ESE 2023 Preliminary Examination

Detailed Solutions

ELECTRONICS & TELECOMMUNICATION ENGINEERING

Set B

Exam held on 19-02-2023

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Electronics & Telecom Engg. Paper Analysis of ESE 2023 Preliminary Examination

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UPSC ESE Prelims 2023
Electronics & Telecom Engg. analysis
by **MADE EASY faculties**
https://www.youtube.com/watch?v=FqI8mxOXV0U

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 $E \times H$.

Ans. (a)

Magnetic vector potential, $\bar{A}$

From Maxwell's equation, $\nabla \cdot \bar{B} = 0$ ...(i)

From Null identity, $\nabla \cdot (\nabla \times \bar{A}) = 0$ ...(ii)

$\therefore$ From (i) and (ii)

$$\bar{B} = \nabla \times \bar{A}$$

End of Solution

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

Given, $\bar{A} = \dfrac{-\rho^2}{4} \hat{a}_z$

As we know that,

Magnetic flux, $\psi_m = \int \bar{B} \cdot \overline{dS}$

$\Rightarrow \psi_m = \int (\nabla \times \bar{A}) \cdot \overline{dS}$ $[\because \bar{B} = \nabla \times \bar{A}]$

Hence,
$$\nabla \times \bar{A} = \frac{1}{h_1 h_2 h_3} \begin{vmatrix} h_1 \hat{a}_u & h_2 \hat{a}_v & h_3 \hat{a}_w \\ \dfrac{\partial}{\partial u} & \dfrac{\partial}{\partial v} & \dfrac{\partial}{\partial w} \\ h_1 A_u & h_2 A_v & h_3 A_w \end{vmatrix}$$

For cylindrical co-ordinate system:
$$h_1\ h_2\ h_3 = |\rho|$$

$\therefore$
$$\nabla \times \bar{A} = \frac{1}{\rho} \begin{vmatrix} \hat{a}_\rho & \rho \hat{a}_\phi & \hat{a}_z \\ \dfrac{\partial}{\partial \rho} & \dfrac{\partial}{\partial \phi} & \dfrac{\partial}{\partial z} \\ 0 & 0 & -\dfrac{\rho^2}{4} \end{vmatrix}$$

$$= \frac{1}{\rho}\left[\frac{\partial}{\partial\rho}\left(-\frac{\rho^2}{4}\right)\right](-\rho\hat{a}_\phi)$$

$$= \frac{2\rho}{4}\hat{a}_\phi = \frac{\rho}{2}\hat{a}_\phi$$

$\therefore$ $$\psi_m = \int \frac{\rho}{2}\hat{a}_\phi \cdot \overline{dS};\quad \overline{dS} = d\rho dz\hat{a}_\phi$$

Hence, $$\psi_m = \int_S \frac{\rho}{2} d\rho dz$$

$$= \frac{1}{2}\int_{\rho=1}^{2} \rho d\rho \int_{z=0}^{5} dz$$

$$= \frac{1}{2}\cdot\frac{\rho^2}{2}\Big|_1^2 \cdot z\Big|_0^5$$

$$= \frac{1}{2}\cdot\frac{3}{2}\cdot 5 = \frac{15}{4} = 3.75 \text{ Wb}$$

End of Solution

3. A vector $\vec{P}$ is given by $\vec{P} = x^3\overrightarrow{a_x} - x^2y^2\overrightarrow{a_y} - x^2yz\overrightarrow{a_z}$. 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)

Given, $$\bar{P} = x^3\hat{a}_x - x^2y^2\hat{a}_y - x^2yz\,\hat{a}_z$$

(i) For solenoid, $$\nabla\cdot\bar{P} = 0$$

$\therefore$ $$\nabla\cdot\bar{P} = 3x^2 - 2x^2y - x^2y = 3x^2 - 3x^2y \neq 0$$

(ii) For irrotational,

$$\nabla\times\bar{P} = 0$$

$\therefore$ $$\nabla\times\bar{P} = \begin{vmatrix} \hat{a}_x & \hat{a}_y & \hat{a}_z \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ x^3 & -x^2y^2 & -x^2yz \end{vmatrix}$$

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

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

End of Solution

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)

Given data $E|_{\text{surface}} = 2$ V/m

As we know that

$$D_n = \rho_s$$

$$\Rightarrow \quad \rho_S = \varepsilon E = \varepsilon_0 \varepsilon_r E$$

$$\Rightarrow \quad \rho_S = 8.85 \times 10^{-12} * 80 * 2 = 1.41 * 10^{-9} \text{ c/m}^2$$

End of Solution

5. If the electric field intensity is 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)

Given that, $\bar{E} = x\hat{u}_x + y\hat{u}_y + z\hat{u}_z$

As we know that

$$V_X - V_Y = -\int_Y^X \bar{E} \cdot \overline{dl} = -\int_{1,2,3}^{2,0,0} \bar{E} \cdot \overline{dl}$$

Here, $\bar{E} = x\hat{u}_x + y\hat{u}_y + z\hat{u}_z$

$$\overline{dl} = dx\,\hat{u}_x + dy\,\hat{u}_y + dz\,\hat{u}_z$$

$$\therefore \quad \bar{E} \cdot \overline{dl} = x dx + y dy + z dz$$

So, $$V_X - V_Y = -\int_{1,2,3}^{2,0,0} x\,dx + y\,dy + z\,dz$$

$$= -\int_{x=1}^{2} x\,dx - \int_{y=2}^{0} y\,dy - \int_{z=3}^{0} z\,dz$$

$$= -\frac{x^2}{2}\Big|_1^2 - \frac{y^2}{2}\Big|_2^0 - \frac{z^2}{2}\Big|_3^0$$

$$= -\frac{3}{2} + \frac{4}{2} + \frac{9}{2} = 5 \text{ V}$$

End of Solution

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

(a) 16.42
(b) 18.02
(c) 20.42
(d) 22.02

Ans. (b)

$$D = G_d(\theta, \phi)|_{max} = \frac{4\pi U(\theta,\phi)|_{max}}{P_{rad}}$$

Now, $U(\theta, \phi) = r^2 P_{avg} = r^2 \cdot \frac{E^2}{2\eta}$

$\Rightarrow$ $U(\theta, \phi) \propto E^2 \equiv F^2(\theta)$

$\Rightarrow$ $U(\theta, \phi) = \cos^8 \theta$

$\therefore$ $U(\theta,\phi)|_{max} = 1$

Now, $P_{rad} = \int U(\theta, \phi) d\Omega$

$= \int \cos^8 \theta \cdot \sin\theta d\theta d\phi$

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

Let $\cos \theta = t \Rightarrow -\sin \theta \, d\theta = dt$

$\therefore$ at $\theta = 0°$, $t = 1$

at $\theta = \pi/2$, $t = 0$

So, $P_{rad} = -\int_1^0 t^8 dt \cdot 2\pi = \left.\frac{t^9}{9}\right|_0^1 \cdot 2\pi = 0.698$

Hence, $D = \frac{4\pi * 1}{0.698} \equiv 18$

$\therefore$ $D = 18$

End of Solution

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 $\theta = 0$ or π. For an isotropic antenna, $G_d(\theta, \phi) = 1$. 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. (c)

End of Solution

8. Consider a parallel-plate capacitor, each of the plates ha 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) $-\dfrac{Q}{\varepsilon S}a_x$
(b) $\dfrac{Qd}{\varepsilon S}$
(c) $\dfrac{1}{2C}Q^2$
(d) $\dfrac{1}{2}Q \cdot C$

Ans. (c)

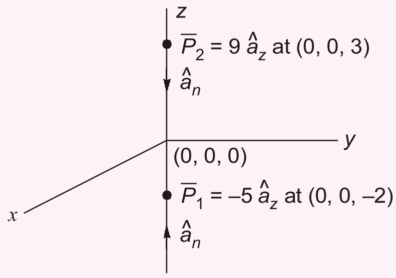
End of Solution

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) –18.25 V

Ans. (c)

Potential due to dipole is given as



$$V = \frac{K\bar{p}.\hat{a}_n}{r^2};\ K = \frac{1}{4\pi \epsilon_0} = 9 \times 10^9 \text{ F/m}$$

For dipole - (1), $\bar{P}_1$:

$$V_1 = \frac{9\times 10^9 \times -5\times 10^{-9}(\hat{a}_z.\hat{a}_z)}{(2)^2} = -11.25 \text{ V}$$

For dipole - (2) $\bar{P}_2$:

$$V_2 = \frac{9\times 10^9 \times 9\times 10^{-9}(\hat{a}_z(-\hat{a}_z))}{(3)^2} = -9 \text{ V}$$

$\therefore$ $$V = V_1 + V_2 = -11.25 - 9 = -20.25 \text{ V}$$

End of Solution

10. If $\nabla \cdot D = \varepsilon \nabla \cdot E$ and $\nabla \cdot J = \sigma \nabla \cdot E$ 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. (b)

$\nabla . \bar{D} = \nabla . \epsilon \bar{E} = \epsilon \nabla . \bar{E} \quad \Rightarrow \quad \bar{D} \propto \bar{E}$; Linear

$\nabla . \bar{J} = \nabla . \sigma \bar{E} = \sigma \nabla . \bar{E} \quad \Rightarrow \quad \bar{J} \propto \bar{E}$; Linear

As ϵ, σ does not depends on space i.e. uniform in space hence, it is homogeneous medium.
So, medium is linear and homogeneous.

End of Solution

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)
For mobile satellite service we use *L* band (1-2 GHz).
For fixed satellite service we use *C* band (4-8 GHz)
For broadcast satellite service we use Ku and K band
Ku – 12.5 – 18 GHz
Ku – 18 – 26.5 GHz

End of Solution

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)
AMPS is a analog cellular phone system, using FDMA only.
D-AMPS is a digital cellular phone system using TDMA and FDMA.
GSM is a digital cellular phone system using TDMA and FDMA.

End of Solution

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. (d)

With zero input, output of op-amp is non-zero is because of input offset voltage. Asymmetries between the internal circuits produces non zero output at op-amp without any input and this can be reduce by connecting the slider of the potentiometer to V_{CC}.

End of Solution

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)

End of Solution

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

(a) a definite minimum and this minimum shifts to longer wavelengths as the temperature decreases.
(b) a definite minimum and this minimum shifts to shorter wavelengths as the temperature increases.
(c) a definite 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)

End of Solution

16. The VSWR can have any value between

(a) 0 and 1
(b) –1 and 1
(c) 1 and ∞
(d) 0 and ∞

Ans. (c)

$$S = \frac{1+|\Gamma|}{1-|\Gamma|}$$

At $|\Gamma| = 0, \quad S = 1$

At $|\Gamma| = 1, \quad S = \infty$

$\therefore$ Range of S : $1 \le S \le \infty$

End of Solution

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)

For $H_z = 0$, $E_z \neq 0$

It is TM - mode.

