac{s+4}{s^2+6s+9}$$

DC gain will be at (S = 0), therefore

$$\text{OLTF} = \frac{s+4}{s^2+6s+9}$$

$$\text{OLTF} = \frac{4}{9}$$

60. A second-order system has a transfer function given by $G(s) = \frac{25}{s^2+8s+25}$. If the system, initially at rest t = 0, the second peak in the response will occur at

A. $\frac{\pi}{3}$ sec
B. $\frac{2\pi}{3}$ sec
C. $\frac{\pi}{2}$ sec
D. π sec

Ans. D

Sol. Standard equation is

$$\frac{\omega_n^2}{s^2+2\varepsilon\omega_n s+\omega_n^2} \quad \text{............(i)}$$

given equation is

$$\frac{25}{s^2+8s+25} \quad \text{............(ii)}$$

From (i) and (ii) we get

$\omega_n = 5$

$\varepsilon = 0.8$

Peak time is given by

$$t_p = \frac{n\pi}{\omega_d} = \frac{3\pi}{\omega_n\sqrt{1-\varepsilon^2}}$$

$$t_p = \frac{3\pi}{5\sqrt{1-0.8}} = \frac{3\pi}{5\times\frac{3}{5}} = \pi \text{ second}$$

61. Which one of the following is used to perform a transfer between two memory-mapped devices without the intervention of the CPU or the use of main memory?

A. Direct virtual memory access
B. Cycle stealing
C. Direct memory access
D. Programmed I/O

Ans. C

Sol. Direct memory access (DMA) is used to perform a transfer between two memory-mapped devices without the intervention of the CPU or the use of main memory. DMA allows a device to transfer data directly to or from memory, bypassing the CPU, and freeing it up to perform other tasks.

62. Consider the division of a dividend X = 0100000 and a D = 0110. Then the quotient (Q) and the remainder (R) respectively are

A. 0101 and 0010

B. 0110 and 0011

C. 1010 and 1011

D. 1100 and 0010

Ans. A

Sol. $X = (0100000)_2 = (32)_{10}$

$D = (0110)_2\ (6)_{10}$

$$\text{So, } 6\overline{\smash{)}\begin{array}{c}32\\30\\\hline 2\end{array}}^{\,5} \Rightarrow \begin{array}{l}R = 2 = (0010)_2\\ Q = 5 = (0101)_2\end{array}$$

63. Which one of the following threats is used to facilitate the designer of a program or system which might leave a hole in the software that only he/she is capable of using?

A. Spyware

B. Trap Door

C. Trojan Horse

D. Logic Bomb

Ans. B

Sol. A trap door, also known as a backdoor, is a type of threat used to facilitate the designer of a program or system in leaving a hole in the software that only he or she is capable of using. A trap door is a hidden entry point in a program that allows the designer or other authorized user to bypass normal security measures and gain access to the system. A trap door can be used to steal or modify data, control the system, or perform other malicious actions.

64. Windows keeps much of its configuration information in internal databases called

A. system restore point

B. service trigger

C. service control manager

D. hives

Ans. D

Sol. Windows keeps much of its configuration information in internal databases called hives. A hive is a logical group of keys, subkeys, and values in the Windows Registry, which is a hierarchical database that stores configuration settings and options for the operating system and other software installed on the system.

65. Which one of the following is a drawback of Programmed and Interrupt-Driven I/O?

A. The processor is tied up in managing an I/O transfer; a number of instructions must be executed for each I/O transfer.

B. A more efficient technique is to use a daisy chain, which provides, in effect, a hardware poll.

C. When the processor detects an interrupt, it branches to an interrupt service routine whose job is to poll each I/O module.

D. A more efficient technique is not to use a daisy chain, which provides, in effect, a hardware poll.

Ans. A

Sol. The processor is tied up in managing an I/O transfer; a number of instructions must be executed for each I/O transfer.

Programmed Interrupt-Driven I/O is a technique in which the processor polls the I/O device at regular intervals to check whether it has data to transfer. When the I/O device has data to transfer, it sends an interrupt signal to the processor, which then transfers the data from the device to the main memory. The processor is responsible for managing the entire I/O transfer, which can tie up the processor and slow down the system. In addition, a number of instructions must be executed for each I/O transfer, which can further reduce the system's performance.

66. Which one of the following methods requires saving the value of the CUP registers from the thread being switched out and restoring the new thread being scheduled?

A. Context switching between kernel level threads

B. Scheduling switching

C. Kernel dispatcher

D. Multilevel queue scheduling

Ans. A

Sol. Context switching between kernel threads typically requires saving the value of the CPU registers from the thread being switched out and restoring the CPU registers of the new thread being scheduled.

67. A parallel-plate air-filled capacitor has plate area of 10^{-4} m^2 and plate separation of 10^{-3} m. It is connected to a 0.5 V, 4.5 GHz source. The magnitude of the displacement current is (take $\varepsilon_0 = \frac{1}{36\pi \times 10^9}$ F / m)

A. 10 mA

B. 10 A

C. 12.5 mA

D. 50 A

Ans. C

Sol. The magnitude of displacement crossed is given by,

$$I_d = \frac{\omega \varepsilon A V}{d}$$

$$= \frac{2\pi \times 4.5 \times 10^9 \times 10^{-4} \times 0.5 \times 8.85 \times 10^{-12}}{10^{-3}} = 12.5 \text{ mA}$$

68. A coaxial cable with an inner diameter of 1 mm and outer diameter of 2.4 mm is filled with a dielectric of relative permittivity 10.89. Given $\mu_0 = 4\pi \times 10^{-7}$H / m, $\varepsilon_0 = \frac{1}{36gp \times 10^9}$F / m. The characteristic impedance of the cable is

A. 33 Ω

B. 43.4 Ω

C. 143.3 Ω

D. 16 Ω

Ans. A

Sol. Inductance and capacitance per unit length of co-axial cable are given as,

$$L = \frac{40}{2\pi} \ln\left(\frac{b}{a}\right) \text{and } C = \frac{2\pi\varepsilon_0\varepsilon_r}{\ln\left(\frac{b}{a}\right)}$$

Characteristics impedance of cable is given as,

$$z_0 = \sqrt{\frac{L}{C}} = \sqrt{\frac{\mu_0}{\varepsilon_0 \varepsilon_r}}\left[\frac{1}{2\pi}\ln\left(\frac{b}{a}\right)\right] = \sqrt{\frac{4\pi\times10^{-7}}{\frac{1}{36\pi}\times10^{-9}}\times\frac{1}{10.89}}\frac{1}{2\pi}\ln(2.4)$$

$$= \frac{120\pi}{2\pi}\times\frac{1}{\sqrt{10.84}}\ln(2.4) = 15.91 = 16\Omega$$

69. The electric field of a uniform plane electromagnetic wave in free space, along the positive x direction, is given by $\bar{E} = 10(a_y + ja_z)e^{-j25x}$. The frequency and polarization of the wave respectively are

A. 1.2 GHz and right circular

B. 1.2 GHz and left circular

C. 4 GHz and right circular

D. 44 GHz and left circular

Ans. B

Sol. $\hat{a}_k = \hat{a}_x$

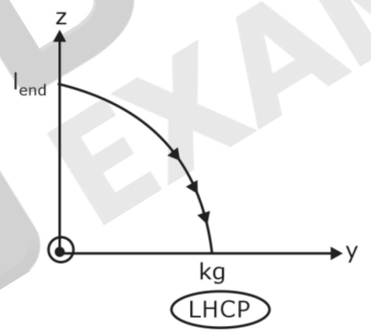
$$\beta = 25 = \frac{\omega}{c}$$

$$\omega = 25c$$

$$2\pi f = 25 \times c$$

$$f = \frac{25\times3\times10^8}{2\pi}$$

$$f = 1.2 \text{ GHz}$$



70. In electromagnetic field, which one of the following does not satisfy the wave equation?

A. $25e^{-(\omega t-3z)}$

B. $\sin(\omega(27z + 15t))$

C. sin (x) cos (t)

D. $\cos(y^2 + 5t)$

Ans. A

Sol. $\frac{\partial^2 E}{\partial t^2} = v_p^2 \frac{\partial^2 E}{\partial z^2} = 0$

71. The intrinsic impedance of copper at high frequency is

A. purely resistive

B. purely inductive

C. complex with an inductive component

D. complex with a capacitive component

Ans. C

Sol. Intrinsic impedance is given by

$$\eta = \sqrt{\frac{\omega\mu}{\sigma}} \angle 45^\circ$$

$$\eta = \frac{1+j}{\sigma\delta}$$

Complex with an inductive component

72. The depth of penetration of a wave in a lossy dielectric increases with increasing

A. conductivity

B. permeability

C. wavelength

D. permittivity

Ans. D

Sol. For low loss

$$\alpha = \frac{\sigma}{2}\sqrt{\frac{\mu}{\in}}$$

$$\delta = \frac{1}{\alpha} = \frac{2}{\sigma}\sqrt{\frac{\in}{\mu}}$$

$\in \uparrow\uparrow$ $\qquad \delta \uparrow\uparrow$

Option D is correct.

73. Which one of the following can wave propagate in a conducting medium before its amplitude becomes insignificant?

A. Characteristic impedance

B. Skip distance

C. Line of sight

D. Skin depth

Ans. D

Sol. Skin depth can wave propagate in a conducting medium before its amplitude becomes insignificant.

74. Copper behaves as a

A. conductor always

B. conductor or dielectric depending on the applied electric field strength

C. conductor or dielectric depending on the frequency

D. conductor or dielectric depending on the dielectric current density

Ans. C

75. A transmission line has a characteristic impedance of 50 Ω and a resistances of 0.1 Ω/m. If the line is distortion-less, the attenuation constant is

A. 500

B. 5

C. 0.01

D. 0.002

Ans. D

Sol. For distortion-less transmission line,

$$\frac{R}{G} = \frac{L}{C}$$

Attenuation constant as given by

$\alpha = \sqrt{RG}$ ....(i)

Characteristics impedance using by

$z_0 = \sqrt{\dfrac{R}{G}}$ ....(ii)

$\alpha z_0 = R \Rightarrow \alpha = \dfrac{R}{z_0} = \dfrac{0.1}{50} = 0.002$

76. By considering standard notations, in a worst-case scenario, the total load capacitance C_L of gate Y depends upon the data activities on the neighboring signals and varies between which one of the following bounds?

A. $C_{GND} \le C_L \le C_{GND} + 4C_C$

B. $C_{GND} \le C_L \le C_{GND} + 2C_C$

C. $C_{GND} \le C_L \le C_{GND} + C_C$

D. $C_{GND} \le C_L \le 2C_{GND} + C_C$

Ans. A

77. In a source follower or common drain amplifier, the voltage gain (A_V) is

A. $A_V = \dfrac{g_{m1}}{g_{m1} + g_{s1} + (g_{ds1} + g_{ds})/2}$

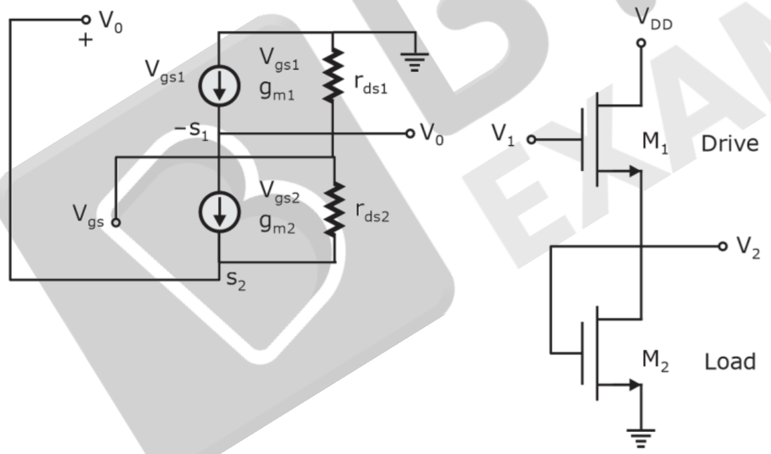
B. $A_V = \dfrac{g_{ds1}}{g_{m1} + g_{s1} + (g_{ds1} + g_{ds})}$

C. $A_V = \dfrac{g_{m1}}{g_{m1} + g_{s1} + g_{ds1} + g_{ds2}}$

D. $A_V = \dfrac{g_{m1}}{2(g_{m1} + g_{s1}) + g_{ds1} + g_{ds2}}$

Ans. *

Sol.



