

OBJECTIVE PAPER-II

1. The closed-loop transfer function of a certain control system is given by $\frac{C}{R}(s) = \frac{100}{s^2 + 10s + 100}$. Then the settling time for a 2% tolerance band is given by (A) 0.8 s (B) 1.2 s (C) 1.5 s (D) 2.1 s

Key: (A)

Sol: $\frac{C}{R}(s) = \frac{100}{s^2 + 10s + 100}$

Settling time for 2% tolerance = 4τ

$\tau = 1/5$

$t_s = 4\tau = 4/5 = 0.8s$

2. The unit step input response of a certain control system is given by $c(t) = 1 + 0.2e^{-60t} - 1.2e^{-10t}$. The undamped natural frequency ω_n and damping ratio δ are, respectively (A) 24.5 and 1.27 (B) 33.5 and 1.27 (C) 24.5 and 1.43 (D) 33.5 and 1.43

Key: (C)

Sol: The step response

$c(t) = 1 + 0.2e^{-60t} - 1.2e^{-10t}$ then ω_n and δ are.
 $c(t) = 1 + 0.2e^{-60t} - 1.2e^{-10t}$

Impulse response

$h(t) = \frac{d}{dt}c(t)$

$\frac{dc(t)}{dt} = 0 + (0.2)(-60)e^{-60t} - 1.2(-10)e^{-10t}$

$h(t) = -12e^{-60t} + 12e^{-10t}$

Then transfer function

$\omega_n = 24.49 \text{ rad/sec}$

$2\xi\omega_n = 70$

$\xi = \frac{70}{2(24.49)} = 1.429$

$= 12 \left[\frac{1}{s+10} - \frac{1}{s+60} \right] = 12 \left[\frac{50}{s^2 + 70s + 600} \right]$

$= \frac{600}{s^2 + 70s + 600}$

$\therefore \omega_n^2 = 600$

3. In Force-Voltage Analogy (A) Force is analogous to current (B) Mass is analogous to capacitance (C) Velocity is analogous to current (D) Displacement is analogous to magnetic flux linkage

Key: (C)

Sol: In force- voltage analogy Velocity analogous to current

4. For a unity feedback control system having an open-loop transfer function $G(s) = \frac{25}{s(s+6)}$, what is the time t_p at which the peak of the step input response occurs? (A) 0.52s (B) 2.75s (C) 0.79s (D) 1.57s

Key: (C)

Sol: $G(s)H(s) = \frac{25}{s(s+6)}$

C.E $= 1 + GH = s^2 + 6s + 25 = 0$

$\omega_n = 5, \xi = 0.6, \omega_d = 4$

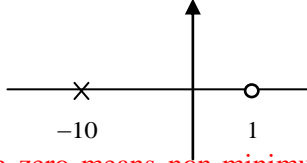
$t_p = \frac{\pi}{\omega_d} = 0.79 \text{ sec}$

5. The transfer function $G(s) = \frac{10(s-1)}{(s+10)}$ represents (A) Unstable system (B) Minimum phase system (C) Non-minimum phase system (D) PID controller system

Key: (C)

Sol: $G(s) = \frac{10(s-1)}{(s+10)}$

Represents
Single right side zero means non-minimum phase



6. What is the maximum input frequency limit of a 3-bit Ripple counter configured around flip-flops, with inherent propagation delay time $t_{pd} = 50 \text{ ns}$?
 (A) 6670 MHz (B) 667 MHz
 (C) 66.7 MHz (D) 6.67 MHz

Key: (D)

Sol: $f_{clk} = \frac{1}{N \cdot t_{pd}} = \frac{1}{3 \times 50 \times 10^{-9}} = 6.67 \text{ MHz}$

7. The characteristic equation of a certain feedback control system is given by $s^4 + 4s^3 + 13s^2 + 36s + k = 0$. The range of values of k for which the feedback system is stable, is given by
 (A) $0 < k < 4$ (B) $4 < k < 36$
 (C) $0 < k < 36$ (D) $13 < k < 36$

Key: (C)

Sol: $s^4 + 4s^3 + 13s^2 + 36s + k = 0$. Then the system is stable for

$$\begin{array}{l|ll} s^4 & 1 & 13 & k \\ s^3 & 4 & 36 & 0 \\ s^2 & 4 & k & 0 \\ s^1 & \frac{(36-k)}{4} & 0 & 0 \\ s^0 & k & 0 & 0 \end{array}$$

The system is stable, when the first column elements are positive.

$$\begin{aligned} 36 &> k \\ k &> 0 \\ 0 &< k < 36 \end{aligned}$$

8. The closed-loop transfer function of a unity feedback control system is,

$$\frac{C(s)}{R(s)} = \frac{\omega_n^2}{s^2 + \xi\omega_n s + \omega_n^2}$$

The velocity error constant of the system is

- (A) $\frac{\omega_n}{2\xi}$ (B) $\frac{\omega_n}{\xi}$ (C) $\frac{2\omega_n}{\xi}$ (D) $\frac{3\omega_n}{2\xi}$

Key: (A)

Sol: $\frac{C(s)}{R(s)} = \frac{\omega_n^2}{s^2 + 2\xi\omega_n s + \omega_n^2}$

$$G(s) = \frac{\omega_n^2}{s(s + 2\xi\omega_n)}$$

The velocity error constant

$$k_v = \lim_{s \rightarrow 0} sG(s)$$

$$\Rightarrow \lim_{s \rightarrow 0} \frac{\omega_n^2}{(s + 2\xi\omega_n)} = \frac{\omega_n^2}{2\xi\omega_n}$$

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

9. The system described by the following state equations

$$\dot{X} = \begin{bmatrix} 0 & 1 \\ 2 & -3 \end{bmatrix} X + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u, Y = [1, 1] X$$

1. Completely controllable
 2. Completely observable

Which of the above statements is/are correct?

- (A) 1 only (B) 2 only
 (C) Both 1 and 2 (D) Neither 1 nor 2

Key: (C)

Sol: $\dot{X} = \begin{bmatrix} 0 & 1 \\ 2 & -3 \end{bmatrix} X + \begin{bmatrix} 0 \\ 1 \end{bmatrix} U$

$$Y = [1, 1] x$$

$$Q_c = [B \quad AB]$$

$$AB = \begin{bmatrix} 0 & 1 \\ 2 & -2 \end{bmatrix} \begin{bmatrix} 0 \\ 1 \end{bmatrix} = \begin{bmatrix} 1 \\ -2 \end{bmatrix} \quad Q_c = \begin{bmatrix} 0 & 1 \\ 1 & -3 \end{bmatrix}$$

$$\text{Det} |Q_c| = -1 \neq 0 \therefore \text{Controllable}$$

$$CA = [1 \ 1] \begin{bmatrix} 0 & +1 \\ 2 & 3 \end{bmatrix}$$

$$= [2 \quad -2]$$

$$Q_0 = \begin{bmatrix} 1 & 1 \\ 2 & -2 \end{bmatrix}$$

$$\det|Q_0| = -2 - 2 = -4 \neq 0$$

∴ Observable

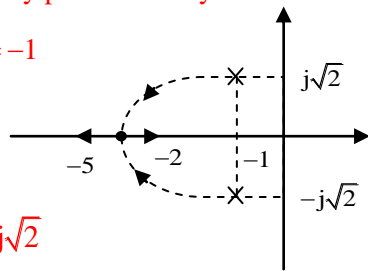
10. Consider the system with $G(s) = \frac{k(s+2)}{s^2 + 2s + 3}$ and $H(s) = 1$. The breakaway point(s) of the root loci is/are at
- (A) -0.265 only
 (B) -3.735 only
 (C) -3.735 and -0.265
 (D) There is no breakaway point

Key: (D)

Sol: $G(s) = \frac{k(s+2)}{s^2 + 2s + 3}$

The Breakaway point of the system is

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



$$s = -2, -1 \pm j\sqrt{2}$$

$$k = \frac{-(s^2 + 2s + 3)}{s + 2}$$

$$\frac{dk}{ds} = \frac{-[(s+2)(2s+2) - (s^2 + 2s + 3)]}{(s+2)^2} = 0$$

$$\frac{dk}{ds} = \frac{-[2s^2 + 2s + 4s + 4 - s^2 - 2s - 3]}{(s+2)^2}$$

$$k' = \frac{-[s^2 + 4s + 1]}{(s+2)^2} = 0$$

Break points

$$s^2 + 4s + 1 = 0$$

$$s = -0.26$$

$$s = -3.73$$

$s = -0.26$ is not on root locus therefore it is not valid

$s = -3.73$ is break in point where the Root locus branches are coming from complex plane to real axis. Therefore there are no break away points in the system.