End of Solution

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 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)

End of Solution

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)

D_3	D_2	D_1	D_0	X	Y
0	0	0	1	0	0
0	0	1	X	0	1
0	1	X	X	1	0
1	X	X	X	1	1

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

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

End of Solution

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)

End of Solution

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)
Two half adders and 4 two input AND gates.

End of Solution

22. For a binary half subtracter 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) $D = \bar{A}B + A\bar{B}, X = \bar{A}B$
(d) $D = AB + \bar{A}B, X = A\bar{B}$

Ans. (c)

A	B	Borrow(X)	Diff(D)
0	0	0	0
0	1	1	1
1	0	0	1
1	1	0	0

Diff = $\bar{A}B + A\bar{B}$ and $X = \bar{A}B$

End of Solution

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)

End of Solution

24. Each cell of a static random access memory contains
(a) six MOS transistors.
(b) four MOS transistors and four capacitors.
(c) two MOS transistors and four capacitors.
(d) one MOS transistor and one capacitor.

Ans. (a)
Six MOS transistors.

End of Solution

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
```

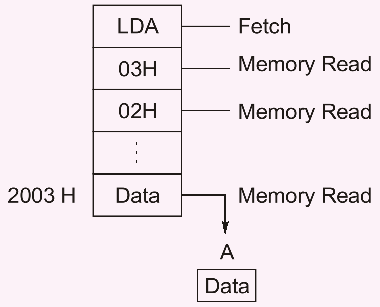
The contents of the stack pointer (SP) and the HL register pair on completion of execution of these instructions are
(a) SP = 27FF H and HL = 1003 H
(b) SP = 27FD H and HL = 1003 H
(c) SP = 27FF H and HL = 1006 H
(d) SP = 27FD H and HL = 1006 H

Ans. (c)
LXI SP, 27FFH ; [SP] = 27FFH
CALL 1006H;
(1) Stack $\leftarrow$ [PC] i.e., stack $\leftarrow$ 1006 H
$\therefore$ [SP] $\leftarrow$ [SP] – 2
(2) [PC] $\leftarrow$ 1006 H i.e., subroutine address into 'PC'
POP H : Data @ Top of Stack memory i.e.,
2 bytes accessed into 'HL' pair and [SP] $\leftarrow$ [SP] + 2
$\therefore$ 'SP' content is unchanged and 'HL' pair contains 1006H.

End of Solution

26. The total number of memory accesses involved when an 8085 processor executes the instruction LDA 2003 H is
(a) 1
(b) 2
(c) 3
(d) 4

Ans. (d)
LDA 2003H $\rightarrow$ 3B Instruction
Load accumulator with the content @ 2003H



∴ FRRR → 4 Memory accesses

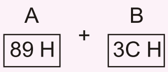
27. The contents of register (B) and accumulator (A) of an 8085 microprocessor are 3C H and 89 H respectively. The contents of A and the status of carry flag (CY) and sign flag (S) after executing SUB B instructions are

(a) $A = C5$ H, $CY = 1$, $S = 1$ (b) $A = 5C$ H, $CY = 1$, $S = 1$

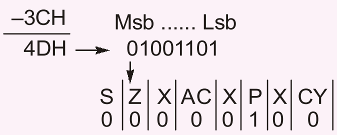
(c) $A = C5$ H, $CY = 0$, $S = 1$ (d) $A = 5C$ H, $CY = 0$, $S = 1$

Ans. (*)

In appropriate options:



SUB B: [ACC] ← [ACC] – [B]



$Cy \rightarrow 0$; No borrow

$S \rightarrow 0$; sign flag

$$ACC = 4DH$$

$$A - B = A + (-B)$$

Microprocessor performs subtraction using 2's complement method.

End of Solution

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

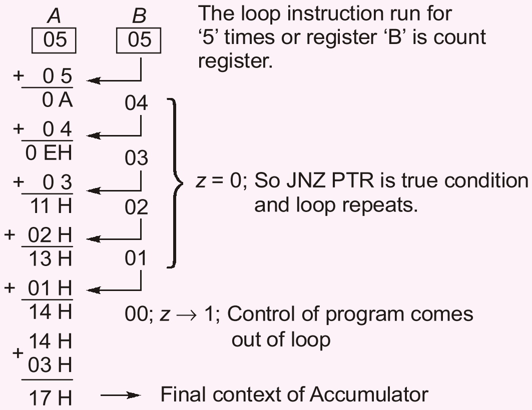
```
      MVI A, 05 H
      MVI B, 05 H
PTR:  ADD B
      DCR B
      JNZ PTR
      ADI 03 H
         HLT
```

At the end of the program, accumulator contains

(a) 17 H (b) 20 H

(c) 23 H (d) 05 H

Ans. (a)



End of Solution

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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 seconds
(c) 0.005 second
(d) 6000 seconds

Ans. (c)

$$\frac{1}{NT_s} \leq 200$$

$$\Rightarrow \quad NT_s \geq \frac{1}{200}$$

$$\Rightarrow \quad NT_s \geq 0.005$$

End of Solution

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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. (*)

$$\Rightarrow \quad y(n) = u(-n) + (0.5)^n\, u(n)$$

$$\Downarrow$$

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

Now, $$X(z) = \frac{Y(z)}{H(z)} = \left[\frac{2z-0.5-z^2}{(1-z)(z-0.5)}\right] 2\left[\frac{z^{-2}-4.5z^{-1}+5}{z^{-1}}\right]$$

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

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

$$= \frac{(2z-0.5-z^2)}{(1-z)(z-0.5)}\cdot\frac{2(z-0.5)(5z-2)}{z}$$

$$= \frac{(2z-0.5-z^2)(10z-4)}{z(1-z)}$$

$$X(z) = \frac{24z-13+2z^{-1}-10z^2}{(1-z)} \quad ; \quad \text{ROC}: |z|<1$$

Because $x(n)$ should be left-sided signal so that $y(n)$ would become both-sided. So, all options are wrong.

End of Solution

31. A second-order system has a closed loop transfer function given by $G(s) = \dfrac{25}{s^2+8s+25}$. 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)

Comparing with standard 2nd order system,

we have $\omega_n = 5$ rad/sec

and $\xi = 0.8$ ..... Underdamped system

∴ The settling time for 5% band in tolerance error is given as,

$$t_s = \frac{3}{\xi\omega_n}$$

$$t_s = \frac{3}{4}\text{ sec}$$

End of Solution

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

(a) $\dfrac{2}{(s+2)(s+\sqrt{3})}$ (b) $\dfrac{1}{s^2+2s+1}$

(c) $\dfrac{3}{s^2+2s+3}$ (d) $\dfrac{4}{s^2+2s+4}$

Ans. (d)

For the standard 2nd order unit step input, the output is defined by

$$C(t) = \left[1 - \frac{e^{-\xi\omega_n t}}{\sqrt{1-\xi^2}}\sin(\omega_d t + \phi)\right]u(t)$$

On comparision we get,

$$\xi\omega_n = 1$$

and

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

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

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

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

and $\omega_n = 2$ rad/sec

∴ Transfer function of the system is given by

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

$$TF = \frac{4}{s^2 + 2s + 4}$$

End of Solution

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)

On comparing with standard 2nd order system we get,

$$\omega_n = 1 \text{ rad/sec}$$

$$\xi = 1$$

∴ The given system is critically damped.

∴ The step response for the critically damped system is given by,

∴ $$C(t) = 1 - e^{-\xi\omega_n t}[1 + \omega_n t]$$

$\therefore$ $$C(t) = 1 - e^{-t}[1 + t]$$
for $t \to \infty$
$$C(\infty) = 1$$
Now, we have to find 't' for which $C(t)$ to reach 94% of its steady-state value,
$$1 - e^{-t}[1 + t] = 0.94$$
On solving we get, $t = 4.50$ sec

End of Solution

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)
Non-minimum phase transfer function is defined as the transfer function which has zeros in the right half of s-plane.

End of Solution

35. A system has poles at 0.01 Hz, 1 Hz and 80 Hz; zeros 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°

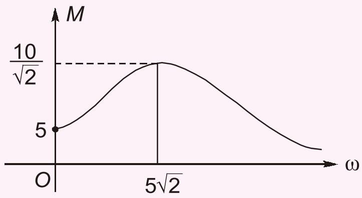
Ans. (a)
There are two poles and one zero are enforces before 20 Hz, hence phase is given by
$$\phi = (P - Z) * (-90°)$$
$$\phi = (2 - 1) * (-90°)$$
$$\phi = -90°$$

End of Solution

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) $\frac{375}{s^2 + 5s + 75}$
(c) $\frac{500}{s^2 + 12s + 100}$ (d) $\frac{1125}{s^2 + 25s + 225}$

Ans. (c)

From the given data the graph can be drawn as,



The resonant peak from graph is given as,

$$M_r = \frac{5}{2\xi\sqrt{1-\xi^2}} = \frac{10}{\sqrt{3}}$$

On solving we get, $\xi = 0.5$ and $\xi = 0.86$

For underdamped system

$$\xi < \frac{1}{\sqrt{2}} = 0.707$$