$V_{gs2} = V_0 - V_{s2} = V_0$

$V_{gs1} = V_1 - V_0$

$V_0 r_{ds1} - g_{m1}V_{gs1} + g_{m2}V_{gs2} + V_0 r_{ds2} = 0$

78. Which one of the following is a program that takes an object file generated and generates a file in a binary code called COM file or EXE file?

A. Editor

B. Assembler

C. Loader

D. Debugger

Ans. C

Sol. The program that takes an object file generated and generates a file in a binary code called COM file or EXE file is a "Loader".

79. Which of the following opcodes is used if the contents of the accumulator are logically ANDed with the 8-bit data and the results are placed in the accumulator?

A. CALL
B. POP
C. ANI
D. ANA

Ans. C

Sol. In 8085 Instruction set, ANI is a mnemonic, which stands for “AND Immediate with Accumulator” and “d8” stands for any 8-bit or 1-Bytedata. This instruction is used to AND 8-bit immediate data with the Accumulator's content.

80. The arrangement of a minimum number of N flip-flops can be used to construct any counter with a modulus given by the equation

A. $2^N - 1 \leq$ modules $\leq 2^{N-1}$
B. $2^{N-1} + 1 \leq$ modules $\leq 2^N$
C. $2^N + 1 \leq$ modules $\leq 2^{N+1}$
D. $2^{N+1} + 1 \leq$ modules $\leq 2^N$

Ans. B

Sol. N = 4

B. 9 ≤ Mod ≤ 15

D. 33 ≤ Mod ≤ 16

highest 2^N

lowest $2^N - (2^{N-1}) + 1$

$2^N (1 - 2^{-1}) + 1$

$= 2^{N-1} + 1$

81. For a CMOS-4000 logic family, supply voltage (V), typical propagation delay (ns), worst-case noise margin (V), speed-power product (pJ) and maxi- mum flip-flop toggle frequency (MHa) respectively are

A. 15 V to 25 V, 150 ns, 1.0 V, 3 pJ
B. 15 V to 25 V, 130 ns, 1.5 V, 3 pJ
C. 3 V to 15 V, 130 ns, 1.5 V, 5 pJ
D. 3 V to 15 V, 150 ns, 1.0 V, 5 pJ

Ans. C

82. By considering standard notations, in approximate analysis of the voltage-divider biasing configuration, which of the following conditions should be satisfied?

A. $\beta/R_E \geq R_2$
B. $\beta R_E \geq R_2$
C. $\beta R_E \geq 10R_2$
D. $\beta 2R_E \geq R_2$

Ans. B

Sol. $$\frac{V_0}{V_S} = \frac{\beta I_B R_E}{I_B R_a + \beta I_B R_E} = 1$$

$$= \beta R_E > R_2$$

83. The power dissipation under constant field after scaling on MOS device characteristics is

A. $\frac{P}{S}$
B. $\frac{2P}{S^2}$
C. $\frac{P}{S^2}$
D. $\frac{P}{2S^2}$

Ans. C

Sol. $P_D = \frac{P_D}{S^2}\left(\begin{matrix} I_{PS}^1 = \frac{I_{PS}}{S} \\ V_{DD}^1 = \frac{V_{DD}}{S} \end{matrix}\right)$

84. Source/Drain region's doping concentration value used for analysis and simulation of MESFET is and SOI short-channel

A. 10^{10} cm^{-3}
B. 10^{20} cm^{-3}
C. 10^{15} cm^{-3}
D. 10^{25} cm^{-3}

Ans. B

Sol. Source/Drain are heavily doped compared to the substrate. From the given options 10^{10} is very lightly doped amount, 10^{15} is the moderately doped amount, 10^{20} is heavily doped amount, and 10^{25} is too much heavily doped amount.

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

Code:

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 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):** Content in the flag register in 8085 microprocessor is read by PUSH PSW followed by POP instruction.

Statement (II): Content in the flag register in 8085 microprocessor is not able to read and store to any general purpose register

Ans. C

Sol. Statement-I is correct, statement-II is not correct as by using PUSH and POP instructions

86. **Statement (I):** Pipeline processing cycle overlaps instruction cycle in computer execution for the performance improvement.

Statement (II): Pipelining is a technique of decomposing a sequential process into sub-operations, with each sub-process being executed in a special dedicated segment that operates concurrently with all other segments.

Ans. B

87. **Statement (I):** A popular method for generating a VSB modulated wave is to use the frequency discrimination method.

Statement (II): One of the sidebands is partially suppressed and a vestige of the other sideband is transmitted to compensate for that suppression.

Ans. D

Sol. One of the sideband is partially suppressed and vestige (portion) of the other sideband is transmitted. This vestige (portion) compensates the suppression of other sideband. It is called vestigial sideband transmission. Frequency description method is used for SSBSC generation.

88. **Statement (I):** The differential amplifier is said to operate in common-mode configuration when the same voltage is applied to both the input terminals.

Statement (II): The ability of a differential amplifier to amplifier common-mode signal is defined as the figure of merit.

Ans. C

Sol. **Statement I:** The differential amplifier is said to operate in common-mode configuration when the same voltage is applied to both input terminals.

Statement II: The ability of a differential amplifier to amplifier common-mode signal is defined as the figure of merit.

Statement I is correct and Statement II is incorrect.

89. **Statement (I):** The set-up time and hold time are met, the data at the D input is copied to the Q′ output after a worst-case propagation delay denoted by t_{c-q}.

Statement (II): The set-up time is the time the data input must be valid before the clock transition and the hold time is the time the data input must remain valid after the clock edge. Critical path is the longest data path.

Ans. B

Sol. Both are correct.

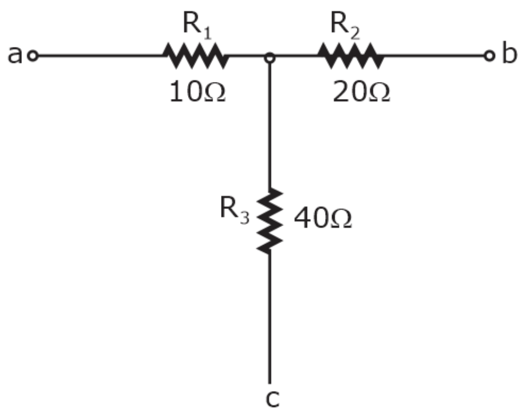
90. **Statement (I):** In the sampling and quarantining operations, errs are introduced into the digital signal. These errors are reversible and it is possible to produce and exact replica of the original analog signal from its digital representation.

Statement (II): The use of digital Communication offers flexibility and compatibility in that the adoption of a common digital format makes it possible for a transmission system to sustain many different sources of information in a flexible manner.

Ans. D

Sol. Statement (I) is false, Statement (II) is correct.

91. What are the values of delta-connected branch resistances R_{ab}, R_{ac} and R_{ca} of the star-connected network shown in the figure using star to delta transformation respectively?



A. 35 Ω, 140 Ω and 70 Ω

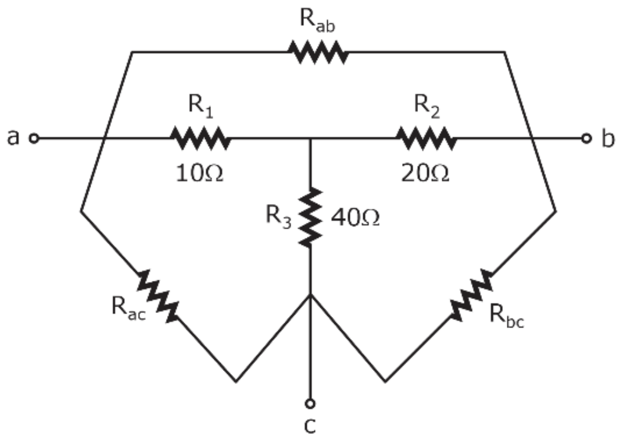
B. 35 Ω, 60 Ω and 70 Ω

C. 70 Ω, 60 Ω and 35 Ω

D. 70 Ω, 150 Ω and 35 Ω

Ans. A

Sol.



$$R_{ac} = R_3 + R_1 + \frac{R_3R_1}{R_2}$$

$$= 40 + 10 + \frac{40 \times 10}{20}$$

$$= 70\,\Omega$$

$$R_{ab} = R_1 + R_2 + \frac{R_1R_2}{R_3}$$

$$= 10 + 20 + \frac{10 \times 20}{40}$$

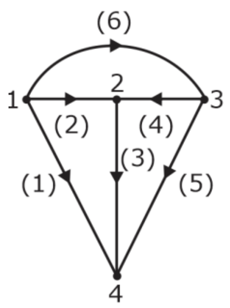
$$= 35\,\Omega$$

$$R_{bc} = R_2 + R_3 + \frac{R_2R_3}{R_1}$$

$$= 20 + 40 + \frac{20 \times 40}{10}$$

$$= 140\,\Omega$$

92. What is the value of number of possible trees of the graph shown in the figure?



A. 14

B. 16

C. 18

D. 20

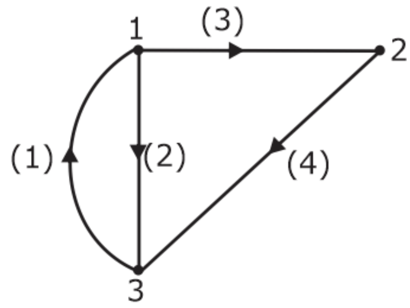
Ans. B

Sol. The possible no. of trees of a graph is given by $n^{(n-2)}$ where 'n' is no. of nodes.

No. of nodes, n = 4.

$\therefore$ No. of trees are, $4^{(4-2)} = 16$

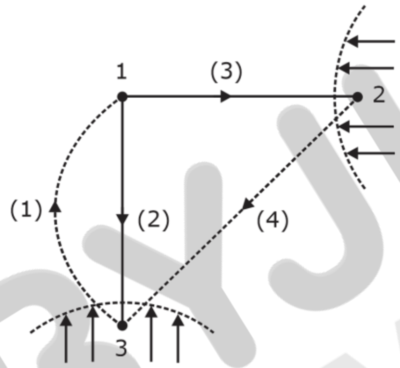
93. Which one of the following is a fundamental cut set of the graph shown in the Figure?