11. How would a binary number 0010 be represented by a 4-bit binary word, if the range of voltage is 0 to 10 V?
- (A) 0.666 V (B) 1.333 V
 (C) 0.333 V (D) 2.000 V

Key: (B)

Sol: Full scale voltage = 10 V

$$\text{Resolution} = \frac{\text{Full Scale output}}{2^n - 1} = \frac{10}{2^4 - 1} = \frac{10}{15}$$

Voltage for binary number $(0010)_2 =$

$$\frac{2}{3} \times 2 = 1.333V$$

12. For a unity feedback system with open-loop transfer function $\frac{25}{s(s+6)}$, the resonant peak output M_m and the corresponding resonant frequency ω_m , are respectively
- (A) 2.6 and 2.64 rad/sec
 (B) 1.04 and 2.64 rad/sec
 (C) 2.6 and 4.8 rad/sec
 (D) 1.04 and 4.8 rad/sec

Key: (B)

Sol: $G(s) = \frac{25}{s(s+6)}$

$$\frac{C(s)}{R(s)} = \frac{25}{s^2 + 6s + 25}$$

$$\omega_n = 5$$

$$2\xi\omega_n = 6 \Rightarrow \xi = \frac{6}{10} = 0.6$$

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

$$= \frac{1}{2(0.6)\sqrt{1-0.6^2}}$$

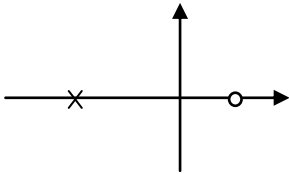
$$= \frac{1}{2(0.6)\sqrt{0.64}} = 1.04$$

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

$$= 5\sqrt{1 - 2(0.6)^2} = 2.645 \text{ rad / sec}$$

13. The transfer function of a control system is said to be 'All Pass System', if it has
- (A) Unit magnitude at all frequencies with anti-symmetric pole-zero pattern
 - (B) Unit magnitude at all frequencies with symmetric pole-zero pattern
 - (C) Magnitude varying with frequency and with anti-symmetric pole-zero pattern
 - (D) Unit magnitude at some frequencies with symmetric pole-zero pattern

Key: (A)
Sol:



Pole zero pattern is anti-symmetric about imaginary axis.

14. Consider the following:
1. Bode plot
 2. Nyquist plot
 3. Nichols chart
- Which of the above frequency response plots are commonly employed in the analysis of control systems?
- (A) 1 and 2 only
 - (B) 1 and 3 only
 - (C) 2 and 3 only
 - (D) 1, 2 and 3

Key: (D)

15. An A-to-D converter in which one sub-circuit is a D-to-A converter is
- (A) Parallel A/D converter
 - (B) Dual slope A/D converter
 - (C) Successive approximation A/D converter
 - (D) Extended parallel type A/D converter

Key: (C)

16. Consider the transfer function:

$$G(s) = \frac{5(s^2 + 10s + 100)}{s^2(s^2 + 15s + 1)}$$

The corner frequencies in Bode's plot for this transfer function are as

- (A) 10 rad/sec and 10 rad/sec
- (B) 100 rad/sec and 10 rad/sec
- (C) 10 rad/sec and 1 rad/sec
- (D) 100 rad/sec and 1 rad/sec

Key: (C)

Sol: $G(s) = \frac{5(s^2 + 10s + 100)}{s^2(s^2 + 15s + 1)}$

The corner frequencies of Bode plot

$$\omega_n = 10,$$

$$10 \text{ rad/sec}, 1 \text{ rad/sec}$$

17. Consider the transfer function $(0.1 + 0.01s)$ for a PD controller. What is the frequency at which the magnitude is 20 dB (by using asymptotic Bode's plot) ?
- (A) 2000 r/s
 - (B) 1000 r/s
 - (C) 200 r/s
 - (D) 100 r/s

Key: (B)

Sol: $G(s) = (0.1 + 0.01s)$

The frequency at which the magnitude is 20dB

$$G(s) = 0.1 [1 + 0.1s]$$

Asymptotic magnitude

$$M_{asy} = 20\log [0.1] + 20\log [0.1\omega] = 20$$

$$20\log[0.1\omega] = 40$$

$$0.1\omega = 10^2$$

$$\omega = 1000 \text{ rad / sec}$$

18. The main objectives of drawing the root locus plot are
1. To obtain a clear picture of the open-loop poles and zeros of the system
 2. To obtain a clear picture of the transient response of the system for varying gain, K

3. To find the range of K to make the system stable

Which of the above statements are correct?

- (A) 1, 2 and 3 (B) 1 and 2 only
(C) 1 and 3 only (D) 2 and 3 only

Key: (D)

Sol: Root locus main objectives

1. The open-loop poles zeros location is known with simple s-plane. The Root locus will give clear picture of closed loop-poles movement.
2. To obtain clear picture of transient response of the system with gain K.
3. To find the range of K to make the system stable.

19. A unity feedback system has open-loop poles at $s = -2 \pm j2$, $s = -1$ and $s = 0$ and a zero at $s = -3$. What are the angles made by the root-loci asymptotes with the real axis?

- (A) 60° , 180° and -60°
(B) 30° , 90° and 60°
(C) 60° , 120° and -30°
(D) 30° , 60° and 180°

Key: (A)

Sol: $s = -2 \pm j2$

$$s = -1$$

$$s = 0$$

are poles of the system $s = -3$ is zero of the system.

The asymptotes are

$$p = 4 \rightarrow \text{number of poles}$$

$$z = 1 \rightarrow \text{number of zeros}$$

$$p - z = 3$$

$$\phi = \frac{(2q+1)180^\circ}{p-z}, q = 0, 1, 2, \dots - p - z - 1$$

\therefore Asymptotes are $\pm 60^\circ, \pm 180^\circ, \pm 300^\circ$

20. The open-loop transfer function of a unity feedback system is $G(s) = \frac{K}{s(s+5)}$. The gain

K that results in a phase margin of 45° is

- (A) 35 (B) 30 (C) 25 (D) 20

Key: (A)

Sol: The K value such that phase margin is $= 45^\circ$

Phase margin ϕ_{pm}

$$\phi_{pm} = 180^\circ + \phi_{sys}(\omega_{gc}) = 45^\circ$$

$$\phi_{pm}(\omega_{gc}) = -135^\circ$$

$$\phi_{sys}(\omega) = -90^\circ - \tan^{-1}\left[\frac{\omega}{5}\right]$$

$$\phi_{sys}(\omega_{gc}) = -90^\circ - \tan^{-1}\left(\frac{\omega_{gc}}{5}\right)$$

$$-90^\circ - \tan^{-1}\left[\frac{\omega_{gc}}{5}\right] = -135^\circ$$

$$\omega_{gc} = 5$$

Magnitude

$$M = \frac{K}{\omega\sqrt{\omega^2 + 25}}$$

$$M(\omega_{gc}) = \frac{K}{\omega_{gc}\sqrt{\omega_{gc}^2 + 25}} = 1$$

$$K = 5\sqrt{25 + 25} = 35.35$$

21. From the Nichols chart, one can determine the following quantities pertaining to a closed-loop system:

- (A) Magnitude, bandwidth and phase
(B) Bandwidth and phase only
(C) Magnitude and phase only
(D) Bandwidth only

Key: (A)

Sol: Nichols chart is used for finding the magnitude, phase and BW

22. In position control systems, the Tachogenerator feedback is used to

- (A) Increase the effective damping in the system
(B) Decrease the effective damping in the system
(C) Decrease the Steady state error
(D) Increase the steady state error

Key: (A)

Sol: Tacho-generator feedback is example for D controller. Derivative controller reduces ripples in the response i.e., maximum peak over shoot reduces.