$\therefore$ $\xi = 0.5$ can be selected

Now, resonant frequency is given as,

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

On solving we get, $\omega_n = 10$ rad/sec

$\therefore$ The transfer function is given as

$$TF = \frac{5 \times 100}{s^2 + 10s + 100}$$

$$TF = \frac{500}{s^2 + 10s + 100}$$

Note: In option (c) there need to be correction in denominator in place of 12s it should be 10s.

End of Solution

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) $\frac{1}{2\zeta\sqrt{1-\zeta^2}}$

(d) $\frac{1}{\zeta\sqrt{1-\zeta^2}}$

Ans. (c)

$\therefore$ The resonant peak for standard second order system is given by

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

End of Solution

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)

Given open loop transfer fucntion

$$G(s)H(s) = \frac{2\sqrt{3}}{s(s+1)}$$

Phase margin is given by,

$$PM = 180° + \left[-90° - \tan^{-1}(\omega)\right]\Big|_{\omega=\omega_{gc}}$$

At ω_{gc} magnitude $|M| = 1$

$$\therefore \quad \frac{2\sqrt{3}}{\omega\sqrt{\omega^2+1}} = 1 \quad \text{at } \omega = \omega_{gc}$$

$$\therefore \quad \omega_{gc} = \sqrt{3}$$

$$\therefore \quad PM = 180° + [-90° - \tan^{-1}[\sqrt{3}]]$$

$$PM = 30°$$

End of Solution

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)

For the given open-looop transfer function, the magnitude varies from 1/2 to 0, hence no gain crossover frequency can be defined.

$$\therefore \quad PM = \infty$$

Note : Gain cross over frequency at which magnitude of open loop system is unity.

End of Solution

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 occurence	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)

$$\text{Average CPI} = \frac{\text{No.of Cycles/program}}{\text{No. of Instruction/program}};$$

$$= \frac{(38\times1)+(15\times3)+(42\times4)+(5\times5)}{100}$$

$$= 2.76$$

End of Solution

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 4 K 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)

Number of Blocks in MM = 4 K

Block size = 16 Words

Number of lines in cache memory = 128

∴ Main memory size = 4 K × 16 W

$= 2^{12} \times 2^4 \text{ W} = 2^{16} \text{ W}$

So, Main memory address = $\log_2 2^{16} = 16 \text{ bit}$

End of Solution

42. Consider the following reference string of a 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)

				6	7	10	4	8
		5	7	7	6	7	10	4
	7	7	5	5	5	6	7	10
4	4	4	4	4	4	5	6	7
4-m	7-m	5-m	7-Hit	6-Hit	7-Hit	10-m	4-m	8-m

5	8	6	8	11	4	9	5	9
8	5	8	6	8	11	4	9	5
4	4	5	5	6	8	11	4	4
10	10	4	4	5	6	8	11	11
5-m	8-Hit	6-m	8-Hit	11-m	4-m	9-m	5-m	9-Hit

6	9	12	4	7	5	7
9	6	9	12	4	7	5
5	5	6	9	12	4	4
4	4	5	6	9	12	12
6-m	9-Hit	12-m	4-m	7-m	5-m	7-Hit

Misses (Page faults) = 18

End of Solution

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 I/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)
STS (Short term scheduler) is responsible to schedule the ready state processes into a running state.

End of Solution

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)

- The bounded-buffer problems (producer-consumer problem) is a classic example of concurrent access to a shared resource.
- Multiple producers and multiple consumers share a single buffer.
- Producer write data into the buffer and consumers read data from the buffer.
- Producers must block when the buffer is full.
- Consumer must block when the buffer is empty.

End of Solution

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)

In non-preemptive scheduling, processes are executed one after another. So, no process is suspended (pre-empted) in the middle of the execution.

End of Solution

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)

$$P_{SSB} = 20 \text{ kW}$$

$$\mu = 0.4 \qquad \therefore \text{ AM Power} = \text{SSB Power}; \ P_t = 20 \text{ kW}$$

$$\eta = \frac{\mu^2}{2+\mu^2}$$

$$= 7.4\%$$

End of Solution

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)

$$x_c(t) = 20\cos\left[200\pi t + \frac{\pi}{4}\right]$$
$$= A_c \cos[\theta_i(t)]$$
$$f_i = \frac{1}{2\pi}\frac{d}{dt}\theta_i(t)$$
$$= \frac{1}{2\pi}[200\pi]$$
$$= 100 \text{ Hz}$$

End of Solution

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)

For FM:
$$f_c = 250 \text{ kHz}$$
$$k_f = 1.5\frac{\text{kHz}}{\text{volt}}$$

For PM:
$$f_c = 500 \text{ kHz}$$
$$k_p = 1.5\frac{\text{rad}}{\text{volt}}$$
$$A_m = 5 \text{ V}$$
$$f_m = 5 \text{ kHz}$$
$$\beta_{FM} = \frac{k_f A_m}{f_m} = \frac{1.5\times1000\times5}{5000} = 1.5$$
$$\beta_{PM} = k_p A_m = 1.5 \times 5$$
`
$$\beta_{PM} = 5 \times \beta f_m$$

End of Solution

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. (d)

$$\frac{\eta_{DSB}}{\eta_{AM}} = \frac{P_c\mu^2/2}{P_c\mu^2/4} = 2$$

$$\eta_{DSB} = 2\cdot\eta_{AM}$$

End of Solution

50. An audio signal $s(t) = 5\cos(2000\pi t)$ 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)

$$S(t) = 5\cos(2000\pi t)$$

$$n = 10$$

$$\frac{S}{N_Q} = \frac{3}{2} \times 2^{2n}$$

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

$$= 1.5 \times 2^{20} = 1.57 \times 10^6$$

End of Solution

51. An FM audio signal with single-tone modulation has a frequency deviation of 25 kHz 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)

$$\Delta_f = 25 \text{ kHz}$$

$$\text{FM BW} = 75 \text{ kHz}$$

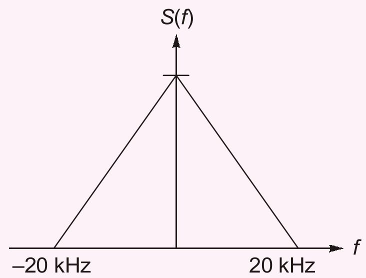
$$\text{BW} = 2[\Delta f + f_m]$$

$$75\text{ k} = 2[25\text{k} + f_m]$$

$$f_m = 12.5 \text{ kHz}$$

End of Solution

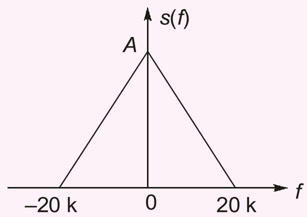
52. An audio signal $s(t)$ is normalized, whose Fourier transform $S(f)$ is shown in the figure, so that $|s(t)| \le 1$. This signal is to be transmitted using FM with a frequency deviation constant k_f = 90 kHz/V. What is the bandwidth required for transmission of the FM audio signal?



(a) 140 kHz
(b) 180 kHz
(c) 220 kHz
(d) 260 kHz

Ans. (c)

Given: $|s(t)| \le 1$



$$k_f = 90 \text{ kHz/volt}$$
$$BW = 2[\Delta f + f_{max}]$$
$$\Delta f = k_f \cdot |m(t)|_{max} = 90 \text{ kHz} \qquad \because |m(t)|_{max} = 1$$
$$BW = 2[90\text{ k} + 20\text{ k}]$$
$$= 220 \text{ kHz}$$

End of Solution

53. A collector modulated class-C power amplifier is giving 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 modulation index is 0.4?

(a) 16.3 W
(b) 40.75 W
(c) 203.7 W
(d) 220 W

Ans. (b)

$$P_t = 220 \text{ W}$$
$$\mu = 0.4$$
$$P_t = P_c\left[1 + \frac{\mu^2}{2}\right]$$

$$P_c = 203.7 \text{ W}$$

Power supplied by modulating amplifier gets converted into output SB power.

Power to be supplied by class C power amplifier

$$= 220 - 203.7 = 16.29 \text{ W}$$

Given collector circuit efficiency = 40% = 0.4

DC power to be supplied by modulating amp = $\dfrac{16.29}{0.4} = 40.7$ W

End of Solution

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)

$$S_{AM}(t) = A_c[1 + k_a m(t)]\cos 2\pi f_c t$$

$$P_{AM} = \frac{A_c^2}{2} + \frac{A_c^2 k_a^2 m^2(t)}{2} \qquad \because k_a = \frac{1}{A_c}$$

Default, $k_a = 1$

$$P_{AM} = \frac{A_c^2}{2} + \frac{A_c^2 m^2(t)}{2}$$

End of Solution

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)

Method 1:

$$P_{t1} = 125 \text{ kW}$$

$$\mu_1 = 0.7$$