A. 1, 2 and 4
B. 1, 2 and 2
C. 2, 3 and 4
D. 1, 3 and 4

Ans. A

Sol. Fundamental cut set is

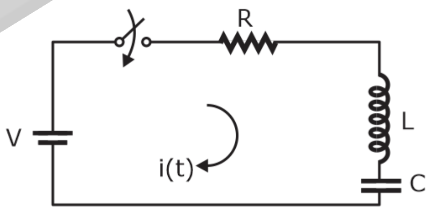


Th possible f-cut set's are

f_{C1} = 1, 2, 4

f_{C2} = 3, 4

94. For the network shown in the figure if the switch is closed at t = 0, and when $\frac{R}{2L} < \frac{1}{\sqrt{LC}}$, which one of the following statements is correct?



A. The roots are real and equal and it gives a critically damped response.
B. The roots are real and unequal and it gives an overdamped response.
C. The roots are complex conjugate and it gives an underdamped response.
D. The roots are real and unequal and it gives an underdamped response.

Ans. C

Sol. The roots are given as

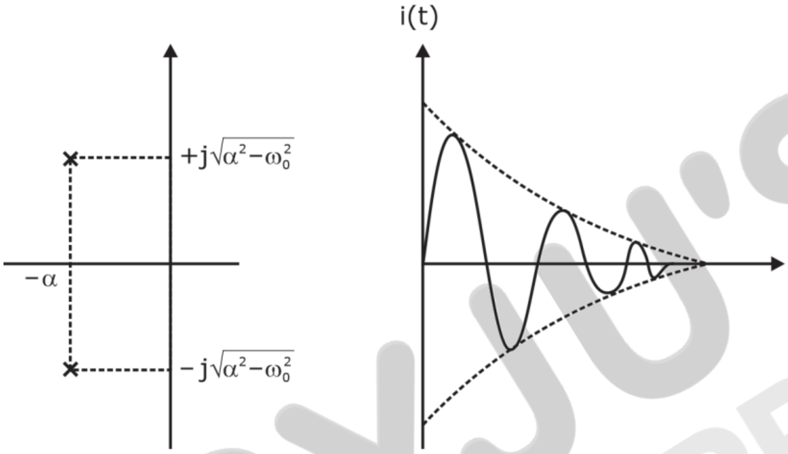
$$s_1 = -\frac{R}{2L} + \sqrt{\left(\frac{R}{2L}\right)^2 - \frac{1}{LC}} \text{ (or) } -\alpha + \sqrt{\alpha^2 - \omega_0^2}$$

$$s_2 = -\frac{R}{2L} - \sqrt{\left(\frac{R}{2L}\right)^2 - \frac{1}{LC}} \text{ (or) } -\alpha - \sqrt{\alpha^2 - \omega_0^2}$$

Where, $\alpha = \frac{R}{2L}$ and $\omega_0 = \frac{1}{\sqrt{LC}}$

If $\alpha < \omega_0$; Then the system is under damped system and the poles will be complex poles on left half of s-plane.

Therefore, the response will be exponentially decaying, damped oscillations as shown in fig below.



95. An R-L-C series circuit has R = 4Ω, L – 2H and of C = 2 F. What transient current response is offered by the circuit for step function voltage type input?

A. Underdamped

B. Not possible to know the response

C. Critically damped

D. Overdamped

Ans. D

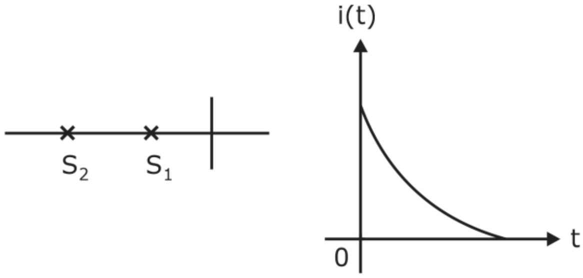
Sol. Given series RLC circuit.

The roots, $S_1 = -\alpha + \sqrt{\alpha^2 - \omega_0^2}$ and $S_2 = -\alpha - \sqrt{\alpha^2 - \omega_0^2}$

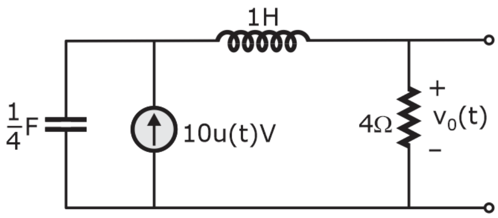
Where, $\alpha = \frac{R}{2L} = \frac{4}{2 \times 2} = 1$ and $\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{2 \times 2}} = \frac{1}{2}$

So, $\alpha > \omega_0$. Therefore the system is overdamped and the system response will be exponentially decaying.

Note: The poles will be located on –ve real axis as shown below



96. What is the value of v_0 (t) for the circuit shown in the figure, assuming zero initial conditions?



A. $v_0(t) = 40(1 - e^{-t} + 2te^{-t})\, u(t)$ V

B. $v_0(t) = 40(1 - e^{-2t} + 2te^{-2t})\, u(t)$ V

C. $v_0(t) = 40(1 - e^{-t} - 2te^{-2t})\, u(t)$ V

D. $v_0(t) = 40(1 - e^{-2t} + 2te^{-t})\, u(t)$ V

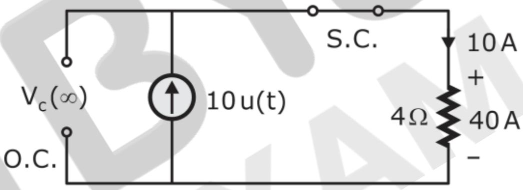
Ans. B

Sol. The response for a series RLC circuit with source will be, $V(t) = V_{ss} + (A_1 + A_2 t)e^{-at}$ for $a = \omega_0$.

Given, R = 4Ω, L = 1H and $C = \frac{1}{4}$F.

$$\left.\begin{aligned} \therefore a &= \frac{R}{2L} = \frac{4}{2\times 1} = 2 \\ \omega_0 &= \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{1\times\frac{1}{4}}} = 2 \end{aligned}\right] \quad a = \omega_0;\ \text{system is critically damped}$$

At t = ∞ ; inductor is S.C and capacitor is O.C.



Now, to calculate A_1 and A_{22}, we will consider initial conditions and proceed further as below.

$V(t) = V_{ss} + (A_1 + A_2 t)\, e^{-at} = 40 + A_1 e^{-2t} + A_2 te^{-2t}$

At t = 0, voltage across capacitor is zero i.e., V(t) = 0

$\therefore 0 = 40 + A_1 e^{-2\times 0} + A_2 te^{-2\times 0}$

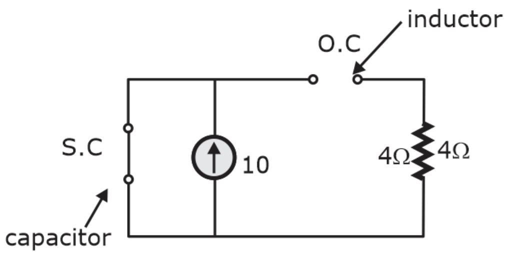
$\therefore A_1 + A_2 = -40$

And $\frac{dv(0)}{dt} = 0 + -2\ A_1 e^{-2t} - 2A_2 te^{-2t} + A_2 e^{-2t}$

$0 = -2 \times (-40) - 0 + A_2$

$\therefore A_2 = -80$

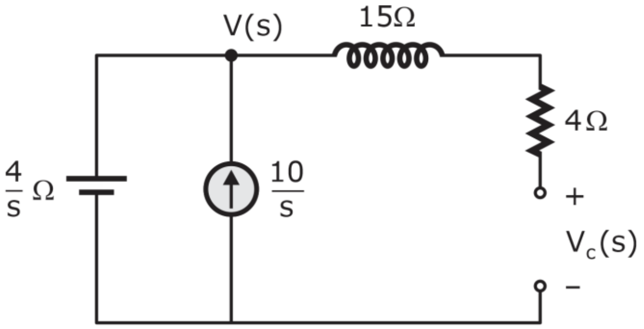
$\frac{dv(0)}{dt} = 0$ (∵ The initial current through inductor is 0A)



Finally, V(t) = 40 + (−40 – 80t) e^{-2t}

V(t) = 40 (1 – e^{-2t} – 2t e^{-2t}) u(t). volts

Alternative Method:



$$V(s) = \frac{40(4+s)}{s[s(4+s)+4]}$$

$$V_0(s) = \frac{V(s)\times 4}{4+s}$$

$$V_0(s) = \frac{40\,(4+s)\times 4}{s[s(4+s)+4](4+s)}$$

$$V_0(s) = \frac{160}{s^2(4+s)+4s} = \frac{160}{s^3+4s^2+4s}$$

$$V_0(s) = \frac{160}{s(s^2+4s+4)} = \frac{160}{s(s+2)^2}$$

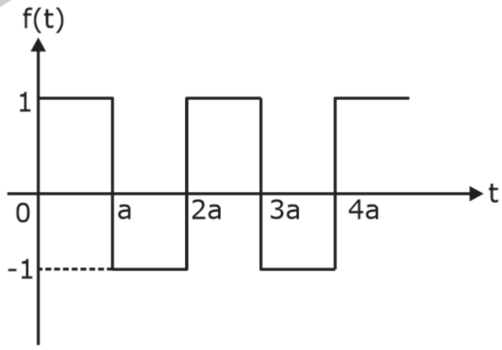
Applying partial fraction, we get

$$\frac{160}{s(s+2)} \longleftrightarrow \frac{40}{s} - \frac{40}{s+2} - \frac{80}{(s+2)^2}$$

Now taking inverse Laplace transform of above equation,

$$\frac{40}{s} - \frac{40}{s+2} - \frac{80}{(s+2)} \overset{L^{-1}}{\longleftrightarrow} 40[1 - e^{-2t} - 2t\,e^{-2t}]u(t)$$

97. What is the Laplace transform of the periodic waveform shown in the figure, where a = 1, 2a = 2, 3a = 3 and 4a = 4?



A. $\frac{1}{s}\tanh\left(\frac{s}{2}\right)$

B. $\frac{1}{2s}\tanh\left(\frac{s}{2}\right)$

C. $\frac{1}{s}\tanh\left(\frac{1}{2}\right)$

D. $\frac{1}{s}\tanh\left(\frac{3}{2}\right)$

Ans. A

Sol. $f(t) = \begin{cases} 1 & ;0 < t < a \quad a = 1 \\ -1 & ;a < t < 2a \quad T = 2a = 2 \end{cases}$

$$L\{f(t)\} = \frac{1}{(1-e^{-st})}\int_0^T e^{-st} f(t)\,dt$$

$$= \frac{1}{(1-e^{-2s})}\left[\int_0^2 e^{-st} f(t)\,dt\right]$$

$$= \frac{1}{(1-e^{-2s})}\left[\int_0^1 e^{-st}\,dt - \int_1^2 e^{-st}\,dt\right]$$

$$= \frac{1}{(1-e^{-2s})}\left[\left(\frac{e^{-st}}{-s}\right)_0^1 - \left(\frac{e^{-st}}{-s}\right)_1^2\right]$$

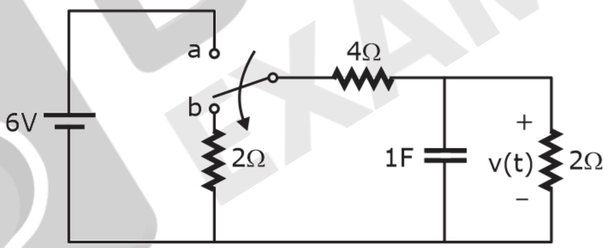
$$= \frac{1}{(1-e^{-2s})}\left[\frac{-e^{-s}}{e} + \frac{1}{s} + \frac{e^{-2s}}{s} - \frac{e^{-s}}{s}\right]$$

$$= \frac{1}{(1-e^{-s})(1+e^{-s})}\,\frac{(1-e^{-s})(1-e^{-s})}{s}$$

$$= \frac{1}{s}\left(\frac{e^{s/2} - e^{-s/2}}{e^{s/2} + e^{-s/2}}\right)$$

$$= \frac{1}{s}\tanh\left(\frac{s}{2}\right)$$

98. For the network shown in the figure, the switch is moved from a to b at t = 0^-. What is the value of voltage v(t)?



A. $v(t) = 2e^{-\frac{2}{3}t}$

B. $v(t) = e^{-\frac{2}{3}t}$

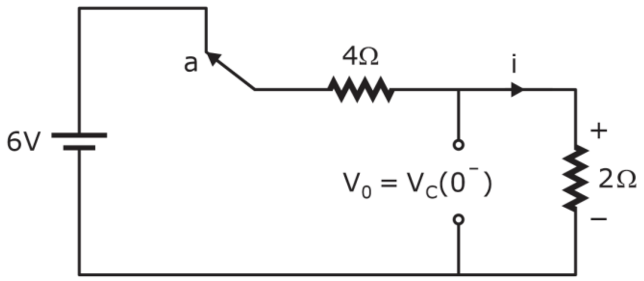
C. $v(t) = 3e^{-\frac{2}{3}t}$

D. $v(t) = 2e^{-\frac{1}{3}t}$

Ans. A

Sol. At t = 0^-; the network is in steady state

∴ The capacitor will be O.C.