$\xi \uparrow$

\therefore effective damping increases

23. Consider the following statements:

1. The pin diode consists of two narrow, but highly doped, semiconductor regions separated by a thicker, lightly doped material called the intrinsic region.
2. Silicon is used most often for its power handling capability and because it provides a highly resistive intrinsic region.
3. The pin diode acts as an ordinary diode at frequencies above 100 MHz.

Which of the above statements are correct?

- (A) 1 and 2 only (B) 1 and 3 only
(C) 2 and 3 only (D) 1, 2 and 3

Key: (A)

Sol: The pin diode acts as an ordinary diode at frequencies up to about 100MHz, but above this frequency the operational characteristics changes and begins acting as a variable resistance.

24. Consider the following statements:

1. Additional cavities serve to velocity modulate the electron beam and produce an increase in the energy available at the output.
2. The addition of intermediate cavities between the input and output cavities of the basic klystron greatly improves the amplification, power output, and efficiency of the klystron.

Which of the above statements is/are correct?

- (A) 1 only (B) 2 only
(C) Both 1 and 2 (D) neither 1 nor 2

Key: (C)

25. In a waveguide with perfectly conducting flat wall, the angle of reflection is equal to the angle of

- (A) Diffraction (B) Incidence
(C) Refraction (D) Penetration

Key: (B)

Sol: In a waveguide with perfectly conducting flat wall, the angle of reflection is equal to the angle of incidence.

26. In microwave system, waveguides have the advantages of

- (A) High power-handling capability and low loss
(B) Thin dielectric substrate
(C) Low power-handling and adequate stability
(D) Positive phase shift

Key: (A)

27. A straight dipole radiator fed in the centre will produce maximum radiation at

1. The plane parallel to its axis
2. The plane normal to its axis
3. Extreme ends

Which of the above statements is/are correct?

- (A) 1 only (B) 2 only
(C) 1 and 3 only (D) 2 and 3 only

Key: (B)

28. In communication systems, modulation is the process of

- (A) Improving frequency stability of transmitter
(B) Combining message signal and radio frequency waves

- (C) Generating constant frequency radio waves
(D) Reducing distortion in RF waves

Key: (B)

Sol: Modulation is a process of changing the characteristic of carrier signal (radio frequency) with respect to message signal.

29. Which one of the following statements is correct?
(A) Sampling and quantization operate in amplitude domain
(B) Sampling and quantization operate in time domain.
(C) Sampling operates in time domain and quantization operates in amplitude domain.
(D) Sampling operates in amplitude domain and quantization operates in time domain.

Key: (C)

Sol: Sampling discretize the time axis. Quantization discretize the amplitude axis.

30. What is the voltage attenuation provided by a 25 cm length of waveguide having a = 1 cm and b = 0.5 cm in which a 1 GHz signal is propagated in the dominant mode?
(A) 721 dB (B) 681 dB
(C) 521 dB (D) 481 dB

Key: (B)

Sol: Given a = 1cm; b = 0.5cm

$$l = 25\text{cm} = 25 \times 10^{-2} \text{ m}$$

$$\lambda_c = 2a = 2\text{cm} = 2 \times 10^{-2} \text{ m}$$

$$\text{Attenuation}(\alpha) = 54.5 \frac{l}{\lambda_c}$$

$$\alpha = 54.5 \left(\frac{25}{2} \right) \text{ dB}$$

$$\alpha = 681.25 \text{ dB}$$

31. When a plane wave travelling in free-space is incident normally on a medium having

$\epsilon_r = 9.0$ and $\mu_r = 1.0$, the fraction of power transmitted into the medium is

- (A) $\frac{4}{3}$ (B) $\frac{3}{4}$ (C) $\frac{1}{2}$ (D) $\frac{1}{3}$

Key: (B)

$$\text{Sol: } \Gamma = \frac{\eta_2 - \eta_1}{\eta_2 + \eta_1} = \frac{\sqrt{\epsilon_1} - \sqrt{\epsilon_2}}{\sqrt{\epsilon_1} + \sqrt{\epsilon_2}}$$

$$\Gamma = \frac{1-3}{1+3} = \frac{-1}{2}$$

Fraction of transmitted power

$$= (1 - |\Gamma|^2) = \left(1 - \frac{1}{4} \right) = \frac{3}{4}$$

32. A microwave antenna with the absorbing cross-section area (A) and the power flux density (S) in the incident wave is employed as an absorber. The absorbed power (P) of the antenna is

- (A) $\frac{A}{S}$ (B) $\frac{S}{A}$ (C) SA (D) $\frac{S+1}{A-1}$

Key: (C)

33. LASER beam of light essentially finds its application in transmission of a signal in the optical fiber communication systems due to
(A) Incredible speed of signal communication
(B) Low loss transmission of the signal
(C) Inexpensive installation cost
(D) Bulk availability of LASER sources

Key: (A & B)

34. The controller which is highly sensitive to noise is
(A) PI (B) PD
(C) Both PI and PD (D) Neither PI nor PD

Key: (B)

Sol: PD controller is very sensitive to noise

35. The 2's complement representation of -17 is
(A) 100001 (B) 101111
(C) 110011 (D) 101110

Key: (B)

Sol: $-17 = 2$'s comp of $(+17) = (1^{\text{st}} \text{ complement} + 1)$
 $= 2$'s comp of (010001)
 $= 101111$

36. The subtraction of two hexadecimal numbers $84_{16} - 2A_{16}$ results in
 (A) $2B_{16}$ (B) $3A_{16}$ (C) $4B_{16}$ (D) $5A_{16}$

Key: (D)

Sol: $84_{16} - 2A_{16} = 5A_{16}$
 $(84)_{16} \rightarrow (132)_{10}$
 $-(2A)_{16} \rightarrow -(42)_{10}$
 $(5A)_{16} \quad (90)_{10}$

37. The Vestigial Side Band (VSB) modulation is preferred in TV systems because

1. It reduces the bandwidth requirement to half
2. It avoids phase distortion at low frequencies

Which of the above statements is/are correct?

- (A) 1 only (B) 2 only
 (C) Both 1 and 2 (D) Neither 1 nor 2

Key: (B)

Sol: Bandwidth in VSB is $1.25B$, where B is message signal bandwidth.
 Phase distortion are reduced at low frequency.

38. If, $A = 60$ and $B = 3$, then using C-programming $A \gg B$ results in

- (A) 11100000 (B) 00000111
 (C) 00111111 (D) 01111000

Key: (B)

Sol: We have to do the right shifting of binary equivalent of 60 by 3 bit positions.
 $00111100 \gg 3 \Rightarrow 00000111$

39. What is the base of the numbers for the following operation to be correct?

$$\frac{(54)_b}{(4)_b} = (13)_b$$

- (A) 2 (B) 4 (C) 8 (D) 16

Key: (C)

Sol: $\frac{54_b}{4_b} = 13_b$
 $(5b + 4) = (b + 3)4$
 $5b + 4 = 4b + 12$
 $\therefore b = 8$

40. It is awkward to employ signed-magnitude system in computer arithmetic, because

1. Sign and magnitude have to be handled separately
2. It has two representations for '0'

Which of the above statements is/are correct?

- (A) 1 only (B) 2 only
 (C) Both 1 and 2 (D) Neither 1 nor 2

Key: (B)

Sol: Statement 2 is correct.