$$P_{t1} = P_c\left[1 + \frac{\mu_1^2}{2}\right] \rightarrow P_c = \frac{125}{1.245}\text{kW}$$

$$P_t = 144.5 \text{ kW} \rightarrow \mu_2 = ?$$

$$\frac{P_t}{P_{t1}} = \frac{P_c\left[1 - \frac{\mu_t^2}{2}\right]}{P_c\left[1 + \frac{\mu_1^2}{2}\right]}$$

$$\frac{144.5K}{125K} = \frac{1+\mu_1^2+\mu_2^2}{1+\frac{\mu_1^2}{2}}$$

$$1.156 = \frac{1+\frac{0.49+\mu_2^2}{2}}{1+\frac{0.49}{2}}$$

$$1.43922 = 1+0.245+\frac{\mu_2^2}{2}$$

$$\mu_2^2 = 0.388$$

$$\mu_2 = \sqrt{0.38}$$

Method 2:

$$P_t = P_c\left[1+\frac{\mu_t^2}{2}\right] = P_c\left[1+\frac{\mu_1^2}{2}\right]+\frac{P_c\mu_2^2}{2}$$

$$144.5\text{ K} = 125\text{ kW}+\frac{P_c\mu_2^2}{2}$$

$$19.5\text{ kW} = \frac{P_c\mu_2^2}{2}$$

$$39\text{ kW} = \frac{125}{1.245}\text{kW}\times\mu_2^2$$

$$\mu_2 = \sqrt{0.388}$$

End of Solution

56. An audio signal comprising of a single sinusoidal term $s(t) = 3\cos(2\pi 1000t)$ is quantized using DM. What is the signal-to-quantization noise ratio?

(a) 120
(b) 170
(c) 107
(d) 100

Ans. (*)

DM:

$$\frac{S}{N_Q} = \frac{3}{8\pi^2}\left(\frac{f_s}{f_m}\right)^3 = \frac{3}{8\pi^2}\left(\frac{2f_m}{f_m}\right)^3$$

$$= \frac{3}{8\pi^2}\times 8 = \frac{3}{\pi^2} = 0.303$$

End of Solution

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) $\frac{1}{3}$
(b) $\frac{1}{4}$
(c) $\frac{1}{5}$
(d) $\frac{1}{6}$

Ans. (a)

$$L\uparrow \rightarrow 4 \text{ to } 54$$
$$n\uparrow \rightarrow 2 \text{ to } 6$$
$$\text{BW} = nf_s$$
$$\text{BW} \propto n$$
$$\frac{\text{BW}_1}{\text{BW}_2} = \frac{n_1}{n_2} = \frac{2}{6} = \frac{1}{3}$$

End of Solution

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)

Derivative controller is functionally a tachometer.

∴ Transfer function = $K_t S$

End of Solution

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)

The open loop transfer function is given by,

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

$$\text{OLTF} = \frac{s+4}{s^2+6s+9} \quad ...(1)$$

* For open-loop DC gain of a unity negative feedback can be found by making s = 0 in equation (1).

$\therefore$ Open loop DC gain $= \frac{4}{9}$

End of Solution

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, is subjected to a unit-step input at $t = 0$, 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)

On comparing with standard 2nd order system

$$\omega_n = 5 \text{ rad/sec}$$
$$\xi = 0.8$$
$$\therefore \quad \omega_d = \omega_n\sqrt{1-\xi^2} = 5\sqrt{1-0.64} = 5 * 0.6$$
$$\omega_d = 3 \text{ rad/sec}$$

The time at which second peak in the response is given by

$$t_p = \frac{n\pi}{\omega d}$$

where n = 3

$$\therefore \quad t_p = \frac{3 \times \pi}{3}$$
$$t_p = \pi \text{ sec}$$

End of Solution

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)

In DMA, bulk amount of data will be transferred from the I/O to MM without involvement of a CPU.

End of Solution

62. Consider the division of a dividend $X = 0100000$ and a divisor $D = 0110$. 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)

$$X = 010000 = 32_{(10)}$$
$$D = 0110 \Rightarrow 6_{(10)}$$

$$6)32(5 \rightarrow 0101 \rightarrow Q$$
$$\underline{30}$$
$$2 \rightarrow 0010 \rightarrow R$$

End of Solution

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)

A trap door is kind of a **secret entry point** into a program that allows anyone to gain access to any system without going through the usual security access procedures.

End of Solution

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)

- Windows Registry (Registry) is a centralized hierarchial data base to store system settings, H/W configurations and user preferences.
- Hives are the top most portions of the hierarchial data tree with each hive containing a certain category of information.

End of Solution

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)

In programmed IO interrupt driven IO both of the modes, CPU is responsible to transfer the I/O data. CPU utilization is inefficient.

End of Solution

66. Which one of the following methods requires saving the value of the CPU 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)

Context switching between the Kernal level threads are used to save the context of a process before suspend the execution (swapping).

End of Solution

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)

As we now that,

$$\bar{J}_d = \frac{\partial \bar{D}}{\partial t} = \varepsilon \frac{\partial \bar{E}}{\partial t}$$

$$\Rightarrow \quad \bar{J}_d = j\omega\varepsilon\bar{E}$$

$$\Rightarrow \quad \bar{J}_d = \omega\varepsilon E A = \omega\varepsilon\left(\frac{V}{d}\right)A$$

$$= 2\pi \times 4.5 \times 10^9 \times \frac{10^{-9}}{36\pi} \times \left(\frac{0.5}{10^{-3}}\right) \times 10^{-4}$$

$$= 12.5 \text{ mA}$$

End of Solution

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, $\varepsilon_0 = \frac{1}{36\pi \times 10^9}$ F/m. The characteristic impedance of the cable is

(a) 33 Ω
(b) 43.4 Ω
(c) 143.3 Ω
(d) 16 Ω

Ans. (d)

Given that $a = 0.5 * 10^{-3}$ m

$b = 1.2 * 10^{-3}$ m

As we know that

characteristic impedance of a co-axial cable is given as

$$z_0 = \frac{60}{\sqrt{\epsilon_r}} \ln\left(\frac{b}{a}\right); \text{ a, b = Radius of inner and outer cable}$$

$$\Rightarrow \quad z_0 = \frac{60}{\sqrt{10.89}} \ln\left(\frac{1.2}{0.5}\right) = 15.91\,\Omega \simeq 16\,\Omega$$

End of Solution

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) 4 GHz and left circular

Ans. (b)

Given, $\bar{E} = (10\hat{a}_y + j10\hat{a}_z)e^{-j25x}$

$$\bar{E}(x,t) = (10\hat{a}_y + j10\hat{a}_z)e^{j(\omega t - 25x)}$$

at $x = 0$, $\bar{E}(t) = (10\hat{a}_y + j10\hat{a}_z)e^{j\omega t}$

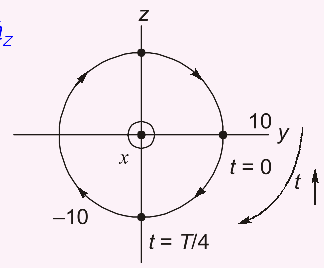
Taking real terms, we get

$$\bar{E}(t) = 10\cos\omega t\,\hat{a}_y + 10\cos(\omega t + \pi/2)\hat{a}_z$$

$$\Rightarrow \quad \bar{E}(t) = 10\cos\omega t\,\hat{a}_y - 10\sin\omega t\,\hat{a}_z$$

at $t = 0$, $\omega t = 0$, $\bar{E}(t) = 10\hat{a}_y$

at $t = \pi/4$, $\omega t = \pi/2$, $\bar{E}(t) = -10\hat{a}_z$



∴ it is LCP.

Also $\beta = 25$

∴ $\beta = \frac{\omega}{c}$; free space given

$\Rightarrow \quad \omega = \beta c = 25 \times 3 \times 10^8 = 75 \times 10^8$ rad/s

$\Rightarrow \quad f = \frac{\omega}{2\pi} = 1.2$ GHz

End of Solution

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

(a) $25e^{j(\omega t - 3z)}$
(b) $\sin(\omega(27z + 15t))$
(c) $\sin(x)\cos(t)$
(d) $\cos(y^2 + 5t)$

Ans. (d)

End of Solution

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)

Copper is a good conductor,

$$\therefore \quad \eta|_{cond} = \sqrt{\frac{\omega\mu}{\sigma}}\angle 45^\circ$$

$$\Rightarrow \quad \eta = \sqrt{\frac{\omega\mu}{2\sigma}} + j\sqrt{\frac{\omega\mu}{2\sigma}} \equiv R_S + j\omega_s$$

End of Solution

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

(a) conductivity
(b) permeability
(c) wavelength
(d) permittivity

Ans. (c)

For a lossy medium

$$\delta \propto \frac{1}{\sqrt{f}}$$

As $\quad v = f\lambda \quad \Rightarrow \quad f \propto \frac{1}{\lambda}$

$$\therefore \quad \delta \propto \sqrt{\lambda}$$

So, if $\lambda\uparrow$, $\delta\uparrow$

End of Solution