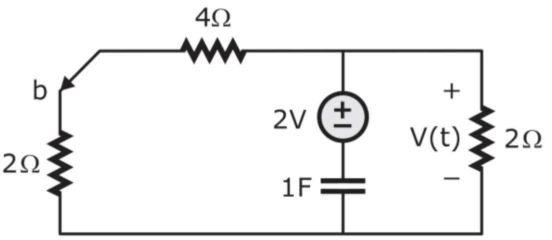


$$i(0^-) = \frac{6}{4+2} = 1A$$

$$V_C(0^-) = 6 \times \frac{2}{4+2}$$

$= 2$ Volts $= V_C(0^+)$

For t > 0; the network will be source free



The response, $V(t) = V_C(t) = V_0.e^{-t/T}$

$\gamma = R_{eq} . C$

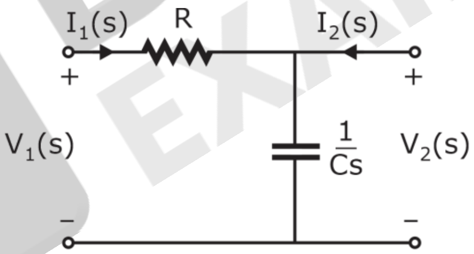
$$= \frac{(4+2)\times 2}{4+2+2} \times 1$$

$$= \frac{3}{2} \text{ sec}$$

$$\therefore\ V(t) = 2.e^{-\frac{t}{3/2}}$$

$$= 2.e^{-\frac{2t}{3}} \text{ Volts}$$

99. What is the voltage transfer function of the two-port network shown in the figure?



A. $\frac{1}{1-RCs}$

B. $\frac{1}{1+RCs}$

C. $\frac{1}{(1+RCs)^2}$

D. $\frac{1}{(1+-Cs)^2}$

Ans. B

Sol. Applying voltage division rule.

$$V_2(g) = \frac{\frac{1}{Cs} \times V_1(s)}{R + \frac{1}{Cs}}$$

$$\frac{V_2(g)}{V_1(s)} = \frac{1}{1+RCs}$$

100. The Z-parameters of a two-port network are Z_{11} = 2 Ω, Z_{12} = 1 Ω, Z_{21} = 10 Ω and Z_{22} = 11 Ω. The corresponding values of hybrid parameters are

A. $\begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{bmatrix} = \begin{bmatrix} \frac{12}{11} & \frac{1}{11} \\ -\frac{10}{11} & \frac{1}{11} \end{bmatrix}$

B. $\begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{bmatrix} = \begin{bmatrix} \frac{1}{11} & \frac{1}{11} \\ -\frac{10}{11} & \frac{12}{11} \end{bmatrix}$

C. $\begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{bmatrix} = \begin{bmatrix} \frac{12}{11} & \frac{10}{11} \\ -\frac{10}{11} & \frac{1}{11} \end{bmatrix}$

D. $\begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{bmatrix} = \begin{bmatrix} \frac{12}{11} & \frac{1}{11} \\ -\frac{10}{11} & \frac{12}{11} \end{bmatrix}$

Ans. A

Sol. Given, Z-parameters

Z_1 = 2 Ω; Z_{12} = 1 Ω

Z_{21} = 10 Ω; Z_{22} = 11 Ω

We know, $V_1 = Z_{11} I_1 + Z_{12} I_2 \Rightarrow V_1 = 2I_1 + 1I_2$ ....(i)

$V_2 = Z_{21} I_1 + Z_{22} I_2 \Rightarrow V_2 = 10I_1 + 11I_2$ ....(ii)

For calculating h-parameters

$$\left.\begin{aligned} V_1 &= h_{11}I_1 + h_{12}V_2 \\ I_2 &= h_{21} + h_{22}V_2 \end{aligned}\right\} \quad h_{11} = \left.\frac{V_1}{I_1}\right|_{V_2=0} ;\ h_{12} = \left.\frac{V_1}{V_2}\right|_{I_2=0} \quad h_{21} = \left.\frac{I_2}{I_1}\right|_{V_2=0} ;\ h_{22} = \left.\frac{I_2}{V_2}\right|_{I_1=0}$$

When V_2 = 0; The equation (ii) becomes; $0 = 10I_1 + 11I_2$

i.e., $I_2 = \frac{-10}{11} I_1$ ....(iii) and $\boxed{\frac{I_2}{I_1} = \frac{-10}{11} = h_{21}}$

Substitute equation (iii) in equation (i); we get

$$V_1 = 2I_1 + 1\left(\frac{-10}{11}\right) I_1 \Rightarrow \boxed{\frac{V_1}{I_1} = h_{11} = \frac{12}{11}\Omega}$$

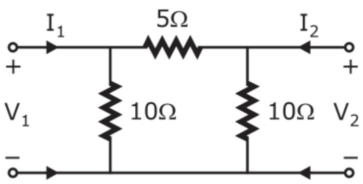
When, I_1 = 0; The equation (i) becomes, $V_1 = 1I_2$

and equation (ii) becomes, $V_2 = 11I_2$

$$\therefore \boxed{h_{12} = \frac{V_1}{V_2} = \frac{1}{11}\frac{I_2}{I_2} = \frac{1}{11}}$$

and $\boxed{h_{22} = \frac{I_2}{V_2} = \frac{I_2}{I_2} = \frac{1}{11}\mho}$

101. What are the lattice equivalent network parameters Z_A and Z_B of a symmetrical π network shown in the figure?



A. Z_A = 2Ω and Z_B = 10Ω

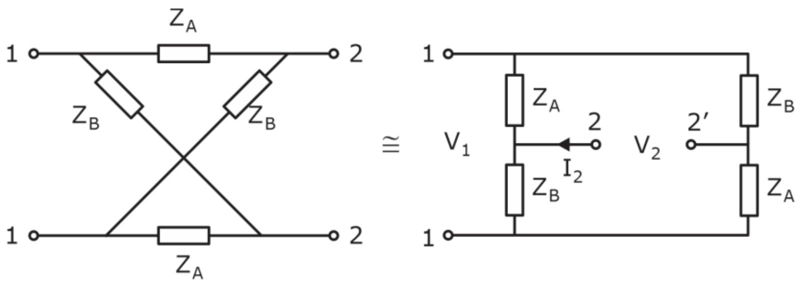
B. Z_A = 10Ω and Z_B = 2Ω

C. Z_A = 4Ω and Z_B = 8Ω

D. Z_A = 8Ω and Z_B = 4Ω

Ans. A

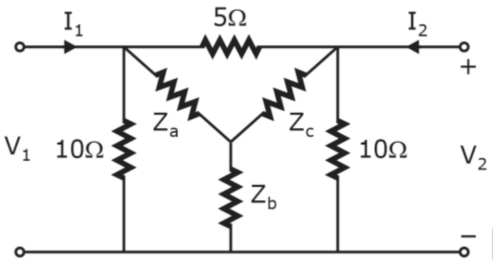
Sol.



If we calculate, Z-parameters for the above network,

We get, $Z_{11} = Z_{22} = \dfrac{Z_A + Z_B}{2}\,\Omega$ and $Z_{12} = Z_{21} = \dfrac{Z_B - Z_A}{2}\,\Omega$

Z-parameter of equivalent π network given will be

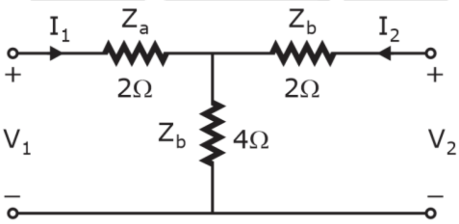


Delta to star,

$$Z_a = \frac{10 \times 5}{10 + 5 + 10} = \frac{50}{25} = 2\,\Omega$$

$$Z_b = \frac{10 \times 10}{10 + 5 + 10} = 4\,\Omega$$

$$Z_c = \frac{5 \times 10}{10 + 5 + 10} = 2\,\Omega$$



Now, the Z-parameter’s are calculated as

$Z_{11} = 2 + 4 = 6\Omega = Z_{22}$

$Z_{12} = Z_{21} = 4\Omega$

From lattice network, we know that

$$Z_{11} = Z_{22} = \frac{Z_A + Z_B}{2} \Rightarrow 6 = \frac{Z_A + Z_B}{2} \Rightarrow Z_A + Z_B = 12 \quad \text{..............} \ \text{(i)}$$

$$Z_{21} = Z_{12} = \frac{Z_B - Z_A}{2} \Rightarrow 4 = \frac{Z_B - Z_A}{2} \Rightarrow -Z_A + Z_B = 8 \quad \text{..............} \ \text{(ii)}$$

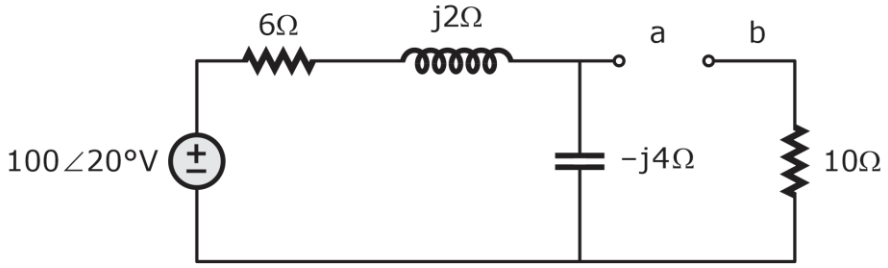
By solving equation (i) and (ii), we get

$$\begin{aligned} Z_A + Z_B &= 12 \\ -Z_A + Z_B &= 8 \\ \hline 2Z_B &= 20 \end{aligned}$$

$Z_B = 10\Omega$

and, $Z_A = 2\Omega$

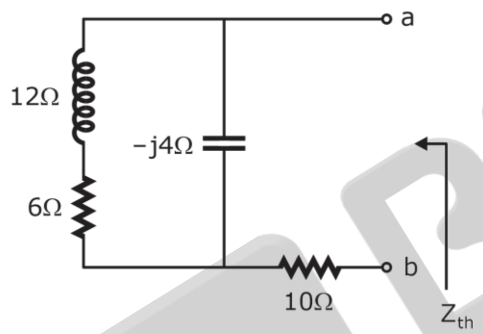
102. What is the Thevenin equivalent impedance of the circuit shown in the figure?