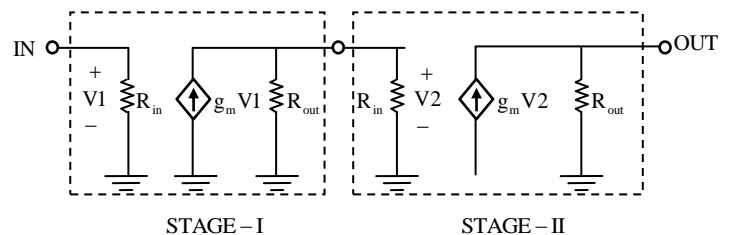
The signed $-$ magnitude system is used in ordinary arithmetic but is awkward when employed in computer arithmetic. Therefore, the signed complement is normally used. The 1 's complement imposes difficulties because it has representations of 0 ($+0$ to -0)

41. A single-stage amplifier has a voltage gain of 100 . The load connected to the collector is 500Ω and its input impedance is $1 \text{ k}\Omega$. Two such stages are connected in cascade through an R-C coupling. The overall gain is

- (A) 10000 (B) 6666.66
 (C) 5000 (D) 1666.66

Key: (B)

Sol:



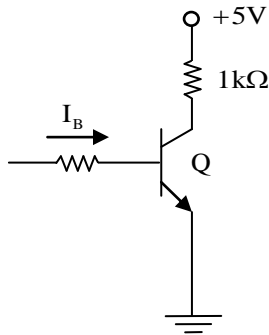
$$R_{IN} = 1k\Omega, R_{OUT} = 500\Omega$$

$$g_m R_{OUT} = 100 \text{ (Given)}$$

$$g_m = \frac{100}{500} = 0.2s$$

$$\begin{aligned} \text{Overall gain} &= g_m (R_{OUT} \parallel R_{IN}) \cdot g_m (R_{OUT}) \\ &= 0.2 \times \frac{1000 \times 0.5}{1.5} \times 0.2 \times 500 \\ &= 6666.66 \end{aligned}$$

42. Assuming $V_{CE(sat)} = 0.3V$ for a Silicon transistor at ambient temperature of $25^\circ C$ and $h_{FE} = 50$, the minimum base current I_B required to drive the transistor into saturation for the circuit shown is



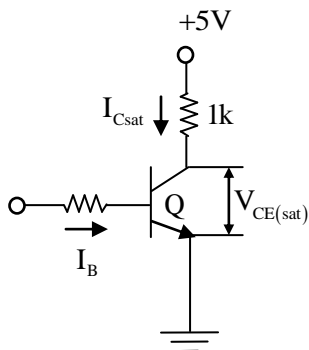
- (A) $64\mu A$ (B) $78\mu A$
(C) $94\mu A$ (D) $140\mu A$

Key: (C)

Sol: Step: (1)

KVL for output section of the circuit

$$I_{Csat} = \frac{5V - V_{CEsat}}{1k} = \frac{5V - 0.3V}{1k} = 4.7mA$$



Step: (2)

Minimum Base current required to drive the BJT into saturation, I_{Bmin}

$$I_{Bmin} = \frac{I_{Csat}}{\beta} = \frac{I_{Csat}}{h_{FE}} = \frac{4.7mA}{50} = 94\mu A$$

43. Which of the following regions of operation are mainly responsible for heating of the transistor under switching operation?
1. Saturation region
 2. Cut-off region
 3. Transition from saturation to cut-off
 4. Transition from cut-off to saturation
- Select the correct answer using the codes given below
(A) 1, 2, and 4 only (B) 1, 3, and 4 only
(C) 2 and 3 only (D) 1 and 3 only

Key: (B)

Sol: The heating of a transistor under switching operation occurs during
→ Transition from saturation to cut-off
→ Transition from cut-off to saturation
→ Saturation region

44. In a sinusoidal oscillator, sustained oscillations will be produced only if the loop gain (at the oscillation frequency) is
- (A) Less than unity but not zero
 - (B) zero
 - (C) Unity
 - (D) Greater than unity

Key: (C)

Sol: The condition for sustained oscillation in a sinusoidal oscillator at a particular frequency is $A_v\beta = \text{Loop gain} = 1$ (Barkhausen criteria)

45. The Class-B push-pull amplifier is an efficient two-transistor circuit, in which the two transistors operate in the following way:

- (A) Both transistors operate in the active region throughout the negative ac cycle
- (B) Both transistors operate in the active region for more than half-cycle but less than a whole cycle
- (C) One transistor conducts during the positive half-cycle and the other during the negative half-cycle
- (D) Full supply voltage appears across each of the transistors

Key: (C)

Sol: In a class-B push-pull amplifier, the conduction angle of each transistor is 180° (i.e.) Each transistor is biased to conduct for **ONE-HALF CYCLE OF INPUT SIGNAL** only. In other words,

→ During +Ve half cycle of input signal, One transistor (Let Q_1) is pulled into ON state and the other transistor (Let Q_2) is pushed into OFF state.

→ During -Ve half-cycle of input, Q_2 is pulled into ON state and Q_1 is pushed into OFF state.

46. Consider the following statements regarding Wien Bridge oscillator:
1. It has a larger bandwidth than the phase shift oscillator.
 2. It has a smaller bandwidth than the phase shift oscillator.
 3. It has 2 capacitors while the phase shift oscillator has 3 capacitors.
 4. It has 3 capacitors while the phase shift oscillator has 2 capacitors.

Which of the above statements are correct?

- (A) 1 and 3 only (B) 2 and 4 only
- (C) 1 and 4 only (D) 2 and 3 only

Key: (A)

Sol: RC Phase shift Oscillator

→ Suitable for oscillations in Audio frequency (AF) range, preferably upto 1

kHz.

→ Three identical RC sections are to be used in the phase shift network to construct a practical RC Phase shift oscillator.

Wien Bridge Oscillator

→ Suitable for Oscillations in AF range up to 100kHz.

→ Two RC sections (One series RC & one parallel RC) are used in the feedback network

47. For normal operation of a transistor
- (A) Forward bias the emitter diode and reverse bias the collector diode
 - (B) Forward bias the emitter diode as well as the collector diode
 - (C) Reverse bias the emitter diode as well as the collector diode
 - (D) Reverse bias the emitter diode and forward bias the collector diode

Key: (A)

Sol: Normal operation of a transistor is **ACTIVE REGION** of operation

Emitter Diode/ Emitter junction, J_E	Collector Diode/ Collector junction	Region of operation
R.B	R.B	Cut-off Region
F.B	F.B	Saturation Region
F.B	R.B	Normal active region
R.B	F.B	Inverse (or) Reverse Active Region

48. Consider the following statements regarding linear power supply:
1. It requires low frequency transformer.
 2. It requires high frequency transformer.

3. The transistor works in active region. Which of the above statements is/are correct?

- (A) 1 only (B) 2 and 3 only
(C) 1 and 3 only (D) 3 only

Key: (C)

Sol: The Requirements of Linear Power supply:

- As the input signal or line voltage frequency is very low, to handle this, a low frequency transformer is required.
- As the transistor is a control element in linear voltage regulator, it must be operated in active region, so that the load current (or Emitter current) is controlled as per the requirements.

49. The capacitance of a full wave rectifier, with 60Hz input signal, peak output voltage $V_p = 10V$, load resistance $R = 10\text{ k}\Omega$ and input ripple voltage $V_r = 0.2V$, is
(A) 22.7 μF (B) 33.3 μF
(C) 41.7 μF (D) 83.4 μF

Key: (C)

Sol: The general formula for ripple voltage V_{ripple} in FWR with capacitor filter is

$$V_{\text{ripple}} = \frac{V_p}{2fCR};$$

$$C = \frac{V_p}{2fR V_{\text{ripple}}}$$

$$= \frac{10V}{2 \times 60\text{Hz} \times 10 \times 10^3 \times 0.2V} = 41.66\mu F$$

50. A full wave rectifier connected to the output terminals of the mains transformer produces an RMS voltage of 18 V across the secondary. The no-load voltage across the secondary of the transformer is
(A) 1.62V (B) 16.2V
(C) 61.2V (D) 6.12V

Key: (B)

Sol: Note: The question should have been “The no-load DC voltage across the output of the rectifier is” Full wave rectifier

$$\text{Step(1): } V_{\text{rms}} = 18V = \frac{V_m}{\sqrt{2}}$$

$$V_m = \sqrt{2} \times 18V = 25.4558V$$

Step(2):

$$\text{No-load voltage } V_{\text{DC}} = \frac{2V_m}{\pi}$$

$$= \frac{2 \times 25.4558V}{\pi} = 16.2139V$$

51. An op-Amp can be connected to provide
1. Voltage controlled current source
2. Current controlled voltage source
3. Current controlled current source
Which of the above statements are correct?
(A) 1 and 2 only (B) 1 and 3 only
(C) 2 and 3 only (D) 1, 2 and 3

Key: (D)

Sol: An Op-amp can be connected to provide

- Voltage controlled voltage source (VCVS), whose output voltage ‘ V_0 ’ is controlled by the input voltage ‘ V_i ’
- Current controlled current source (CCCS), whose output current ‘ I_0 ’ is controlled by the input current ‘ I_i ’
- Voltage controlled current source (VCCS), whose output current ‘ I_0 ’ is controlled by the input voltage ‘ V_i ’.
- Current controlled voltage source (CCVS), whose output voltage ‘ V_0 ’ is controlled by the input current ‘ I_i ’.