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)

End of Solution

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. (a)
Due to very large loss tangent of copper because of conductivity, Cu behaves as a conductor in all conditions.

End of Solution

75. A transmission line has a characteristic impedance of 50 Ω and a resistance of 0.1 Ω/m. If the line is distortionless, the attenuation constant is
(a) 500 (b) 5
(c) 0.01 (d) 0.002

Ans. (d)
Given that:

$$Z_0 = 50\ \Omega$$
$$R = 0.1\ \Omega/\text{m}$$

Line is distortionless.
As we know that,

$$\alpha = \sqrt{RG} = R\sqrt{\frac{C}{L}}$$

$$Z_0 = \sqrt{\frac{C}{L}}$$

$$\therefore \quad \alpha Z_0 = R$$

$$\therefore \quad \alpha = \frac{R}{Z_0} = \frac{0.1}{50} = 0.002$$

End of Solution

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 neighbouring 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)

End of Solution

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

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

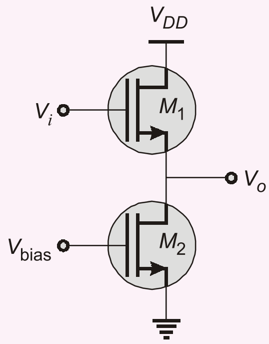
(b) $A_V = \dfrac{g_{ds1}}{g_{m1} + g_{s1} + (g_{ds1} + g_{ds2})}$

(c) $A_V = \dfrac{g_{m1}}{g_{m1} + g_{s1} + g_{ds1} + g_{ds2}}$

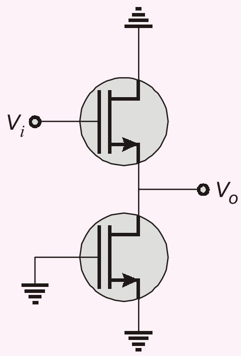
(d) $A_V = \dfrac{g_{m1}}{2(g_{m1} + g_{s1}) + g_{ds1} + g_{ds2}}$

Ans. (c)

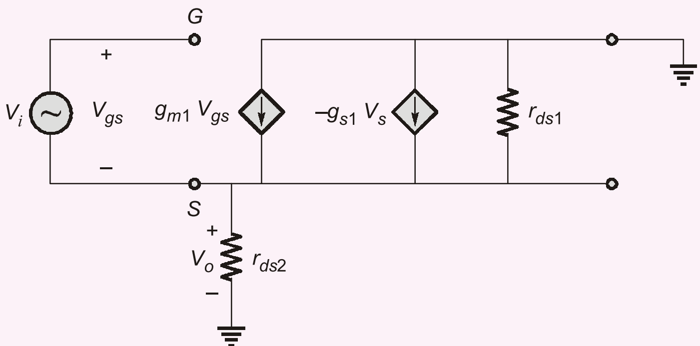
Common drain amplifier can be drawn as,



Under AC analysis the equivalent circuit is



Drawing small signal model of above circuit by taking body effect



r_{ds1} and r_{ds2} are in parallel and $V_s = V_o$.

By applying KCL at source terminal:

$$g_{m1}V_{gs} - g_{s1}V_o = \frac{V_o}{(r_{ds1}) \| (r_{ds2})}$$

$$\frac{V_o}{V_i} = \frac{g_{m1}}{g_{m1} + g_{s1} + g_{ds1} + g_{ds2}} \quad \ldots \; V_i = V_{gs}$$

End of Solution

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)

Assembler O/P → Object file.

Loader:

1. Converts object file to hex file.
2. Finally dumps program to memory.

End of Solution

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)

ANI 8-bit data.
'AND' immediate 8-bit data to accumulator.

End of Solution

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) $2^N - 1 \leq \text{modulus} \leq 2^{N-1}$
(b) $2^{N-1} + 1 \leq \text{modulus} \leq 2^N$
(c) $2^N + 1 \leq \text{modulus} \leq 2^{N+1}$
(d) $2^{N+1} + 1 \leq \text{modulus} \leq 2^N$

Ans. (b)

End of Solution

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

(a) 15 V to 25 V, 150 ns, 1.0 V, 3 pJ and 10 MHz
(b) 15 V to 25 V, 130 ns, 1.5 V, 3 pJ and 12 MHz
(c) 3 V to 15 V, 130 ns, 1.5 V, 5 pJ and 10 MHz
(d) 3 V to 15 V, 150 ns, 1.0 V, 5 pJ and 12 MHz

Ans. (c)

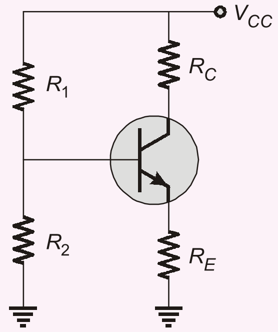
End of Solution

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

(a) $\beta/2R_E \geq 10$
(b) $\beta R_E \geq R_2$
(c) $\beta R_E \geq 10R_2$
(d) $\beta 2R_E \geq R_2$

Ans. (c)

Voltage divider biasing configuration is as shown below:



For stable I_C,

$(1 + \beta)R_E >> R_B$

$$R_B = R_1 \parallel R_2 \approx R_2$$

In design rule much greater than indicate atleast 10 time value higher.

$$(1 + \beta)R_E \geq 10R_B$$
$$(1 + \beta)R_E \geq 10R_2$$
$$\beta)R_E \geq 10R_2$$

End of Solution

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)

End of Solution

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

(a) 10^{10} cm^{-3}
(b) 10^{20} cm^{-3}
(c) 10^{15} cm^{-3}
(d) 10^{25} cm^{-3}

Ans. (b)

End of Solution

Directions : Each of the next six (6) items consists of two statements, one labelled as the 'Statement (I) and the other labelled as 'Statement (II)'. You are to examine these two statements carefully and select the answers to these items using the codes given below :

Codes :

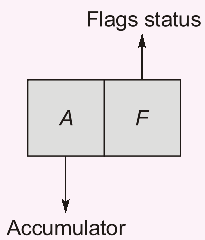
(a) Both Statement (I) and Statement (II) is the correct explanation of Statement (I).
(b) Both Statement (I) and Statement (II) are individually true, but Statement (II) is not the correct explanation of Statement (I).
(c) Statement (I) is true, but Statement (II) is false.
(d) Statement (I) is false,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

85. **Statement (I) :** 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. (a)

PSW → Program states word →



8085 doesn't has any separate instruction to read flags states into any general purpose register.

So, PUSH PSW and 'POP' are used to know/read status of flags into some RP (Register Pair) using POP R_p. So, 'II' and 'I' are correct and II is right reason.

x

End of Solution

86. **Statement (I) :** Pipeline processing cycle overlaps computer instruction cycle in 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. (a)

Pipelining allows overlapping execution. So, instruction level parallelism present in the system.

∴ System performance is improved using pipelining technique.

End of Solution

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)

End of Solution

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 accept a common-mode signal is defined as the figure of merit.

Ans. (c)

- If same input applied to both terminals then it is a common mode configuration.
- Figure of merit is known as CMRR (Common mode rejection ratio).
- CMRR of a differential amplifier is to reject a common mode signal.

End of Solution

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)

End of Solution

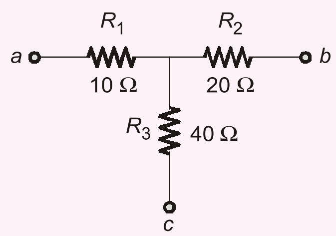
90. **Statement (I) :** In the sampling and quantizing operations, errors are introduced into the digital signal. These errors are reversible and it is possible to produce an exact replica of the original analog signal from its digital representation.

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)

End of Solution

91. What are the values of delta-connected branch resistances R_{ab}, R_{bc} and R_{ac} 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)

$$R_{ab} = \frac{(10\times40)+(10\times20)+(20\times40)}{40} = 35\ \Omega$$

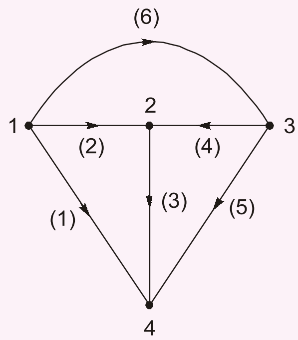
$$R_{ab} = \frac{(10\times40)+(10\times20)+(20\times40)}{10} = 140\Omega$$

$$R_{ab} = \frac{(10\times40)+(10\times20)+(20\times40)}{20} = 70\ \Omega$$

R_{ab} = 35 Ω ; R_{bc} = 140 Ω ; R_{ac} = 70 Ω

End of Solution

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)

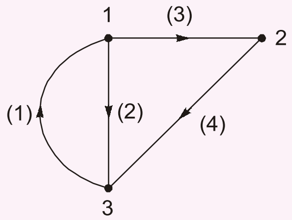
The number of possible tree = N^{N-2}

where, N = Number of nodes in graph

Number of possible tree = $4^{(4-2)} = 4^2 = 16.$

End of Solution

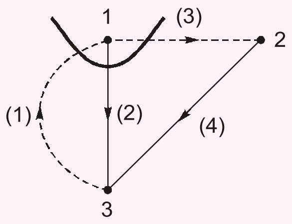
93. Which one of the following is a fundamental cut set of the graph shown in the figure?



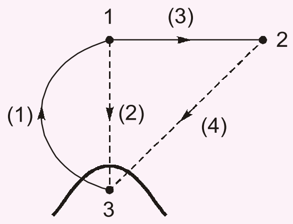
(a) 1, 2 and 4
(b) 1, 2 and 3
(c) 2, 3 and 4
(d) 1, 3 and 4

Ans. (a, b)

The possible fundamental cut-set are



Fundamental cut-set = [1, 2, 3]

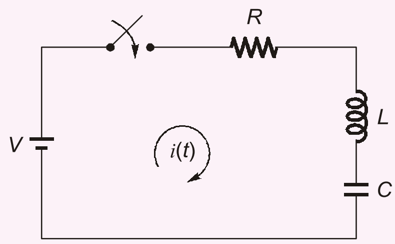


Fundamental cut-set = [1, 2, 4]

So, both options (a) and (b) are correct.

End of Solution

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)

Given: $\frac{R}{2L} < \frac{1}{\sqrt{LC}}$

This is an underdampd system and hence the roots are complex conjugate.

End of Solution

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