A. 12.4 – j3.2Ω
B. 12.4 – j2.2Ω
C. 11.4 – j3.2Ω
D. 11.4 – j2.2Ω

Ans. A

Sol.



$Z_{th} = (6 + j1) \parallel (-j9) + 10$

$Z_{th} = \dfrac{(6+j2)(-j4)}{6-2j} + 10$

$Z_{th} = \dfrac{-24j+8}{6-2j} + 10$

$Z_{th} = 2.4 - 3.2j + 10$

$Z_{th} = 12.4 - 3.2j$

103. What is the maximum conversion time for an n-bit counting ADC?

A. $2^n + 1$ clock cycles
B. $2^n - 1$ clock cycles
C. 2n – 1 clock cycles
D. 2n + 1 clock cycles

Ans. B

Sol. Maximum conversion time for n-bit counting ADC is $(2^n - 1)$ clock cycles.

104. If a square wave is impressed upon either a point contact or a p-n junction germanium diode, the resistance does not change instantaneously from its forward value to its back value, or vice versa. Which of the following is required for this change to take place?

A. Change-over time
B. Recovery time
C. Settling time
D. Propagation delay time

Ans. B

105. By considering standard notations, the time period of a linear ramp generator in 555 timer is

A. $T = \dfrac{\left(\frac{1}{2}\right) V_{CC} R_E (R_1 + R_2) C}{R_2 V_{CC} - V_{BE}(R_1 + R_2)}$

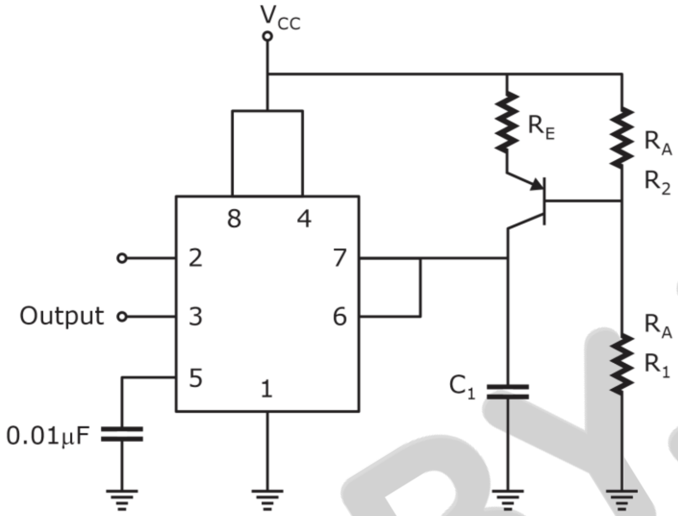
B. $T = \dfrac{V_{CC} R_E (R_1 + R_2) C}{R_1 V_{CC} - V_{BE}(R_1 + R_2)}$

C. $T = \dfrac{\left(\frac{2}{3}\right) V_{CC} R_E (R_1 + R_2) C}{R_1 V_{CC} - V_{BE}(R_1 + R_2)}$

D. $T = \dfrac{\left(\frac{2}{3}\right) V_{CC} R_E (R_1 + R_2) C}{R_1 V_{CC} + V_{BE}(R_1 + 2R_2)}$

Ans. C

Sol.



$$T = \frac{2}{3}\frac{V_{CC} R_E (R_1 + R_2) C_1}{R_1 V_{CC} - (R_1 + R_2) V_{BE}}$$

106. The self-inductances of three coils are L_A = 20H, L_B = 30H and L_C = 40H. The coils are connected in series in such a way that fluxes of L_A and L_B add, fluxes of L_A and L_C are in opposition and fluxes of L_B and L_C are in opposition. If M_{AB} = 8H, M_{BC} = 12H and M_{AC} = 10H. What is the total inductance of the circuit?

A. 46H

B. 62H

C. 70H

D. 82H

Ans. B

Sol. Total inductance, $L_T = L_A + L_B + L_C + 2M_{AB} - 2M_{BC} - 2M_{AC}$

$= 20 + 30 + 40 + 2 \times 8 - 2 \times 12 - 2 \times 10$

$= 62$ H

107. A 100 kVA, 50 Hz single-phase transformer has ratio of secondary to primary turns as 0.1. The secondary voltage at no-load condition is 100V. What is the value of primary voltage?

A. 100V

B. 500V

C. 1000V

D. 5000V

Ans. C

Sol. $\frac{N_2}{N_1} = 0.1$

$V_2 = 100$ V

We know,

$V_1 = \frac{N_1}{N_2} V_2$

$= \frac{1}{0.1} \times 100$

$= 1000$ V

108. A 230V DC shunt machine has an armature resistance of 0.5Ω and a field resistance of 115Ω. What are the values of e.m.f. induced when the machine acts as a generator and acts as a motor respectively by assuming a line current of 50A in both the cases?

A. 256 V and 206 V

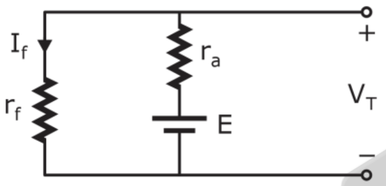
B. 206 V and 256 V

C. 251 V and 211 V

D. 211 V and 251 V

Ans. A

Sol.



$V_T = 230V$; $r_a = 0.5\Omega$

$r_f = 115\Omega$; $I_L = 50A$

$I_f = \frac{V_T}{r_f} = \frac{230}{115} = 2A$

For generator,

Armature current, $I_a = I_f + I_L$

$I_a = 50$ A

$E = V_T + I_a r_a$

$= 230 + 52 \times 0.5$

$= 256$ V

For moto,

$I_a = I_L - I_f$

$= 48$ A

$E = V_T - I_a r_a$

$= 230 - 48 \times 0.5$

$= 206$ V

109. A 4-pole, three-phase induction motor is supplied form 50 Hz AC supply and the full-load speed of the motor is 1455 r.p.m. What are the values of slip and frequency of the rotor induced e.m.f. at standstill respectively?

A. 0.03 and 15 Hz

B. 0.03 and 50 Hz

C. 0.06 and 50 Hz

D. 0.06 and 15 Hz

Ans. B

Sol. P = 4

N_r = 1455 rpm

$N_s = \frac{120f}{P}$

$= \frac{120 \times 50}{4}$ = 1500 rpm

Slip, $S = \frac{N_s - N_r}{N_s}$

$= \frac{1500 - 1455}{1500}$ = 0.03

At, stand still,

Rotor frequency = 50 Hz

110. The pressurized-water reactor is similar to a boiling-water reactor, except that the coolant water is pumped through the reactor under.

A. High pressure
B. Low pressure
C. Moderate pressure
D. Constant pressure

Ans. A

Sol.

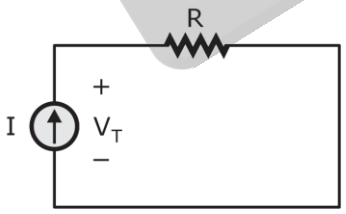
Pressure is maintained in PWR in such a way that coolant does not convert into steam. IN BWR evaporation is required.

111. A discharged battery is charged at 6 A for 3 hours after which it is discharged through a resistor of RΩ. if the discharge period is 7 hours and the terminal voltage remains fixed at 12V, what is the value of R approximately assuming the Ah efficiency of the battery as 85%?

A. 3.37Ω
B. 5.49Ω
C. 7.62Ω
D. 9.72Ω

Ans. B

Sol.



I = 6A; Time = 3h

Discharge period is 7 hours

V_T = 12V

η = 85%

Ah stored, $P_{in} = 6 \times 3 = 18$ Ah

$\eta = \frac{P_0}{P_{in}} \Rightarrow P_0 = 0.85 \times 18$

P_0 = 15.3 Ah

Now, P_0 = 15.3

I × 7 = 15.3

I' = 2.18A

$$R = \frac{V_T}{I'}$$

$$R = \frac{12}{2.18}$$

$$= 5.49\Omega$$

112. The longest wavelength that can be absorbed by silicon, which has the band gap of 1.12eV, is 1.1μm. If the longest wavelength that can be absorbed by another material is 0.87 μm, then the band gap of this material is approximately.

A. 1.416 eV
B. 0.886 eV
C. 2.854 eV
D. 3.706 eV

Ans. A

Sol. $\lambda_c = \frac{k}{E_g}$

Where, λ_c = Wavelength

E_g = Energy band gap

k = constant

Let, $\lambda_{c_1} = \frac{k}{E_{g_1}}$

From given data,

$$1.1\ \mu m = \frac{k}{1.12\,eV} \Rightarrow k = 1.1 \times 1.12$$

Let, $\lambda_{c_2} = \frac{k}{E_{g_2}}$

$$E_{g_2} = \frac{(1.1)(1.12)}{0.87}$$

$$= 1.416\ eV$$

113. The band gap of germanium at room temperature is

A. 2.3 eV
B. 0.7 eV
C. 1.1 eV
D. 3.4 eV

Ans. B

Sol. For germanium:

$E_G(T) = 0.785 - \beta T$

At, room temperature,

$E_G(300\ K) = 0.785 - \beta(300\ K)$

$E_G(300\ K) = 0.72\ eV$

114. Silicon is doped with boron to a concentration of 4×10^{17} atoms/cm^3. Assume the intrinsic carrier concentration of silicon to be $1.5 \times 10^{10}/cm^3$ and the value of T/q to be 25 mV at 300K. Compared to undoped silicon, the Fermi level of doped silicon.

A. goes down by 0.13 eV
B. goes up by 0.13 eV
C. goes down by 0.427 eV
D. goes up by 0.427 eV

Ans. C

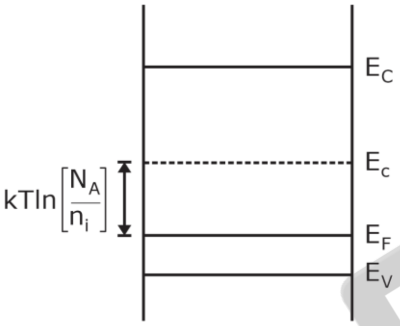
Sol. Given that,

$N_A = 4 \times 10^{17}/cm^3$

$n_i = 1.5 \times 10^{10}/cm^3$

$\frac{kT}{q} = V_T = 25$ mV

Given, dopants are p-type so, energy band near to valency band So compared to undoped silicon, in p-type semiconductor fermi level goes down.



$$E_i - E_F = kT\ln\left[\frac{4 \times 1017}{1.5 \times 10^{10}}\right]$$

= 25 meV (17.09

= 0.42 eV

115. The resistivity of a uniformly doped n-type silicon sample is 0.5Ω-cm. If the electron mobility (μ_n) is 1250 cm^2/V-sec and the chare of an electron is 1.6×10^{-19} coulomb, the donor impurity concentration (N_D) in the sample is

A. $2 \times 10^{16}/cm^3$
B. $1 \times 10^{16}/cm^3$
C. $2.5 \times 10^{15}/cm^3$
D. $2 \times 10^{15}/cm^3$

Ans. B

Sol. $\sigma = \frac{1}{e} = nq\mu_n$

$n = N_D \frac{1}{eq\mu_n}$

$= \frac{1}{0.5 \times 1.6 \times 10^{-19} \times 1250}$

$= 10^{16}$

116. A silicon sample A is doped with 10^{18} atoms/cm^3 of boron. Another sample B of identical dimensions is doped with 10^{18} atoms/cm^3 of phosphorus. The ratio of electron to hole mobility is 3. The ratio of conductivity of the sample A to that of sample B is

A. $\frac{1}{2}$

B. $\frac{1}{3}$

C. $\frac{2}{3}$

D. $\frac{1}{4}$

Ans. B

Sol. We know that,

$\sigma_p = eq\mu_p$

$\sigma_n = nq\mu_n$

Sample 'A'	Boron	p-type
Sample 'B'	Phosphorus	n-type

$$\frac{\sigma_p}{\sigma_n} = \frac{pq\mu_p}{nq\mu_n}$$

$$= \frac{\mu_p}{\mu_n} \quad (\because P = n)$$

$$\frac{\sigma_p}{\sigma_n} = \frac{1}{3} \qquad \left(\because \frac{\mu_n}{\mu_p} = 3\right)$$

117. According to the Einstein relation, for any semiconductor, the ratio of diffusion constant to mobility of carriers

A. depends upon the temperature of the semiconductor

B. depends upon the type of the semiconductor

C. varies with lifetime of the semiconductor

D. increase the velocity of the charge carries

Ans. A

Sol. According to Einstein relation

$$\frac{D_p}{\mu_p} = \frac{D_n}{\mu_n} = V_T = \frac{T}{11600}$$

From above equation, it is clear that depends upon the temperature D/μ of the semiconductor.