52. In an Op-Amp, if the feedback voltage is reduced by connecting a voltage divider at the output, which of the following will happen?
1. Input impedance increases
2. Output impedance reduces
3. Overall gain increases
Which of the above statements is/are correct?
(A) 1only (B) 2 only
(C) 3 only (D) 1, 2 and 3

Key: (C)

Sol: If Feedback factor (β) is reduced

$$\beta = \frac{V_f}{V_o}$$

$$A_{CL} = \frac{A}{1 + A\beta} \rightarrow \text{Increases}$$

$$R_{IN_{CL}} = R_{IN}(1 + A\beta) \rightarrow \text{Decreases}$$

$$R_{OUT_{CL}} = \frac{R_{OUT}}{1 + A\beta} \rightarrow \text{Increases}$$

53. The transient response rise time (unity gain) of an Op-Amp is 0.05 μ s. The small signal bandwidth is

- (A) 7 kHz (B) 20 kHz
(C) 7 MHz (D) 20 MHz

Key: (C)

Sol: Rise time of an op-Amp, $t_r = 0.05\mu\text{sec}$
Small-signal band width can be related to t_r using the relation

$$t_r = \frac{0.35}{\text{BW}}$$

$$\text{BW} = \frac{0.35}{t_r} = \frac{0.35}{0.05 \times 10^{-6}} = 7\text{MHz}$$

54. A negative feedback of $\beta = 2.5 \times 10^{-3}$ is applied to an amplifier of open-loop gain 1000. What is the change in overall gain of the feedback amplifier, if the gain of the internal amplifier is reduced by 20%?

- (A) 295.7 (B) 286.7
(C) 275.7 (D) 266.7

Key: (D)

Sol: $A = 1000, \beta = 2.5 \times 10^{-3} = 0.0025$

Step (1)

$$A_f = \frac{A}{1 + A\beta} = \frac{1000}{1 + 1000 \times 0.0025} = 285.714$$

Step: (2)

Gain of internal amplifier is reduced by 20% \Rightarrow 20% of 1000 = 200

i.e., $A_{New} = 1000 - 200 = 800$

$$A_{f_{New}} = \frac{800}{1 + 800 \times 0.0025} = \frac{800}{1 + 2} = 266.667$$

55. If the quality factor of a single-stage single tuned amplifier is doubled, the bandwidth will

- (A) Remain the same
(B) Become half
(C) Become double
(D) Become four times

Key: (B)

Sol: Quality factor $Q \uparrow = \frac{f_0}{\text{BW} \downarrow}$

If Q is doubled \Rightarrow Bandwidth will become half

56. Consider the following statements related to oscillator circuits:

1. The tank circuit of a Hartley oscillator is made up of a tapped capacitor and a common inductor.
2. The tank circuit of a Colpitts oscillator is made up of a tapped capacitor and a common inductor.
3. The Wien Bridge oscillator is essentially a two-stage amplifier with an RC bridge in the first stage, and, the second stage serving as an inverter.
4. Crystal oscillators are fixed frequency oscillators with a high Q-factor.

Which of the above statements are correct?

- (A) 1, 2 and 3 only (B) 2, 3 and 4 only
(C) 1, 2 and 4 only (D) 1, 3 and 4 only

Key: (B)

Sol: Hartley Oscillator used as a tapped inductor

57. The most commonly used transistor configuration for use as a switching devices is

- (A) Common-base configuration
(B) Common-collector configuration
(C) Collector-emitter shorted configuration
(D) Common-emitter configuration

Key: (D)

Sol: CB configuration

1. Current amplifier
2. Used as current Buffer
3. Current controlled current source

CC configuration

1. Voltage amplifier
2. Used as voltage Buffer
3. Voltage controlled voltage source

CE configuration

General purpose configuration used in

1. Amplifier circuits
2. Switching circuits

- 58.** The value of h_{FE} (the hybrid parameters) of a Common-Emitter (CE) connection of a Bipolar Junction Transistor (BJT) is given as 250. What is the value of α_{dc} (ratio of collector current to emitter current), for this BJT?

- (A) 0.436 (B) 0.656
(C) 0.874 (D) 0.996

Key: (D)

Sol: The current amplification factor of a BJT in CE configuration

$$\beta = h_{FE} = \frac{I_C}{I_B} = 250$$

$$\alpha_{DC} = \frac{I_C}{I_E} = \frac{\beta}{1 + \beta} = \frac{250}{251} = 0.996$$

- 59.** For realizing a binary half-subtractor having two inputs A and B, the correct set of logical expressions for the outputs D (A minus B) and X(borrow) are

1. The difference output $D = \bar{A}B + A\bar{B}$
2. The borrow output $B = A\bar{B}$

Which of the above statements is/are correct?

- (A) 1 only (B) 2 only
(C) Both 1 and 2 (D) Neither 1 nor 2

Key: (A)

Sol: $D = \text{Difference} = \bar{A}B + A\bar{B}$
 $B = \text{Borrow} = A\bar{B}$

- 60.** The simplified form of the Boolean expression $AB + A(B + C) + B(B + C)$ is given by

- (A) $AB + AC$ (B) $B + AC$
(C) $BC + AC$ (D) $AB + C$

Key: (B)

Sol: $F = AB + A(B + C) + B(B + C) = AB + AB + AC + B + BC = B(A + A + 1 + C) + AC$ [$\because 1 + A = 1$]
 $= B + AC$

- 61.** Consider the following statements: Pointers in C-programming are useful to

1. Handle the data tables efficiently
 2. Reduce the length of a program
 3. Reduce the complexity of a program
- Which of the above statements are correct?

- (A) 1 and 2 only (B) 1, 2 and 3
(C) 2 and 3 only (D) 1 and 3 only

Key: (B)

Sol: With the help of pointer concept only. We can pass all the elements of the array just by passing the base address.

- 62.** Data transfer between the main memory and the CPU register takes place through two registers, namely,

- (A) General purpose register and MDR
(B) Accumulator and Program counter
(C) MAR and MDR
(D) MAR and Accumulator

Key: (C)

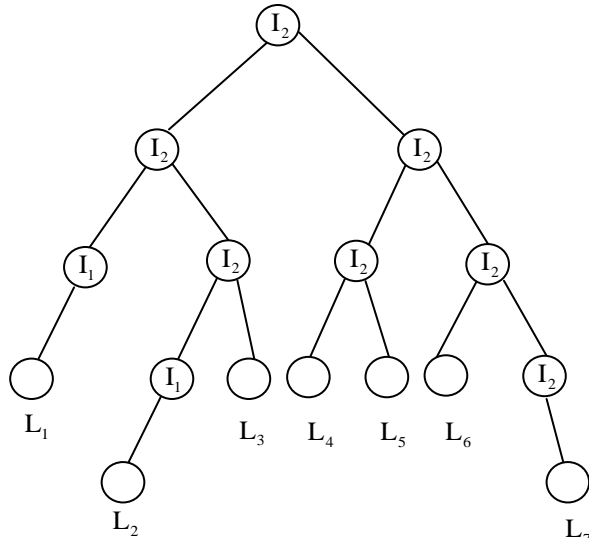
Sol: **MAR** → Memory Address Register
The MAR holds the address of the location to be accessed.

MDR → Memory Data Register
The MDR contains the data to be written into or read out of the addressed location.

63. In a binary tree, the number of internal nodes of degree 1 is 3, and the number of internal nodes of degree 2 is 6. The number of leaf nodes in the binary tree is
(A) 7 (B) 8 (C) 9 (D) 10

Sol: $I_1 = 3, I_2 = 6, E = 15$
node = 16

Number of edges = $(2) \times 16 + (1) \times 3 = 15$
nodes = $15 + 1 = 16$



The number of leaf nodes $s = 16 - (6+3) = 7$

64. Consider the following:
1. Operation code
2. Source operand reference
3. Result operand reference
4. Next instruction reference
Which of the above are typical elements of machine instructions?
(A) 1, 2 and 3 only (B) 1, 2 and 4 only
(C) 3 and 4 only (D) 1, 2, 3 and 4

Key: (A)

Sol: Typical elements of machine instructions are
1. Operation code (Op-code)
2. Source operand reference
3. Result operand reference

65. Which addressing mode helps to access table data in memory efficiently?

- (A) Indirect mode
(B) Immediate mode
(C) Auto-increment or Auto-decrement mode
(D) Index mode

Key: (D)

Sol: Index addressing mode helps to access table data in memory efficiently

66. Converting an analog signal to digital signal is done by Sampling and
(A) Companding (B) Mixing
(C) Quantizing (D) Pre-emphasis

Key: (C)

Sol: Total Data rate = $N \cdot r_b$

$N =$ number of users

$r_b =$ Bit rate

Total data rate = $4 \times 3\text{kbps}$
= 12kbps

Bit duration = $\frac{1}{12 \times 10^3}$

For one frame 4 bits are included.