(a) underdamped
(b) not possible to know the response
(c) critically damped
(d) overdamped

Ans. (d)

For series R-L-C circuit,

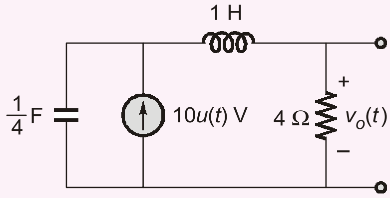
$$\xi = \frac{R}{2}\sqrt{\frac{C}{L}}$$

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

$\xi > 1$; overdamped.

End of Solution

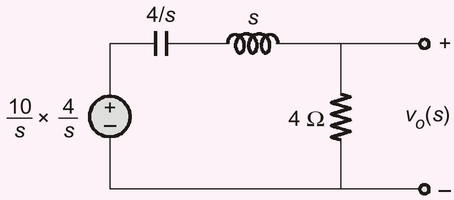
96. What is the value of $v_o(t)$ for the circuit shown in the figure, assuming zero initial conditions?



(a) $v_o(t) = 40(1 - e^{-t} + 2te^{-t})\ u(t)$ V (b) $v_o(t) = 40(1 - e^{-2t} - 2te^{-2t})\ u(t)$ V
(c) $v_o(t) = 40(1 - e^{-t} - 2te^{-2t})\ u(t)$ V (d) $v_o(t) = 40(1 - e^{-2t} + 2te^{-t})\ u(t)$ V

Ans. (b)

By using source transformation,



By using voltage division rule,

$$v_o(s) = \frac{4}{4 + s + \frac{4}{s}} \times \frac{40}{s^2} = \frac{160}{s(s^2 + 4s + 4)} = \frac{160}{s(s+2)^2}$$

By using partial fraction,

$$v_o(s) = \frac{A}{s} + \frac{B}{s+2} + \frac{C}{(s+2)^2}$$

On solving, $A = 40,\quad B = -40,\quad C = -80$

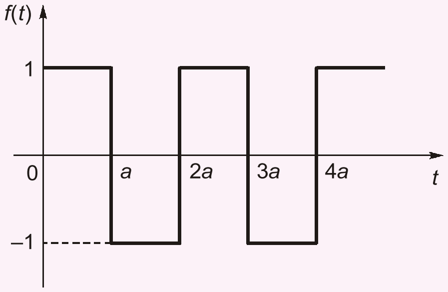
$$v_o(s) = \frac{40}{s} - \frac{40}{s+2} - \frac{80}{(s+2)^2}$$

$$v_o(t) = [40 - 40e^{-2t} - 80te^{-2t}]\ u(t)$$

$$v_o(t) = 40[1 - e^{-2t} - 2e^{-2t}]\ u(t)\ \text{V}$$

End of Solution

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

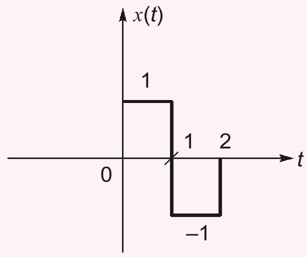
(c) $\frac{1}{s}\tanh\left(\frac{1}{2}\right)$

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

Ans. (a)

$$F(s) = \frac{X(s)}{1-e^{-sT}} \quad \text{where, } T = 2 \qquad \ldots(i)$$

and $x(t)$



From the figure,

$$x(t) = u(t) - 2u(t-1) + u(t-2)$$

$$\Downarrow$$

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

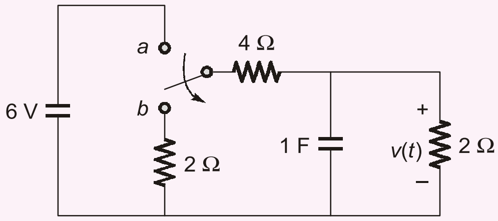
From equation (i), $$F(s) = \frac{(1-e^{-s})^2}{s(1-e^{-2s})} = \frac{1-e^{-s}}{s(1+e^{-s})}$$

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

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

End of Solution

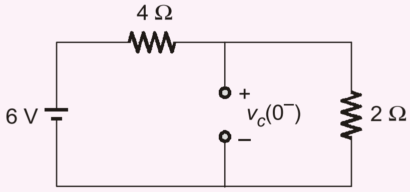
98. For the network shown in the figure, the switch is moved from a to b at $t = 0^-$. What is the value of voltage $v(t)$?



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

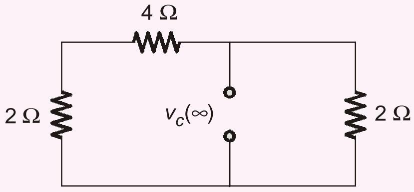
Ans. (a)

At $t = 0^-$



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

At $t > 0$;



$$v_c(\infty) = 0\text{ V}$$

$$v(t) = v_c(\infty) + [v(0) - v(\infty)]\,e^{-t/\tau}$$

$$\tau = R_{eq}C$$

$$R_{eq} = \frac{6 \times 2}{6+2} = \frac{3}{2}\,\Omega,\ C = 1\text{F}$$

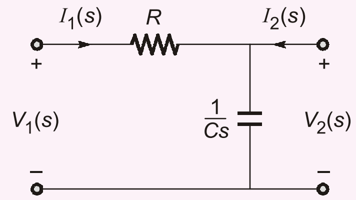
$$\tau = \frac{3}{2}\text{ sec}$$

$$v(t) = 0 + (2 - 0)e^{-t/(3/2)}$$

$$v(t) = 2e^{-(2/3)t}\text{ V}$$

End of Solution

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



(a) $\dfrac{1}{1-RCs}$ (b) $\dfrac{1}{1+RCs}$

(c) $\dfrac{1}{(1+RCs)^2}$ (d) $\dfrac{1}{(1-RCs)^2}$

Ans. (b)

The voltage transfer function,

$$\frac{V_2(s)}{V_1(s)} = \frac{\frac{1}{Cs}}{R+\left(\frac{1}{Cs}\right)}$$

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

End of Solution

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)

From given two-port parameters,

$$V_1 = 2I_1 + I_2 \quad \text{...(i)}$$

$$V_2 = 10I_1 + 11I_2 \quad \text{...(ii)}$$

From equations (ii),

$$I_2 = \frac{1}{11}V_2 - \frac{10}{11}I_1 \quad \text{...(iii)}$$

Put I_2 in equation (i),

$$V_1 = 2I_1 + \frac{1}{11}V_2 - \frac{10}{11}I_1$$

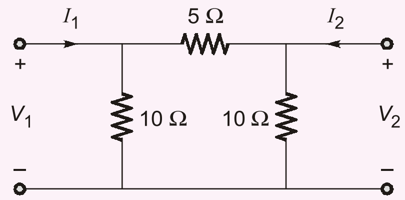
$$V_1 = \frac{12}{11}I_1 + \frac{1}{11}V_2$$

$$I_2 = -\frac{10}{11}I_1 + \frac{1}{11}V_2$$

$\Rightarrow$ h-parameters, $$[h] = \begin{bmatrix} \frac{12}{11} & \frac{1}{11} \\ -\frac{10}{11} & \frac{1}{11} \end{bmatrix}$$

End of Solution

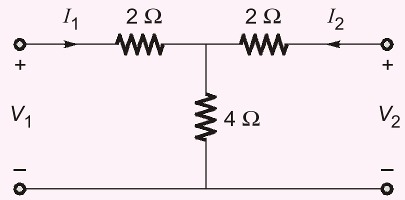
101. What are the lattice equivalent network parameters Z_A and Z_B of a symmetrical π network shown in the figure?



(a) Z_A = 2 Ω and Z_B = 10 Ω
(b) Z_A = 10 Ω and Z_B = 2 Ω
(c) Z_A = 4 Ω and Z_B = 8 Ω
(d) Z_A = 8 Ω and Z_B = 4 Ω

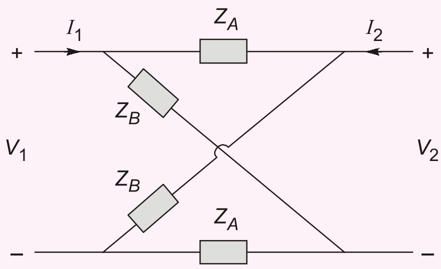
Ans. (a)

Apply Δ to Y transformation,



$$Z_{11} = Z_{22} = 6\ \Omega$$
$$Z_{21} = Z12 = 4\ \Omega$$

From Z-parameters equivalent



$$Z_{11} = Z_{22} = \frac{Z_B + Z_A}{2}$$

$$Z_{21} = Z_{12} = \frac{Z_B - Z_A}{2}$$

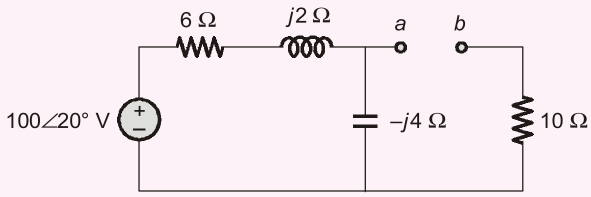
$$6 = \frac{Z_B + Z_A}{2} \Rightarrow Z_B + Z_A = 12$$

$$4 = \frac{Z_B - Z_A}{2} \Rightarrow Z_B - Z_A = 8$$

On solving, $Z_A = 2\ \Omega$ and $Z_B = 10\ \Omega$

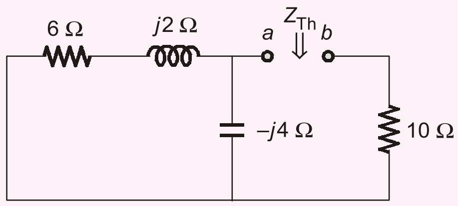
End of Solution

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



(a) $12.4 - j3.2\ \Omega$
(b) $12.4 - j2.2\ \Omega$
(c) $11.4 - j3.2\ \Omega$
(d) $11.4 - j2.2\ \Omega$

Ans. (a)



$$Z_{Th} = 10 + (6 + j2) \,||\, (-j4)$$

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

$$= 10 - \frac{j2(6 + j2)}{3 - j}$$

$$Z_{Th} = 10 + 2.4 - j3.2$$

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

End of Solution

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)

End of Solution

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 one 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)

End of Solution

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

(a) $T = \dfrac{\left(\frac{1}{3}\right)V_{CC}R_E(R_1+R_2)C}{R_2V_{CC}-V_{BE}(R_1+R_2)}$

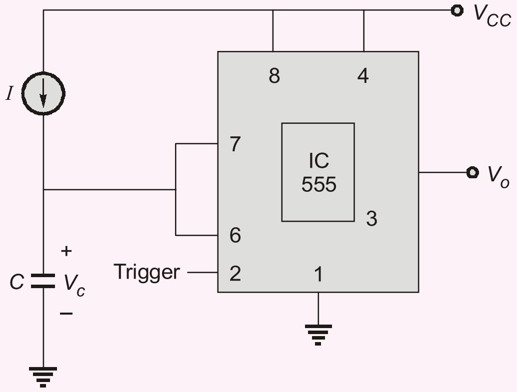
(b) $T = \dfrac{V_{CC}R_E(R_1+R_2)C}{R_1V_{CC}-V_{BE}(R_1+R_2)}$

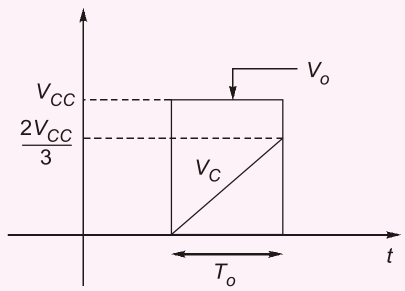
(c) $T = \dfrac{\left(\frac{2}{3}\right)V_{CC}R_E(R_1+R_2)C}{R_1V_{CC}-V_{BE}(R_1+R_2)}$

(d) $T = \dfrac{\left(\frac{2}{3}\right)V_{CC}R_E(R_1+R_2)C}{R_1V_{CC}+V_{BE}(R_1+2R_2)}$

Ans. (c)

Monostable multivibrator can acts as ramp generator



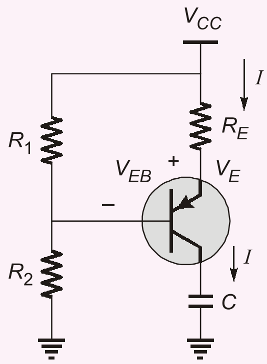


When current through capacitor is constant:

$$I \times \Delta t = C \times \Delta V_c$$

$$I \times T_o = C \times \frac{2V_{CC}}{3} \qquad ...(i)$$

Now, constant current source of 555 timer can be replace as;



$$I = I_C = \frac{V_{CC} - V_E}{R_E} = \frac{V_{CC} - \left(V_{EB} + V_{CC} \times \frac{R_2}{R_1 + R_2}\right)}{R_E} \quad \text{...(ii)}$$

$$I = \frac{V_{CC}R_1 - V_{EB}(R_1 + R_2)}{R_E(R_1 + R_2)}$$

Put equation (ii) in equation (i),

$$T_o = \frac{\frac{2}{3}V_{CC}R_E(R_1 + R_2)C}{R_1V_{CC} - V_{BE}(R_1 + R_2)}$$

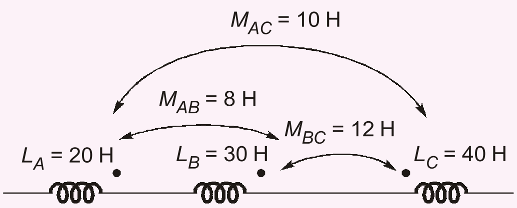
End of Solution

106. The self-inductance of three coils are L_A = 20 H, L_B = 30 H and L_C = 40 H. 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} = 8 H, M_{BC} = 12 H and M_{AC} = 10 H, what is the total inductance of the circuit?

(a) 46 H
(b) 62 H
(c) 70 H
(d) 82 H

Ans. (b)

From the description,



$$L_{eq} = L_A + L_B + L_C + 2M_{AB} - 2M_{BC} - 2M_{AC}$$
$$= 20 + 30 + 40 + 2 \times 8 - 2 \times 12 - 2 \times 10$$
$$L_{eq} = 62 \text{ H}$$

End of Solution

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 100 V. What is the value of primary voltage?
(a) 100 V
(b) 500 V
(c) 1000 V
(d) 5000 V

Ans. (c)

$$\frac{N_2}{N_1} = 0.1 = \frac{V_2}{V_1}$$

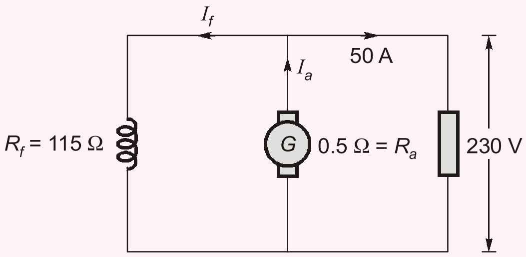
$$V_1 = \frac{V_2}{0.1} = \frac{100}{0.1} = 1000 \text{ V}$$

End of Solution