118. A heavily doped n-type semiconductor has the following characteristics:

Hole-electron mobility ratio: 0.4

Doping concentration: 4.2×10^8 atoms/m^3

Intrinsic concentration: 1.5×10^4 atoms/m^3

The ratio of conductance of the n-type semiconductor to that of the intrinsic semiconductor of same material and at the same temperature is given by

A. 50×10^3

B. 2×10^3

C. 10×10^3

D. 20×10^3

Ans. D

Sol. Given,

$$\frac{\mu_p}{\mu_n} = 0.4$$

$n = N_D = 4.2 \times 10^8$ atoms/m^3

$n_i = 1.5 \times 10^4$ atoms/m^3

$\sigma_i = qn\mu_n + qp\mu_p$

$= qn_i[\mu_p + \mu_n]$ $\quad (\because n = p = n_i)$

$\sigma_n = qn\mu_n \ (n >> p)$

$= qN_A\mu_n$

$$\frac{\sigma_n}{\sigma_i} = \frac{qN_A\mu_n}{qn_i\left[\mu_p + \mu_n\right]}$$

$$= \frac{4.2 \times 10^8}{1.5 \times 10^4\left[1 + \frac{\mu_p}{\mu_n}\right]}$$

$$= \frac{4.2 \times 10^8}{1.5 \times 10^4\,[1 + 0.4]}$$

$= 2 \times 10^4$

$= 20 \times 10^3$

119. A silicon bar is doped with donor impurities $N_D = 2.25 \times 10^{15}$ atoms/cm^3. Given the intrinsic carrier concentration of silicon at T = 300K is 1.5×10^{10}/cm^3. Assuming complete impurity ionization, the equilibrium electron and hole concentrations are respectively.

A. $n_0 = 1.5 \times 10^{10}$/cm^3, $p_0 = 1 \times 10^5$/cm^3

B. $n_0 = 1.5 \times 10^{10}$/cm^3, $p_0 = 1.5 \times 10^{10}$/cm^3

C. $n_0 = 2.25 \times 10^{15}$/cm^3, $p_0 = 1.5 \times 10^{10}$/cm^3

D. $n_0 = 2.25 \times 10^{15}$/cm^3, $p_0 = 1 \times 10^5$/cm^3

Ans. D

Sol. From given data,

$n_0 \approx N_D = 2.25 \times 10^{15}$/cm^3

$$P_a = \frac{n_i^2}{n_0} = \frac{(1.5 \times 10^{10})^2}{2.25 \times 10^{15}}$$

$$= \frac{2.25 \times 10^{20}}{2.25 \times 10^{15}}$$

$p_0 = 10^5$/cm^3

120. In an open-circuited step-graded junction, the left-half of the bar is p-type with a constant concentration N_A, whereas the right-half is n-type with a uniform density N_D. in this type of doping, the density changes abruptly from p-type to n-type. What is the contract different of potential V_0?

A. 1.6021×10^{-19} J

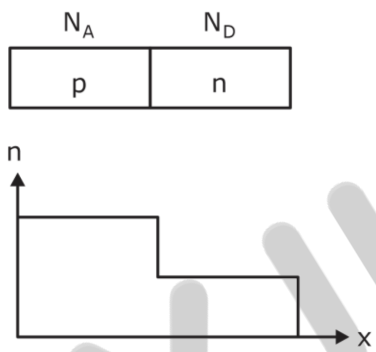
B. $V_{n_0} - V_{i_0} = V_{n_i}$

C. $V_{21} = V_0 = \ln\left(\frac{p_{p_0}}{p_{n_0}}\right)$

D. $V_0 = V_T \ln\left(\frac{N_A N_D}{n_i^2}\right)$

Ans. D

Sol.



Contact different of potential

$V_0 = V_T \ln\left[\frac{N_A N_D}{n_i^2}\right]$

121. By considering standard notations, in VCO, the centre frequency is

A. $f_0 = 2\frac{V_+ + V_C}{V_+ R_1 C_1}$

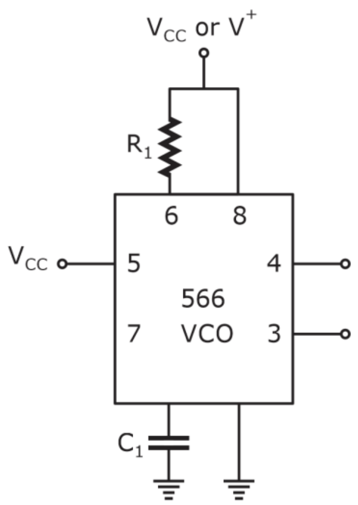
B. $f_0 = 4\frac{V_+ + V_C}{V_+ R_1 C_1}$

C. $f_0 = 4\frac{V_+ - V_C}{V_+ R_1 C_1}$

D. $f_0 = 2\frac{V_+ - V_C}{V_+ R_1 C_1}$

Ans. D

Sol.



$$f_0 = \frac{2}{R_1C_1}\left[1 - \frac{V_c}{V_+}\right]$$

$$f_0 = \frac{2}{R_1C_1}\left[\frac{V_+ - V_c}{V_+}\right]$$

D option is correct.

122. According to the properties of intrinsic semiconductors at room temperature, the intrinsic resistivity of germanium is

A. 25 Ω-m

B. 35 Ω-m

C. 45 Ω-m

D. 55 Ω-m

Ans. C

123. In Auger Recombination Process, recombination in an n-type semiconductor involves the interaction of

A. two electrons and one hole

B. one electron and one hole

C. two holes and one electron

D. two holes and three electrons

Ans. C

124. In reduction in noise and nonlinear distortion, additional stages are used to bring the overall gain up to the level

A. without feedback, and introduce as much noise back into the system as that reduced by the feedback amplifier.

B. with feedback, and introduce as low noise back into the system as that reduced by the feedback amplifier.

C. without feedback, and introduce as low noise back into the system as that reduced by the feedback amplifier

D. with feedback, and introduce as much noise back into the system as that reduced by the feedback amplifier

Ans. B

Sol. Due to negative feedback there is reduction is noise and non-linear distortion but gain reduces. To maintain gain additional stage are used.

125. The failure of the transistor to respond to the trailing edge of the driving pulse is due to

A. accumulation charge of excess minority carriers stored in the collector.

B. saturation charge of excess majority carriers stored in the base.

C. saturation charge of excess minority carriers stored in the base.

D. recombination charge of carriers stored in the collector.

Ans. C

126. By considering standard notations, for a depletion MOSFET, the SPICE parameter LAMBDA value is

A. $\frac{3}{V_A}$

B. $\frac{2}{3V_A}$

C. $\frac{1}{2V_A}$

D. $\frac{1}{V_A}$

Ans. D

127. The Nyquist criterion for stability states that an amplifier is unstable if the Nyquist curve encloses the −1+j0 point, and the amplifier is stable if the curve does not enclose this point. If $A\beta$.

A. extends outside this circle, the feedback is negative

B. lies within this circle, then $|1 + A\beta| < 1$, and the feedback is negative

C. does not enclose the point $-1 + j0$, i.e., $|1 + A\beta| > 1$, then the amplifier is unstable and the feedback is negative for all frequencies

D. extends inside this circle, the feedback is negative

Ans. *

128. Coulomb blockade can be readily observed when the single electron charging energy is larger than

A. the broadening r and larger than kT

B. the lowering r and larger than kT

C. the broadening r and smaller than kT

D. the broadening r and smaller than kT

Ans. A

Sol. Coulomb blockade can be readily observed when single electron charging energy is larger than broadening r and also large than kT.

129. The switching point of the SCR is controlled by the values of the two power supply resistances R_S and R_w. Adding more tub ties

A. equates the values of R_S and R_w

B. reduces the values of R_S and R_w

C. reduces the values of R_S and $R_w/2$

D. equates the values of R_S and $R_w/4$

Ans. B

130. A coil consists of 1000 turns of copper wire having a cross-sectional area of 0.8 mm^2. The means length per turn is 80 cm and the resistivity of copper is 0.02 $\mu\Omega$-m. What are the values of resistance of the coil and power absorbed by the coil when connected across 100V DC supply respectively?

A. 20 Ω and 250 W

B. 40 Ω and 250 W

C. 20 Ω and 500 W

D. 40 Ω and 500 W

Ans. C

Sol. N = 1000

$A = 0.8\ mm^2$

L = 80 cm

$\rho = 0.02\mu\Omega\text{-m}$

$$R = N\left(\frac{\rho L}{A}\right)$$

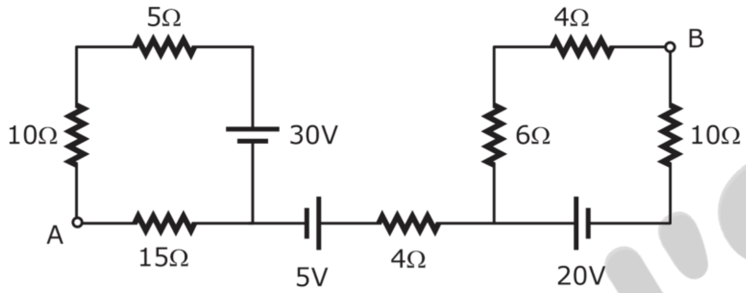
$$= \frac{0.02 \times 10^{-6} \times 80 \times 10^{-2}}{0.8 \times 10^{-6}} \times 1000$$

$= 20\Omega$

$$P = \frac{V^2}{R} = \frac{100^2}{20}$$

$= 500$ W

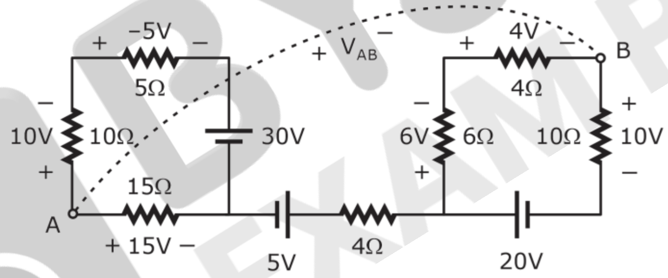
131. What is the value of voltage between points A and B of the network shown in the figure?