Thus time duration for one frame =

$4 \times \frac{1}{12 \times 10^3} = \frac{1}{3} \times 10^{-3} = 0.33\text{msec}$

67. A computer employs RAM chips of 256 bytes and ROM chips of 1024 bytes. If the computer system needs 1 kB of RAM and 1 kB of ROM, then how many address lines are required to access the memory?
(A) 10 (B) 11 (C) 12 (D) 13

Key: (B)

Sol: As per question, computer system needs 1kB of RAM and 1kB ROM which means that computer system needs 2kB, (RAM size+ ROM size) of total memory.
 $2\text{kB} = 2^1 \cdot 2^{10} \text{B} = 2^{11} \text{B}$ so, number of address lines = 11. Hence option B is correct answer.

68. A computer system has a cache with access time 10 ns, a hit ratio of 80% and average

memory access time is 20 ns. Then what is the access time for physical memory?

- (A) 50 ns (B) 40 ns (C) 30 ns (D) 20 ns

Key: (A)

Sol: Given data

$$T_C = 10\text{ns}, H = 80\%$$

$$T_{\text{avg}} = 20\text{ns}, T_M = ?$$

$$T_{\text{avg}} = H \times T_C + (1 - H)(T_C + T_M)$$

$$20 = (0.8)(10) + (0.2)(10 + T_M)$$

$$20 = \frac{8}{10} \times 10 + \frac{2}{10} \times 10 + (0.2)T_M$$

$$20 = 10 + 0.2T_M \Rightarrow 20 - 10 = 0.2T_M$$

$$0.2T_M = 10 \Rightarrow T_M = \frac{10}{0.2} = 50\text{ns}$$

69. In synchronous TDM, there are four inputs and data rate of each input connection is 3 kbps. If 1 bit at a time is multiplexed, what is the duration of each frame ?

- (A) 0.02 ms (B) 0.03 ms
(C) 0.33 ms (D) 0.22 ms

Key: (C)

Sol: Synchronous TDM,

$$\text{No. of Inputs} = N = 4$$

Data rate of each input connection

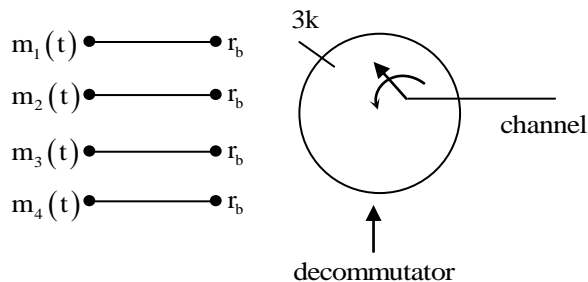
$$= 3 \text{ kbps} = n f_s$$

Data rate of TDM system (in the channel)

$$= N.n f_s = 4 \times 3\text{k}$$

$$r_b = 12 \text{ kbps}$$

$$\text{Each bit duration} = T_b = \frac{1}{r_b} = \frac{1}{12\text{k}} \text{ sec}$$



“1 bit at a time is multiplexed”. Collection of each sample from all signals constitutes a frame. Since 1 bit at a time is multiplexing one frame contains 4 bits.

(∵ Input signals are 4)

∴ Frame duration = 4bits duration

$$= 4T_b$$

$$= 4 \times \frac{1}{12\text{k}} = 0.33\text{msec}$$

70. Consider the following statements comparing Static RAM with Dynamic RAM:

1. In Static RAM typical cell requires more number of transistors than the Dynamic RAM.
2. Power consumption per bit of Static RAM is less than that of Dynamic RAM.
3. Dynamic RAM is less expensive than the Static RAM.

Which of the above statements are CORRECT?

- (A) 1, 2 and 3 (B) 1 and 2 only
(C) 2 and 3 only (D) 1 and 3 only

Key: (D)

- Sol:**
- In Static RAM typical cell requires more number of transistors than the Dynamic RAM.
 - Dynamic RAM is less expensive than the Static RAM.
 - SRAM Consumes more power.

71. An addressing mode in which the location of the data is contained within the mnemonic, is known as

- (A) Immediate addressing mode
(B) Implied addressing mode
(C) Register addressing mode
(D) Direct addressing mode

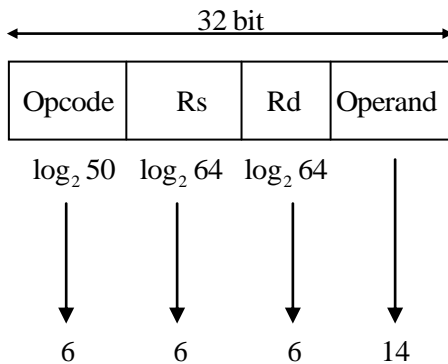
Key: (D)

Sol: An addressing mode in which the location of the data is contained within the mnemonic, is known as “Direct addressing mode”.

72. A processor has 32-bit architecture. Each instruction is 1 word long (32 bits). It has 64 registers. It supports 50 instructions, which have 2 register operands + 1 immediate operand. Assuming that the immediate operand is an unsigned integer, what is its maximum value?
- (A) 16383 (B) 32767
(C) 65536 (D) 1024

Key: (A)

Sol:



With 14 bit, the Highest unsigned integer is $2^{14} - 1 = 16383$

73. Microwave resonators are used in
1. Microwave oscillators
 2. Microwave narrow band amplifiers
 3. Microwave frequency meters
- Which of the above are correct ?
- (A) 1 and 2 only (B) 1 and 3 only
(C) 2 and 3 only (D) 1, 2 and 3

Key: (D)

74. The serial connection of interrupt lines for establishing hardware priority is known as
- (A) Daisy Chaining Priority
(B) Parallel Priority
(C) Polling
(D) Serial-line Priority

Key: (A)

Sol: The Daisy Chaining method of establishing priority consists of a serial connection of all devices that request an interrupt. The device with the highest priority is placed in the first position, followed by lower priority devices upto the device with the lowest priority, which is placed last in the chain.

Directions: Each of the next six (6) items consist of two statements, one labeled as the ‘Statement (I)’ and the other as ‘Statement (II)’. Examine these two statements carefully and select the answer to these items using the codes given below:

Codes:

- (A) Both statement (I) and statement (II) are individually true and statement (II) is the correct explanation of statement (I).
(B) Both statement (I) and statement (II) are individually true and 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

75. **Statement (I):** PAM can be demodulated using a suitable integrator.
Statement (II): A suitable integrator practically acts as can an envelop detector.

Key: (A)

76. **Statement (I):** The direction flag D in 8086 selects increment or decrement mode for DI and/or SI registers.
Statement (II): If D = 0, the register are automatically decremented.

Key: (C)

77. **Statement (I):** An antenna of length $\frac{\lambda}{2}$ will have radiation patterns of two lobes.

Statement (II): An antenna of length $\frac{3\lambda}{2}$ will have radiation pattern of two lobes and two minor lobes.