108. A 230 V DC shunt machine has an armature resistance of 0.5 Ω. and a field resistance of 115 Ω. 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 50 A 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)

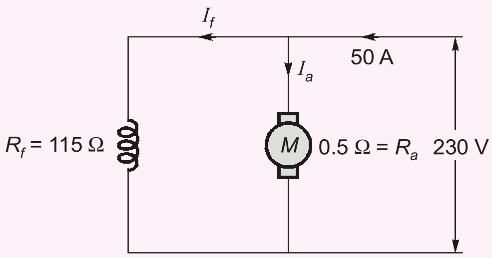
Working as Generator :



$$I_f = \frac{V}{R_f} = \frac{230}{115} = 2 \text{ A}$$

$$I_a = 50 + 2 = 52 \text{ A}$$
$$E_g = V + I_aR_a$$
$$E_g = 230 + 52(0.5)$$
$$E_g = 256 \text{ V}$$

Working as Motor :



$$I_f = \frac{V}{R_f} = \frac{230}{115} = 2\ A$$

$$I_a = 50 - 2 = 48\ A$$
$$E_b = V - I_aR_a$$
$$E_b = 230 - 48(0.5)$$
$$E_b = 206\ V$$

End of Solution

109. A 4-pole, three-phase induction motor is supplied from 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)

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

$$s = \frac{N_S - N}{N_S} = \frac{1500 - 1455}{1500} = 0.03$$

At stand still $\Rightarrow$ $N = 0$

Hence, $s = \frac{N_S - N}{N_S} = 1$

$$f' = sf$$
$$f' = f \qquad (\because\ s = 1)$$
$$f' = 50\ \text{Hz}$$

End of Solution

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)

End of Solution

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

(a) 3.37 Ω
(b) 5.49 Ω
(c) 7.62 Ω
(d) 9.72 Ω

Ans. (b)

$$\text{A.h efficiency} = \frac{7 \times I_{\text{discharge}}}{6 \times 3} = 0.85$$

$$I_{\text{discharge}} = \frac{0.85 \times 6 \times 3}{7} = 2.1857 \text{ A}$$

$$R = \frac{12}{2.1857} = 5.49\ \Omega$$

End of Solution

112. The longest wavelength that can be absorbed by silicon, which has the band gap of 1.12 eV, is 1.1 μm. 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)

$$E_{G_1} = 1.12 \text{ eV}$$

$$\lambda_1 = 1.1\ \mu\text{m}$$

$$E_{G_2} = ?$$

$$\lambda_2 = 0.87\ \mu\text{m}$$

$$E = \frac{hc}{\lambda}$$

$$\frac{E_{G_1}}{E_{G_2}} = \frac{\lambda_2}{\lambda_1}$$

$$\Rightarrow \quad E_{G_2} = \frac{\lambda_1}{\lambda_2} E_{G_1} = \frac{1.1}{0.87} \times 1.12 = 1.42 \text{ eV}$$

End of Solution

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)

Band gap of Ge at room temperature = 0.7 eV

End of Solution

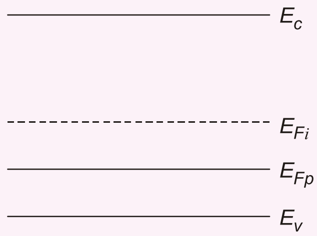
114. Silicon is doped with boron to a concentration of 4×10^{17} atoms/cm^3. Assume the intrinsic carrier concentration of silicon to be 1.5×10^{10}/cm^3 and the value of kT/q to be 25 mV at 300 K. Compare to undoped silicon, the Fermi level of doped silicon

(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)

$$N_A = 4 \times 10^{17} \text{ atoms/cm}^3 \text{ (P-type S.C.)}$$
$$n_i = 1.5 \times 10^{10}/\text{cm}^3$$
$$\frac{kT}{q} = 25 \text{ mV}$$
$$E_{Fi} - E_{Fp} = kT\ln\left(\frac{N_A}{n_i}\right) = 0.025\ln\left(\frac{4\times10^{17}}{1.5\times10^{10}}\right)$$
$$= 0.427 \text{ eV}$$

Goes down by 0.427 eV



Hence, option (c) is correct.

End of Solution

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

(a) $2 \times 10^{16}/\text{cm}^3$
(b) $1 \times 10^{16}/\text{cm}^3$
(c) $2.5 \times 10^{15}/\text{cm}^3$
(d) $2 \times 10^{15}/\text{cm}^3$

Ans. (b)

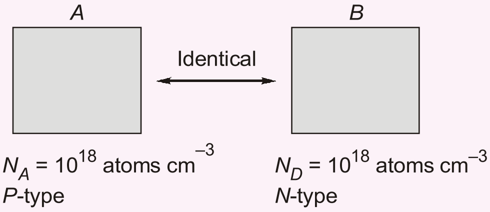
$$\sigma_{N\text{-type}} = nq\mu_n + p_q\mu_p \simeq nq\,\mu_n = N_D q\mu_n$$
$$\frac{1}{0.5\,\Omega\text{-cm}} = N_D q\,\mu_n$$
$$N_D = \frac{1}{1.6\times10^{-19}\times1250\times0.5} = 1\times10^{16}\text{ cm}^{-3}$$

End of Solution

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) 1/2
(b) 1/3
(c) 2/3
(d) 1/4

Ans. (b)



$$\frac{\sigma_A}{\sigma_B} = ?$$

$$\frac{\sigma_A}{\sigma_B} = \frac{\sigma_{P\text{-type}}}{\sigma_{N\text{-type}}} \simeq \frac{Pq\mu_p}{nq\mu_n} = \frac{N_A\mu_p}{N_D\,\mu_n} = \frac{10^{18}}{10^{18}} \times \frac{1}{3}$$

$$\frac{\sigma_A}{\sigma_B} = \frac{1}{3}$$

End of Solution

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) increases the velocity of the charge carriers

Ans. (a)

$$\frac{D}{\mu} = kT = V_T = \frac{T(\text{Kelvin})}{11{,}600}$$

End of Solution

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 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)

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

$$N_D = 4.2\times 10^8\ m^{-3} \simeq n$$

$$n_i = 1.5 \times 10^4\ \text{m}^{-3} \Rightarrow P = \frac{n_i^2}{n} = 0.5357\ \text{m}^{-3}$$

Ratio of conductance (G) $\Rightarrow \dfrac{G_n}{G_i} = \dfrac{\frac{1}{R_n}}{\frac{1}{R_i}} = \dfrac{R_i}{R_n}$

$$R = \frac{\rho L}{A} \quad \Rightarrow \frac{G_n}{G_i} = \frac{\rho_i}{\rho_n} = \frac{\sigma_n}{\sigma_i}$$

$$\frac{G_n}{G_i} = \frac{\sigma_n}{\sigma_i} \simeq \frac{nq\mu_n}{n_i q(\mu_n + \mu_p)} \simeq \frac{n\mu_n}{n_i(\mu_n + \mu_p)} \quad P << n$$

$$= \frac{n}{n_i}\left(\frac{1}{1+\frac{\mu_p}{\mu_p}}\right) = \frac{4.2\times 10^8}{1.5\times 10^4}\times\left(\frac{1}{1+0.4}\right)$$

$$= \frac{2.8\times 10^4}{1.5} = 1.866\times 10^4 = 18.6\times 10^3$$

End of Solution

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

(a) n_0 = 1.5 × 10^{10}/cm^3, p_0 = 1 × 10^5/cm^3
(b) n_0 = 1.5 × 10^{10}/cm^3, p_0 = 1.5 × 10^{10}/cm^3
(c) n_0 = 2.25 × 10^{15}/cm^3, p_0 = 1.5 × 10^{10}/cm^3
(d) n_0 = 2.25 × 10^{15}/cm^3, p_0 = 1 × 10^5/cm^3

Ans. (d)

$$N_D = 2.25 \times 10^{15} \text{ atoms/cm}^3$$
$$n_i = 1.5 \times 10^{10} \text{ cm}^{-3}$$
$$N_D >> n_i$$
$$n_o \simeq N_D = 2.25 \times 10^{15} \text{ cm}^{-3}$$
$$p_o \simeq \frac{n_i^2}{n_o} = 1\times 10^5 \text{ cm}^{-3}$$

End of Solution

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 contact difference of potential V_0?

(a) 1.6021 × 10^{-19} J
(b) $V_{n_0} - V_{i_0} = V_{n_i}$
(c) $V_{21} = V_0 = \ln(p_{p_0}/p_{n_0})$
(d) $V_0 = V_T \ln(N_A N_D / n_i^2)$

Ans. (d)

$$V_o = V_T \ln\left(\frac{P_{p_o}}{P_{n_o}}\right) = V_T \ln\left(\frac{n_{n_o}}{n_{p_o}}\right)$$

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

End of Solution

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

(a) $f_0 = 2\frac{V_+ + V_C}{V_+ R_1 C_1}$

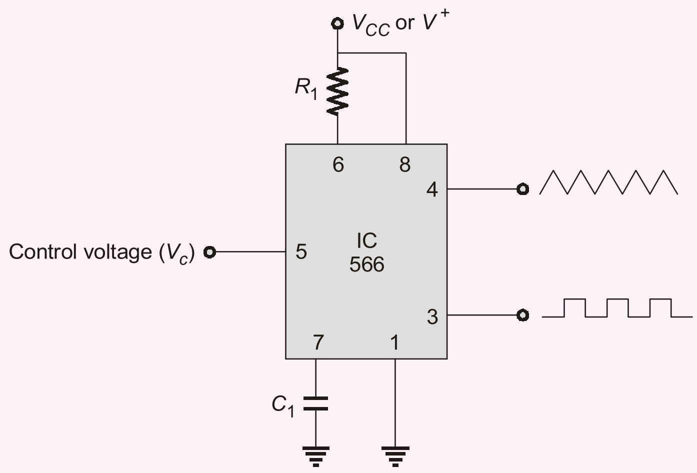
(b) $f_0 = 4\frac{V_+ + V_C}{V_+ R_1 C_1}$

(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)

The VCO design using 566 timer



$\therefore$ The centre frequency $(f_o) = \frac{2}{R_1 C_1}\left(1 - \frac{V_C}{V^+}\right) = 2\left[\frac{V_+ - V_C}{V_+ R_1 C_1}\right]$

End of Solution

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

(a) 25 Ω-cm

(b) 35 Ω-cm

(c) 45 Ω-cm

(d) 55 Ω-cm

Ans. (c)

$$\rho_i = \frac{1}{\sigma_i} = \frac{1}{n_i q(\mu_n + \mu_p)}$$

$$n_i = 2.5 \times 10^{13} \text{ cm}^{-3}$$

$$\mu_n = 3800 \text{ cm}^2/\text{V-sec}$$
$$\mu_p = 1800 \text{ cm}^2/\text{V-sec}$$
$$P_i = \frac{1}{2.5\times10^{13}\times1.6\times10^{-19}\,(3800+1800)} = 44.64 \simeq 45\ \Omega\text{-cm}$$

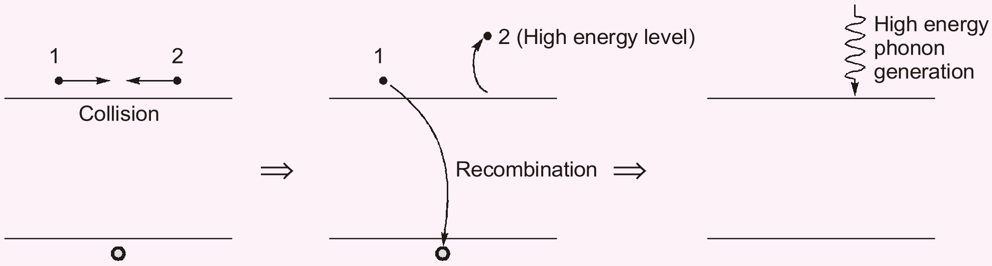
End of Solution

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. (a)

N-type ⇒ $n > p$



End of Solution

124. In reduction in noise and non-linear 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 introduced 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. (a)

End of Solution

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)

End of Solution

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)

End of Solution

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 Aβ

(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. (b)

End of Solution