A. 15 V
B. 30 V
C. – 30 V
D. – 15 V

Ans. B

Sol.

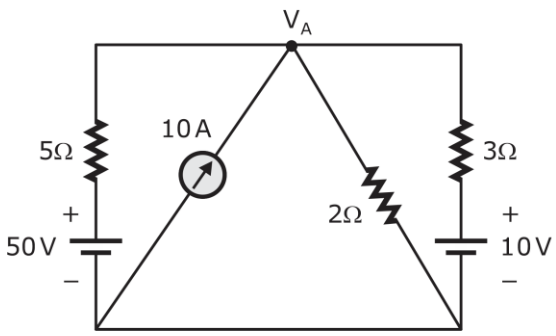


Apply KVL we get,

$V_{AB} + 10 - 20 - 5 - 15 = 0$

$V_{AB} = 40 - 10 = 30V$

132. What is the value of voltage at node V_A shown in the network below?



A. 21.65 V
B. 22.65 V
C. – 21.65 V
D. – 22.65 V

Ans. B

Sol. Apply KCL at node (V_A)

$$\frac{V_A - 50}{5} - 10 + \frac{V_A}{2} + \frac{V_A - 10}{3} = 0$$

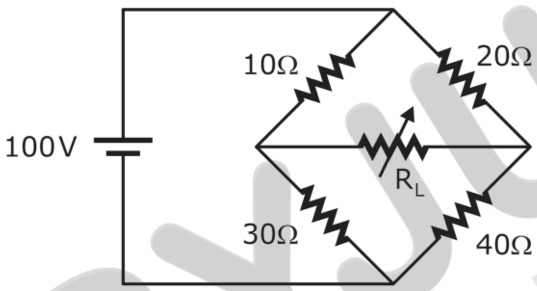
$$\frac{V_A}{5} + \frac{V_A}{2} + \frac{V_A}{3} = 20 + \frac{10}{3}$$

$$6V_A + 15V_A + 10V_A = \frac{70}{3} \times 30$$

$$V_A = \frac{70 \times 30}{3 \times 31}$$

V_A = 22.58 Volts

133. What is the value of resistance R_L in the circuit shown in the figure to deliver maximum power from the source to load?



A. 22.83 Ω

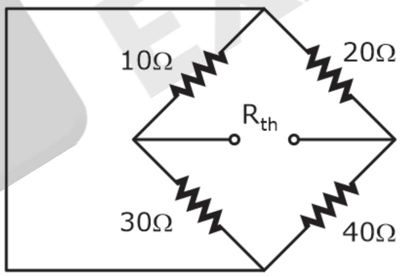
B. 20.83 Ω

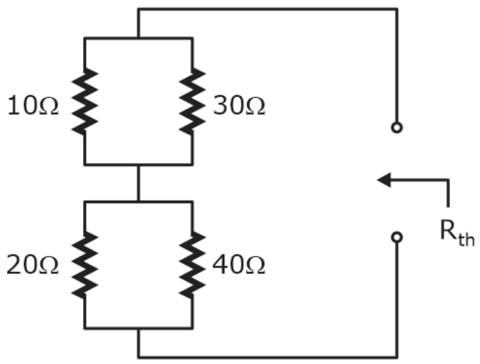
C. 18.83 Ω

D. 16.83 Ω

Ans. B

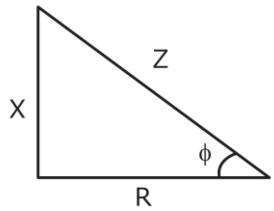
Sol. Finding R_{th}





$$R_{th} = 10 \parallel 30 + 20 \parallel 40 = \frac{300}{40} + \frac{800}{60} = 20.83\Omega$$

134. From the impedance triangle of an R-L series circuit fed with single-phase voltage, what is the value of power factor of the circuit?



A. $\left(\frac{X}{Z}\right)$ lagging

B. $\left(\frac{R}{X}\right)$ lagging

C. $\left(\frac{R}{Z}\right)$ lagging

D. $\left(\frac{X}{Z}\right)$ leading

Ans. C

Sol. Power factor = $\cos\phi = \frac{R}{Z}$

The series RL circuit power factor can be lagging. Therefore, option C is correct.

135. A coil consists of 750 turns and a current of 10A in the coil gives rise to a magnetic flux of 1200μWb. What are the inductance of the coil and the average e.m.f. induced in the coil when this current is reversed in 0.01 second respectively?

A. 0.09 H and 180 V

B. 0.09 H and 90 V

C. 0.18 H and 90 V

D. 0.18 H and 180 V

Ans. B

Sol. Inductance, $L = \frac{N\phi}{I}$

$$L = \frac{750 \times 1200 \times 10^{-6}}{10} = 0.09H$$

$$E = N\frac{d\phi}{dt}$$

$$= \frac{750 \times (2 \times 1200 \times 10^{-6})}{0.01}$$

$$= 90V$$

136. In a physical diode, there is a component of the revers saturation current due to leakage over the surface. The reverse saturation current increases approximately 7 percent/°C for both silicon and germanium. The relationship between T and V in V-I characteristics:

A. T increases and V decreases

B. V decreases and T increases

C. T and V both increases

D. T and V both decreases

Ans. A

137. Which of the following is correct related to properties of good insulating material?

A. Having high dielectric strength, very low dissipation factor and high operating temperature limit.

B. Having low dielectric strength, very low dissipation factor and high operating temperature limit.

C. Having high dielectric strength, very high dissipation factor and low operating temperature limit.

D. Having low dielectric strength, very high dissipation factor and low operating temperature limit.

Ans. A

Sol. The insulating material should have the following properties.

High insulation resistance i.e. high resistivity.

High dielectric strength

Low permittivity

High mechanical strength

Non-hygroscopic i.e., it should not absorb moisture from air or soil

Non-inflammable

Unaffected by acids and alkalis

The electrical and chemical properties of the material should not be affected by the temperature.

138. What one of the following statements I correct related to long range order in ferromagnets?

A. A magnetic field of about 1 T can be produced in annealed iron with an external field of about 0.0002T, a multiplication of the external field by a factor of 5000.

B. A magnetic field of about 1 T can be produced in annealed iron with an external field of about 0.0005 T, a multiplication of the external field by a factor of 2000.

C. A magnetic field of about 1 T can be produced in annealed iron with an external field of about 0.0005 T, a multiplication of the external field by a factor of 5000.

D. A magnetic field of about 1 T can be produced in annealed iron with an external field of about 0.0002 T, a multiplication of the external field by a factor of 2000.

Ans. A

Sol. We know that,

$B = \mu_0\mu_r H$

Case-I:

Given,

B = IT and $\mu_0 H = 0.0002T$

Multiplication factor

$$\mu = \frac{B}{\mu_0 H}$$

$$= \frac{1T}{0.0002T}$$

$= 5000$

139. Relative static error (ε_r) is

A. $\frac{\text{absolute error}}{2 \times \text{ true value}}$

B. $\frac{2 \times \text{ absolute error}}{\text{true value}}$

C. $\frac{\text{absolute error}}{\text{true value}}$

D. absolute error × true value

Ans. C

Sol. Static error = Measured value – True value

or

Absolute error = $A_m - A_t$

Relative error (ε_r)

or

$$\text{Relative static error } (\varepsilon_r) = \frac{\text{Absolute error}}{\text{True value}}$$

$$= \frac{A_m - A_t}{A_t}$$

140. In order to eliminate the effect on temperature variables open the length of the spring.

A. two springs coiled in opposite direction are used

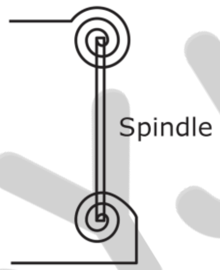
B. three springs coiled are added in the same direction

C. two spring coiled in same and other two in opposite directions are used

D. two spring coiled in same directions are used

Ans. A

Sol. To eliminate temperature variables in spring's and to get good control torque, we use two springs at top and bottom in opposite direction as shown below.



141. A variation in the ambient humidity causes a variation in the resistance of the element that is usually mixture of

A. a hygroscopic salt, for example, lithium chloride and carbon on an insulating substrate between metal electrodes

B. a hygroscopic salt, for example, lithium hydroxide and aluminium on an insulating substrate between metal electrodes

C. a hygroscopic salt, for example, lithium chloride and silicon on an insulating substrate between metal electrodes

D. a hygroscopic salt, for example, lithium chloride and nickel on an insulating substrate between metal electrodes

Ans. C

142. The typical range of dissipation factor (D) of capacitor is

A. 0.2 for electrolytic capacitors to less than 10^{-2} for capacitors with a plastic film dielectric

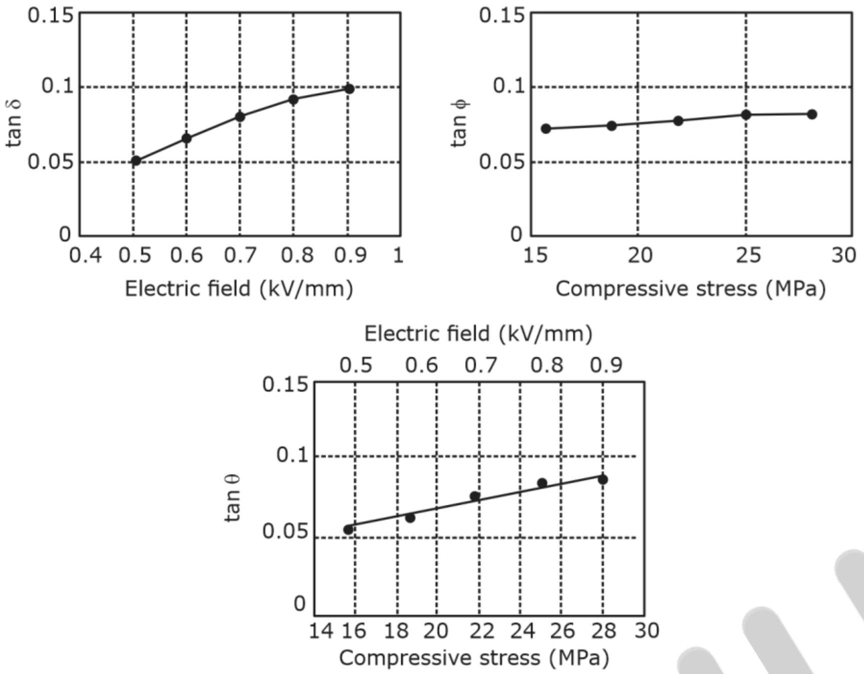
B. 0.1 for electrolytic capacitors to less than 10^{-4} for capacitors with a plastic film dielectric

C. 0.5 for electrolytic capacitors to less than 10^{-5} for capacitors with a plastic film dielectric

D. 0.4 for electrolytic capacitors to less than 10^{-3} for capacitors with a plastic film dielectric

Ans. B

Sol.



143. Match the following lists:

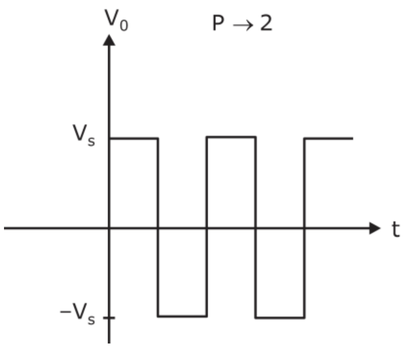
List-I		List-II	
P.	Square wave	1.	Less harmonics
Q.	Triangular wave	2.	Made up of fundamental frequency plus an infinite number of odd harmonics
R.	Two waveforms deliver same power to identical resistors	3.	RMS voltages must be the same

Select the correct answer using the code given below.