Key: (C)

Sol: $\cos\theta_{null} = \pm 1 \pm \frac{n\lambda}{H}$

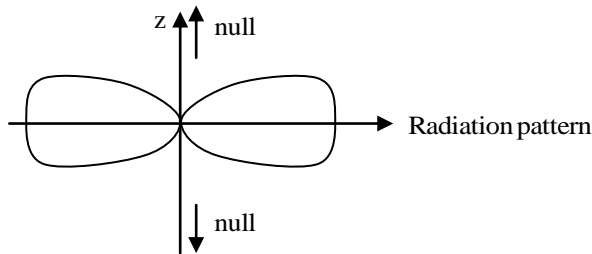
(1) $l = \frac{\lambda}{2} \Rightarrow H = \frac{\lambda}{4}$

$\cos\theta_{null} = \pm 1 \pm 4n$

For $n = 0$

$\cos\theta_{null} = \pm 1$

$\theta_{null} = 0, \pi$



(2) $l = \frac{3\lambda}{2} \Rightarrow H = \frac{3\lambda}{4}$

$\cos\theta_{null} = \pm 1 \pm \frac{4n}{3}$

For $n=0$

$\cos\theta_{null} = \pm 1$

$\theta_{null} = 0, \pi$

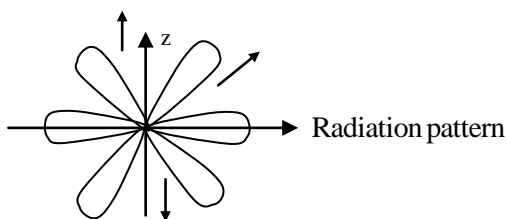
For $n = 1$

$\cos\theta_{null} = \pm 1 \pm \frac{4}{3}$

$= -1 \pm \frac{4}{3}$

$\cos\theta_{null} = \frac{1}{3}, -\frac{1}{3}$

$\theta_{null} = 70.5, 109.4$



78. Statement (I): The complex conjugate poles and zeros of the open-loop transfer function have no effect on the root-loci on the real axis.

Statement (II): Angle contribution of such a pair of conjugate poles or zeros is 2π radians on the real axis

Key: (A)

79. Statement (I): A basic memory unit of a flip-flop is a bistable multivibrator.

Statement (II): A flip-flop has two stable states. It remains in one state until it is directed by an input signal to switch over.

Key: (A)

80. Statement (I): Multimode fibers are now used for long distance communication.

Statement (II): Multimode fibers have larger core-radius than single-mode fibers.

Key: (D)

81. Product of Max terms representation for the Boolean function $F = \bar{B}D + \bar{A}D + BD$ is

- (A) $\Pi M(1,3,5,7)$ (B) $\Pi M(0,2,4,6)$
(C) $\Pi M(0,1,2,3)$ (D) $\Pi M(4,5,6,7)$

Key: (B)

Sol: Convert SOP to POS form

$F(A, B, D) = \bar{B}D + \bar{A}D + BD$

$= \bar{B}D(A + \bar{A})\bar{A}D(B + \bar{B}) + BD(A + \bar{A})$

$= \bar{A}\bar{B}D + \bar{A}\bar{B}D + \bar{A}BD + \bar{A}\bar{B}D + ABD + \bar{A}BD$
 $= \sum m(1,3,5,7)$

$F = \Pi M(0,2,4,6)$

82. Simplified form of the Boolean expression

$Y = \overline{(A \cdot B + \bar{C})} \overline{(A + B + C)}$ is

(A) $\bar{A}\bar{C} + A\bar{C} + \bar{B}\bar{C} + \bar{B}C$

(B) $(\bar{A} + \bar{B} + \bar{C})(A + B + C)$

(C) $(\bar{A} + \bar{B})(A + \bar{C})$

(D) $A(B + C)$

Key: (B)

Sol: $Y = \overline{(A.B + \bar{C})} \overline{(A + B + C)}$

$= \overline{(AB + \bar{C})} \overline{(\bar{A}.\bar{B} + C)}$ ($\because A\bar{A} = 0, A + B = \overline{\bar{A}.\bar{B}}$)

$= \overline{ABC + \bar{A}\bar{B}\bar{C}} = \overline{ABC}.\overline{\bar{A}.\bar{B}.\bar{C}}$

$= (\bar{A} + \bar{B} + \bar{C})(A + B + C)$

83. What is the maximum frequency for a sine wave output voltage of 10V peak with an Op-Amp whose slew rate is 1V/μs?

- (A) 15.92 kHz
- (B) 19.73 kHz
- (C) 23.54 kHz
- (D) 27.36 kHz

Key: (A)

Sol: Slew rate of op-Amp = 1V/μsec
 $= 1 \times 10^6 \text{ V/sec}$ & $V_m = 10V$

We have slew rate = $2\pi V_m \cdot f_m$

The maximum frequency upto which the op-Amp can provide undistorted output ,

$f_{\max} = \frac{\text{slew rate}}{2\pi V_m} = \frac{1 \times 10^6}{2\pi \times 10V} = 15.9235\text{kHz}$

84. Which one of the following statements is correct?

- (A) TTL logic cannot be used un digital circuits
- (B) Digital circuits are linear circuits
- (C) AND gate is a logic circuit whose output is equal to its highest input.
- (D) In a four-input AND circuits, all inputs must be high for the output to be high.

Key: (D)

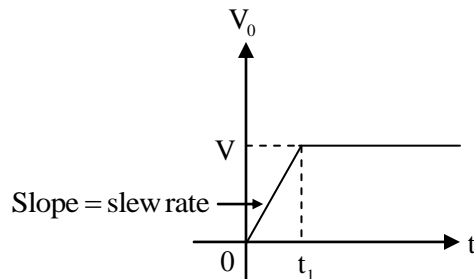
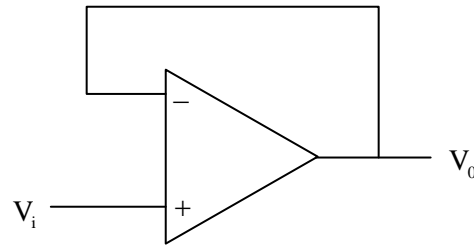
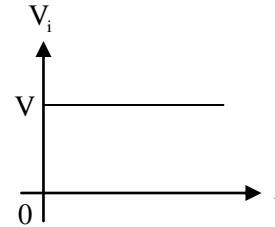
85. The Slew rate is the rate of change of output voltage of an operational amplifier when a particular input is applied. What is that input?

- (A) Sine wave input
- (B) Ramp input
- (C) Pulse input
- (D) Step input

Key: (D)

Sol: Slew rate is defined as the maximum rate of change in the output voltage of an op-Amp caused by step input voltage

Slew rate ... (1)



86. Except at high frequencies of switching, nearly all the power dissipated in the switch mode operation of a BJT occurs, when the transistor is in the

- (A) Active region
- (B) Blocking state
- (C) Hard saturation region
- (D) Soft saturation region

Key: (D)

Sol: Switches are designed to operate in either cut-off or hard-saturation. No power dissipation in cut-off.

87. Consider the following statements with respect to combinational circuit:

1. The output at any time depends only on the present combination of inputs.
2. It does not employ storage elements
3. It performs an operation that can be specified logically by a set of Boolean functions.

Which of the above statements are correct?

- (A) 1 and 2 only (B) 1 and 3 only
(C) 2 and 3 only (D) 1, 2 and 3

Key: (D)

88. Consider the following statements:

A multiplexer

1. selects one of the several inputs and transmit it to a single output.
2. routes the data from a single input to one of many outputs.
3. converts parallel data into serial data
4. is a combinational circuit

Which of the above statements are correct?

- (A) 1 and 3 only (B) 2 and 4 only
(C) 1, 3 and 4 only (D) 2,3 and 4 only

Key: (C)

89. What are the two types of basic adder circuits?

- (A) Half adder and full adder
(B) Half adder and parallel adder
(C) Asynchronous adder and synchronous adder
(D) One's complement adder and two's complement adder

Key: (A)

90. Consider the following statements:

1. An 8-input MUX can be used to implement any 4 variable functions.
2. A 3-line to 8-line DEMUX can be used to implement any 4 variable functions.
3. A 64-input MUX can be built using nine 8-input MUXs.
4. A 6-line to 64-line DEMUX can be built using nine 3-line to 8-line DEMUXs.

Which of the above statements are correct?

- (A) 1, 2, 3 and 4 (B) 1, 2 and 4 only
(C) 3 and 4 only (D) 1, 2 and 3 only

Key: (C)

91. For an n-bit binary adder, what is the number of gates through which a carry has to propagate input to output?

- (A) n (B) 2n (C) n^2 (D) n+1

Key: (B)

92. The main disadvantage of DTL logic circuits is

- (A) Medium speed
(B) Very large power supply voltage
(C) High cost
(D) Very large gate propagation delay.