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 lowering r and smaller than kT.

Ans. (a)

End of Solution

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)

End of Solution

130. A coil consists of 1000 turns of copper wire having a cross-sectional area of 0.8 mm^2. The mean 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 100 V 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

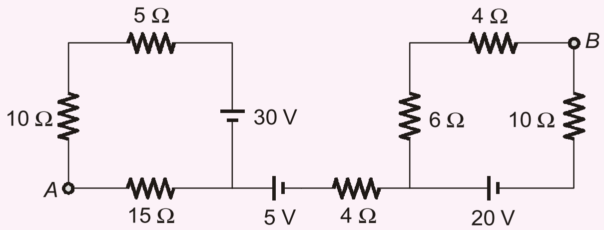
Ans. (c)

Given:

$$N = 1000 \; ; \quad V = 100 \text{ V}$$
$$A = 0.8 \times 10^{-6} \text{ m}^2$$
$$l = 80 \times 10^{-2} \text{ m}$$
$$\rho = 0.02 \times 10^{-6} \; \Omega\text{-m}$$
$$R = N\left(\frac{\rho l}{A}\right) = \frac{0.02 \times 10^{-6} \times 80 \times 10^{-2}}{0.8 \times 10^{-6}} \times 1000$$
$$R = 20 \; \Omega$$
$$P = \frac{V^2}{R} = \frac{(100)^2}{20} = 500 \text{ W}$$

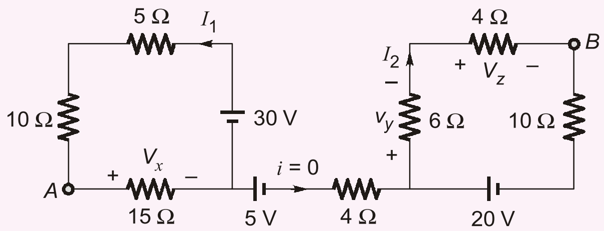
End of Solution

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

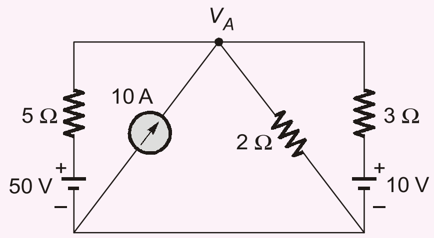
Ans. (b)



$$I_1 = \frac{30}{5 + 10 + 15} = 1 \text{ A}$$
$$I_2 = \frac{20}{4 + 6 + 10} = 1 \text{ A}$$
$$V_{AB} = V_x + 5 + V_y + V_z$$
$$= 15 \times 1 + 5 + 6 \times 1 + 4 \times 1$$
$$V_{AB} = 30 \text{ V}$$

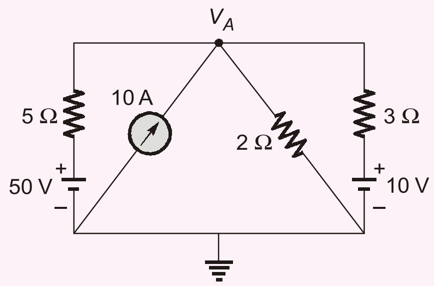
End of Solution

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)



Apply nodal at node V_A,

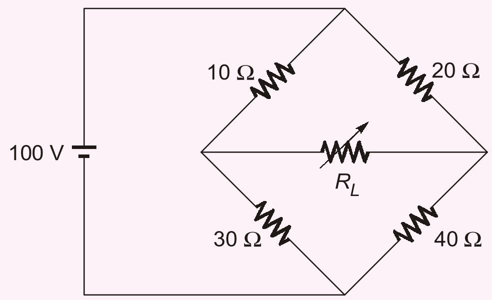
$$\frac{V_A - 50}{5} + \frac{V_A}{2} + \frac{V_A - 10}{3} = 10$$

$$V_A\left[\frac{1}{5} + \frac{1}{2} + \frac{1}{3}\right] = 10 + 10 + \frac{10}{3}$$

$$V_A = 22.65 \text{ V}$$

End of Solution

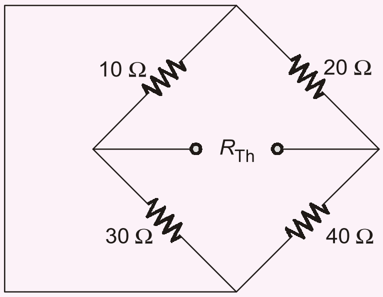
133. What is the value of resistance R_L in the circuit shown in the figure to deliver maximum power from the source to load?



(a) 22.83 Ω
(b) 20.83 Ω
(c) 18.83 Ω
(d) 16.83 Ω

Ans. (b)

For maximum power transfer, remove R_L from the circuit, and then calculate R_{Th} across it.



$$R_{Th} = (10 \,||\, 30) + (20 \,||\, 40) = \frac{10 \times 30}{40} + \frac{20 \times 40}{60}$$

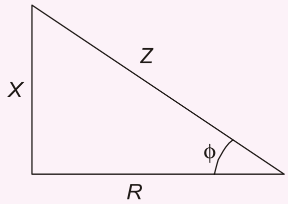
$$= 20.83 \ \Omega$$

For maximum transfer from source to load.

$$R_L = R_{Th} = 20.83 \ \Omega$$

End of Solution

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) (X/Z) lagging
(b) (R/X) lagging
(c) (R/Z) lagging
(d) (X/Z) leading

Ans. (c)

For RL series circuit,

Power factor, $\cos\phi = \frac{R}{Z}$ lagging

End of Solution

135. A coil consists of 750 turns and a current of 10 A in the coil gives rise to a magnetic flux of 1200 μWb. 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)

$$C = N\frac{d\phi}{dI} = 750 \times \frac{1200 \times 10^{-6}}{10} = 0.09 \text{ H}$$

$$E = 750 \times \frac{1200 \times 10^{-6}}{0.01} = 90 \text{ V}$$

End of Solution

136. In a physical diode, there is a component of the reverse 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* and *V-I* characteristics:
(a) *T* increases and *V* decreases
(b) *V* decreases and *T* increases
(c) *T* and *V* both increase
(d) *T* and *V* both decrease

Ans. (a)

T increases, I_o increases, I increases
T increases, *V* decreases.

$$\frac{dV}{dT} \simeq -2.5 \text{ mV/°C}$$

End of Solution

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)

A good insulating material should have
- Low dissipation factor.
- High dielectric strength.
- High operating temperature limit.

End of Solution

138. Which one of the following statements is 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 0.0005T, 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 0.0005T, 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 0.0002T, a multiplication of the external field by a factor of 2000.

Ans. (a)

$$B = \mu_r \mu_o H$$

$\Rightarrow$ $$B = \mu_r \times \mu_o H$$

where, $\mu_o H \rightarrow$ External field in Tesla
μ_r for iron is approximately 5000

$\therefore$ $$B = 5000 \times 0.0002 = 1 \text{ T}$$

End of Solution

139. Relative static error (ε_r) is

(a) $\dfrac{\text{absolute error}}{2 \times \text{true value}}$

(b) $\dfrac{2 \times \text{absolute error}}{\text{true value}}$

(c) $\dfrac{\text{absolute error}}{\text{true value}}$

(d) absolute error × true value

Ans. (c)

$$\text{Relative static error} = \frac{A_m - A_T}{A_T} = \frac{\text{Absolute error}}{\text{True value}}$$

End of Solution

140. In order to eliminate the effect of temperature variations upon the length of the spring.
(a) two spring coiled in opposite directions 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 springs coiled in same direction are used.

Ans. (a)
Two spring coiled in opposite directions are used.

End of Solution

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. (a)
Hygroscopic ⇒ Lithium chloride + Carbon on insulating substrate.

End of Solution

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)

Typical values of dissipation factor lies between 0.0001 to 0.001.

$$0.0001 \leq \tan\delta \leq 0.001$$

End of Solution

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:

(a) *P* *Q* *R*
2 1 3

(b) *P* *Q* *R*
3 1 2

(c) *P* *Q* *R*
2 3 1

(d) *P* *Q* *R*
1 2 3

Ans. (a)

End of Solution

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

(a) with limited shunt resistance.
(b) without any series resistance.
(c) without any shunt resistance.
(d) with minimum series resistance.

Ans. (c)

Without any shunt resistance.

End of Solution

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. (d)

Poisson's ratio for most metals lies in the range of 0.25 to 0.35.

End of Solution

146. The relation among minimum detectable signal (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)

The following formula is used to calculate the minimum detectable signal.

$$\text{MDS} = 10\times\log_{10}\left(\frac{kT}{1\,\text{mW}}\right) + \text{Noise Figure} + 10\times\log_{10}(\text{Bandwidth})$$

where,
MDS = Minimum Detectable Signal in dBm
T = Temperature in Kelvin
k = Boltzmann's constant (–228 dBW/(k.Hz))
Noise figure in dB
Bandwidth in Hz/MHz/GHz

End of Solution

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 obtaining the value of the attenuation at f_a directly.

Select the correct answer using the code given below:

(a) P Q R
2 3 1

(b) P Q R
3 2 1

(c) P Q R
1 2 3

(d) P Q R
3 1 2

Ans. (d)

End of Solution

148. In a rosette gauge, the angle between any two longitudinal gauge axes is
(a) 45° (b) 60°
(c) 70° (d) 85°

Ans. (a)
45° to the axis.

End of Solution

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. (a)

End of Solution

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)
Given that: EDM type instrument

$$\Rightarrow \quad I = 25 \text{ A}, \quad \frac{dM}{d\theta} = 0.0035 \text{ mH/rad}$$

$$K_c = 10^{-6} \text{ N-m/rad} \qquad \frac{dM}{d\theta} = 0.0035 \times 10^{-6} \text{ H/rad}$$

$$\theta = \frac{I^2}{K_c} \cdot \frac{dM}{d\theta}$$

$$\Rightarrow \quad \theta = \frac{(25)^2}{10^{-6} \text{ N-m/rad}} \times 0.0035 \times 10^{-6} \text{ H/rad}$$

$$\theta = 2.18 \text{ rad}$$

$$\theta = 2.18 \times \frac{180°}{\pi} = 125°$$

End of Solution

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