	P	Q	R
A.	2	1	3
B.	3	1	2
C.	2	3	1
D.	1	2	3

Ans. A

Sol.



$V_0 \sum_{n=1,3,5}^{\infty} \frac{\mu V_s}{n\pi} \sin(n\omega t)$

$Q \rightarrow 1$

$R \rightarrow 3$

144. One of the advantages of Ayrton shunt is that it eliminates the possibility of the meter movement being in the circuit

A. with limited shunt resistance

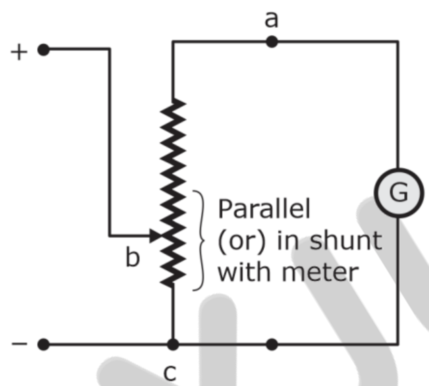
B. without any series resistance

C. without minimum series resistance

D. with minimum series resistance

Ans. A

Sol. Ayrton shunt:



ab > > bc

i.e., ab resistance is in series with galvanometer and bc resistance is in parallel with the meter +ab.

So, most of the current passes through bc (low) resistance and very low (or) almost negligible current flows through galvanometer, which doesn't results in deflection of galvanometer.

145. The Poisson's ratio for most metals lies

A. in the range of 0.05 to 0.15

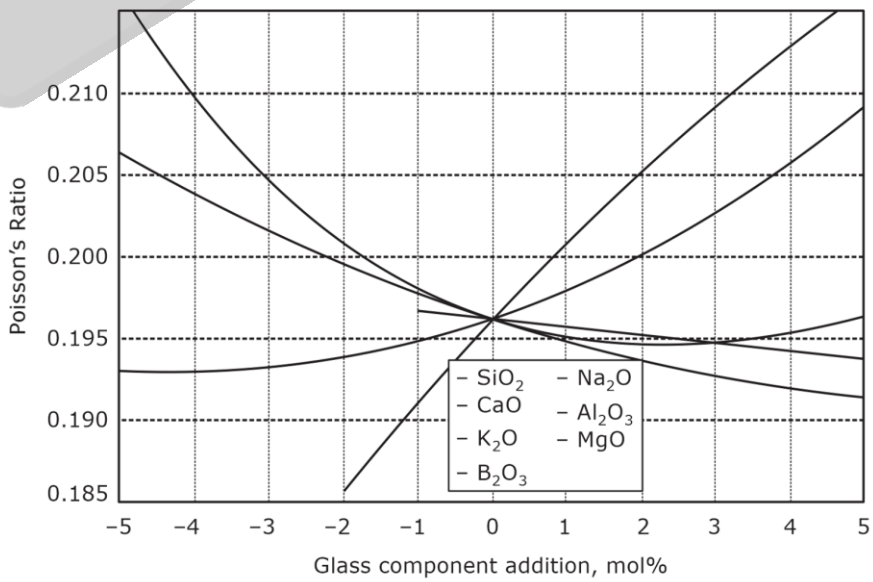
B. in the range of 0.15 to 0.25

C. in the range of 0.35 to 0.45

D. in the range of 0.25 to 0.35

Ans. *

Sol.



146. The relation among minimum detectable single (MDS), IF bandwidth (BW) and noise figure (NF) of a spectrum analyzer is

A. MDS = –125 dBm + 10 log (BW/4 MHz) + NF

B. MDS = –100 dBm + 10 log (BW/2 MHz) + NF

C. MDS = –114 dBm + 10 log (BW/1 MHz) + NF

D. MDS = –110 dBm + 10 log (BW/3 MHz) + NF

Ans. C

147. In the design of Digital IIR Filters by means of Bilinear Transform, the design specifications are given. Match the following lists:

List-I		**List-II**	
P.	N and Δf fixed	1.	The design procedure has to start with the evaluation of the order of the filter necessary to meet the specifications in terms of the desired attenuation, transition bandwidth and pass-band deviation.
Q.	Δf and δ fixed	2.	The filter is completely specified and the transition bandwidth is directly obtainable during the design procedure.
R.	N and δ fixed	3.	The design is completely determined for the Butterworth filter case by obtained the value of the attenuation at f_a directly.

Select the correct answer using the code given below.

	P	Q	R
A.	2	3	1
B.	3	2	1
C.	1	2	3
D.	3	1	2

Ans. D

148. In a rosette gauge, the angle between any two longitudinal gauge axes is

A. 45°

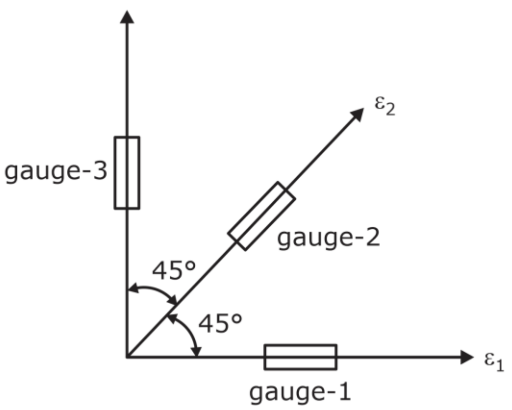
B. 60°

C. 70°

D. 85°

Ans. A

Sol.



The angle between any two guage axes is 45° i.e., ε_1 and ε_2 (or) ε_2 and ε_3

149. A chopper-stabilized amplifier circuit eliminates the effects of

A. DC offset voltages and the drift currents only

B. DC offset voltages only

C. DC offset currents and the drift of other DC parameters by using an AC-coupled amplifier

D. The drift of other AC parameters by using a DC-coupled amplifier only

Ans. *

150. The inductance of a 25 A electrodynamic ammeter changes uniformly at the rate of 0.0035 mH/radian. The spring constant is 10^{-6} N-m/radian. What is the angular deflection at full scale approximately?

A. 420° B. 210°

C. 250° D. 125°

Ans. D

Sol. At steady state $T_c = T_d$

$T_c = k_c\theta$ and $t_d = i^2 \cdot \frac{dM}{d\theta}$ [for EMMC]

Now, $k_c\theta = i^2 \cdot \frac{dM}{d\theta}$ $\begin{bmatrix} \frac{dm}{d\theta} = \frac{0.0035\,mH}{Radian} \\ k_c = 1 \times 10^{-6} \text{ N-m/radian} \end{bmatrix}$ given

$$(1 \times 10^{-6})\,\theta = \frac{(25)^2 \times 0.0035 \times 10^{-3}}{\frac{\pi}{180^\circ}}$$

$$\theta = \frac{625 \times 0.0035 \times 10^{-3}}{1 \times 10^{-6} \times \frac{\pi}{180^\circ}} = 125334.1°$$

Note: If $\frac{dM}{d\theta}$ is given as 0.0035 μH/radian, then the answer would lead to 125.33°

***

Answer Key

Set-B

Q. No.	Answer	Q. No.	Answer	Q. No.	Answer	Q. No.	Answer
1.	A	26.	D	51.	A	76.	A
2.	C	27.	*	52.	C	77.	*
3.	C	28.	A	53.	B	78.	C
4.	D	29.	C	54.	A	79.	C
5.	C	30.	*	55.	A	80.	B
6.	B	31.	B	56.	A	81.	C
7.	A	32.	D	57.	A	82.	B
8.	C	33.	C	58.	A	83.	C
9.	C	34.	A	59.	D	84.	B
10.	C	35.	C	60.	D	85.	C
11.	D	36.	C	61.	C	86.	B
12.	B	37.	C	62.	A	87.	D
13.	*	38.	C	63.	B	88.	C
14.	D	39.	D	64.	D	89.	B
15.	D	40.	A	65.	A	90.	D
16.	C	41.	D	66.	A	91.	A
17.	C	42.	C	67.	C	92.	B
18.	B	43.	A	68.	A	93.	A
19.	A	44.	B	69.	B	94.	C
20.	C	45.	C	70.	A	95.	D
21.	B	46.	C	71.	C	96.	B
22.	C	47.	B	72.	D	97.	A
23.	A	48.	D	73.	D	98.	A
24.	A	49.	A	74.	C	99.	B
25.	C	50.	C	75.	D	100.	A

Q. No.	Answer	Q. No.	Answer
101.	A	126.	D
102.	A	127.	*
103.	B	128.	A
104.	B	129.	B
105.	C	130.	C
106.	B	131.	B
107.	C	132.	B
108.	A	133.	B
109.	B	134.	C
110.	A	135.	B
111.	B	136.	A
112.	A	137.	A
113.	B	138.	A
114.	C	139.	C
115.	B	140.	A
116.	B	141.	C
117.	A	142.	B
118.	D	143.	A
119.	D	144.	A
120.	D	145.	*
121.	D	146.	C
122.	C	147.	D
123.	C	148.	A
124.	B	149.	*
125	C	150.	D

ESE EC Prelims Previous Year's Cut off

S. No.	Year	General	EWS	OBC	SC	ST
1.	**2023**	180-190	175-185	180-190	150-160	160-170
2.	**2022**	184	184	184	158	169
3.	**2021**	208	200	208	202	155
4.	**2020**	245	226	245	205	202
5.	**2019**	226	NA	221	176	165
6.	**2018**	213	NA	206	173	155
7.	**2017**	221	NA	205	167	171

Our Outstanding GATE Results

100+
Students under AIR-100
2021

Rank 02
Poojasree (EC)

Rank 03
Manoj (EC)

Rank 03
Munish (ME)

Rank 06
Parag (EC)

Rank 07
Vatsal (ME)

Rank 08
Rahul (CE)

Rank 08
Hemant (EE)

Rank 08
Rajat (ME)

Rank 09
Vamsi (EC)

Rank 13
Shashwat (CE)

50+
Students under AIR-100
2020

Rank 06
Ghanendra (EC)

Rank 09
Avinash (ME)

Rank 09
Himanshu (EE)

Rank 26
Kartikay (CE)

Rank 30
Raja (EC)

Rank 39
Akash Singh (CS)

Rank 39
Navneet (CS)

Rank 54
Rishi (EE)

Rank 56
Apurv Mittal (ME)

Rank 56
Nikhil (ME)

Our Success Stories

Our Outstanding GATE Results

80+
Students under AIR-100
2022

Rank 01
Ram (EC)

Rank 02
Amit (CE)

Rank 02
Vandit (EE)

Rank 03
Parvinder (ME)

Rank 06
Abhishek (ME)

Rank 06
Vivek (CE)

Rank 08
Kiran (CS)

Rank 09
Shivam (EC)

Rank 09
Tushar (EE)

Rank 10
Mitesh (CS)

Rank 11
Kaustav (ME)

Rank 11
Souvik (ME)

Rank 12
Himanshu (CE)

Rank 15
Surya (CS)

Rank 18
Swastik (CE)

Rank 20
Lakshay (ME)

Rank 21
Tathagata (CS)

Rank 22
Ayush (CE)

Rank 29
Piyush (EE)

Rank 38
Rajat (EE)