Key: (D)

93. Which one of the following statements best describes the operation of a negative-edge triggered D flip-flop?

- (A) The logic level at the D input is transferred to Q on NGT of CLK
(B) The Q output is always identical to the CLK input if the D input is high
(C) The Q output is always identical to the D input when CLK = PGT
(D) The Q output is always identical to the D input .

Key: (A)

94. A 3-bit ripple counter is constructed using three T flip-flops to do the binary counting. The three flip-flops have T-inputs fixed at

- (A) 0, 0 and 1 (B) 1, 0 and 1
(C) 0, 1 and 1 (D) 1, 1 and 1

Key: (D)

Sol: In ripple counter, whether up-counter or down counter all T-flip flop are operated in toggle mode.

95. What is the function $Y = A + \bar{B}C$ in Product-of Sums (POS) form?

- (A) $M_6M_5M_4M_3$ (B) $M_3M_2M_1M_{10}$
(C) $M_0M_2M_3$ (D) $M_4M_3M_2M_1$

Key: (C)

Sol: Convert SOP to POS form

$$Y = A + \bar{B}C$$

$$= A(B + \bar{B})(C + \bar{C}) + \bar{B}C(A + \bar{A})$$

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

$$= \Pi M(0, 2, 3)$$

96. The initial content of a four-bit shift register is 1000. What is the register content after it is shifted four times to the right, with the serial input being 111100?

- (A) 1111 (B) 1100
(C) 1000 (D) 0011

Key: (A)

Sol:

Clk	Serial I/P	Q ₃	Q ₂	Q ₁	Q ₀
0	—	1	0	0	0
1	1	1	1	0	0
2	1	1	1	1	0
3	1	1	1	1	1
4	1	1	1	1	1
	0				
	0				

97. When a large number of analog signals is to be converted to digital form, an analog multiplexer is used. The A-to-D converter most suitable in this case will be

- (A) Forward counter type

- (B) Up-down counter type
(C) Successive approximation type
(D) Dual slope type

Key: (C)

98. For Emitter-coupled logic (ECL), the switching speed is very high because

- (A) Negative logic is used
(B) The transistors are not saturated when they are conducting
(C) Multi-emitter transistors are used
(D) Of low fan-out

Key: (B)

99. A flip-flop is a

- (A) Combinational logic circuit and edge sensitive
(B) Sequential logic circuit and edge sensitive
(C) Combinational logic circuit and level sensitive
(D) Sequential logic circuit and level sensitive

Key: (B)

100. The transfer function $\frac{1}{2s+1}$ will have

- (A) dc gain 1 and high frequency gain 1
(B) dc gain 0 and high frequency gain ∞
(C) dc gain 1 and high frequency gain 0
(D) dc gain 0 and high frequency gain 1

Key: (C)

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

$$M = \frac{1}{\sqrt{(2\omega)^2 + 1}}$$

$\omega = 0 \quad M = 1$

$\omega = \infty \quad M = 0$

101. Consider the following statements:

The Gain margin and phase margin of an unstable minimum phase system may respectively be

1. Positive, negative
2. Negative , positive
3. Negative , negative

Which of the statements is/are correct?

- (A) 3 only (B) 1 and 2 only
(C) 2 and 3 only (D) 1,2 and 3

Key: (A)

Sol: Gain margin and phase margin for unstable system

$$GM_{dB} = -vedB$$

$$PM(deg rees) = -ve$$

- 102.** A phase lead compensator has its transfer function, $G_c(s) = \frac{1+0.5s}{1+0.05s}$. The maximum phase lead and the corresponding frequency, respectively are nearly
- (A) $\sin^{-1}(0.9)$ and $6r/s$
(B) $\sin^{-1}(0.82)$ and $4 r/s$
(C) $\sin^{-1}(0.9)$ and $4 r/s$
(D) $\sin^{-1}(0.82)$ and $6 r/s$

Key: (D)

Sol: $G(s) = \frac{1+0.5s}{1+0.5s}$

$$\frac{1+\tau s}{1+\alpha\tau s} = \frac{1+0.5s}{1+0.05s}$$

$$\tau = 0.5$$

$$\alpha\tau = 0.05$$

$$\alpha = 0.1$$

$$\omega_m = \frac{1}{\tau\sqrt{\alpha}} = \frac{1}{0.5\sqrt{0.1}} = 6.3rad/s$$

$$\phi_m = \sin^{-1}\left[\frac{1-\alpha}{1+\alpha}\right] = \sin^{-1}[0.82]$$

- 103.** Consider the following statements:
1. Lead compensation decreases the bandwidth of the system.
 2. Lag compensation increases the bandwidth of the system
- Which of the above statement is/are correct?

- (A) 1 only (B) 2 only
(C) Both 1 and 2 (D) Neither 1 nor 2

Key: (D)

Sol: Lead compensator, Bandwidth increases
Lag compensator, Bandwidth decreases

- 104.** A proportional controller with transfer function, K_p is used with a first-order system having its transfer function as $G(s) = \frac{K}{(1+s\tau)}$, in unity feedback structure.

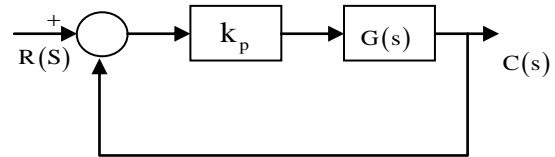
For step inputs, an increase in K_p will

- (A) Increase the time constant and decrease the steady state error
(B) Decrease the time constant of CLTF and decrease the steady state error
(C) Decrease the time constant of CLTF and increase the steady state error
(D) Increase the time constant and increase the steady state error

Key: (B)

Sol: $OLTF = \frac{k_p k}{(1+s\tau)}$

$$\tau_{OLTF} = \tau$$



$$k_p = \lim_{s \rightarrow 0} OLTF = k_p k$$

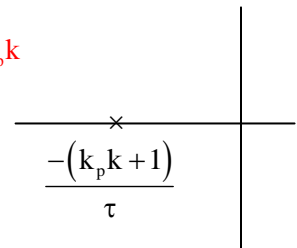
$$e_{ss} = \frac{1}{1+k_p k}$$

$$k_p \uparrow \Rightarrow e_{ss} \downarrow$$

$$CLTF = \frac{k_p k}{s\tau + 1 + k_p k}$$

$$\tau_{CLTF} = \frac{\tau}{1+k_p k}$$

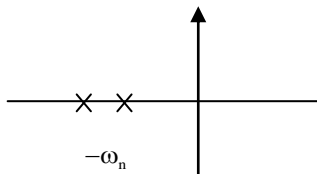
$$k_p \uparrow \Rightarrow \tau_{CLTF} \downarrow$$



105. For a second-order differential equation, if the damping ratio ξ is unity, then
- Then poles are imaginary and complex conjugate
 - The poles are in the right half of s-plane
 - The poles are equal, negative and real
 - Both the poles are unequal, negative and real

Key: (C)

Sol: $\xi = 1, \frac{C}{R} = \frac{\omega_n^2}{s^2 + 2\xi\omega_n s + \omega_n^2}$



The poles are equal, real and -Ve

106. Consider the following statements associated with micro strip patch antenna:
- The micro strip patch behaves more like a leaky cavity rather than like a radiator and this is not a highly efficient antenna.
 - They can be adapted for radiation of circularly polarized waves. Which of the above statement is/true correct?
- (A) 1 only (B) 2 only
(C) Both 1 and 2 (D) Neither 1 nor 2

Key: (C)

107. A carrier waveform $10 \cos \omega_c t$ and modulating signal $3 \cos \omega_m t$ have $f_c = 100\text{kHz}$ and $f_m = 4\text{kHz}$. Given that sensitivity of FM is 4 kHz/V and FM spectra beyond J_6 is negligible, what are the channel bandwidth requirements for AM and FM, respectively?
- 12 kHz and 48 kHz
 - 8 kHz and 48 kHz
 - 12 kHz and 254 kHz
 - 8 kHz and 24 kHz

Key: (B)

Sol: AM Bandwidth
 $= 2B = 2 \times 4\text{kHz} = 8\text{kHz}$

(\because B is message signal bandwidth)

For FM Total frequency spread is from $f_c - 6f_m$ to $f_c + 6f_m$

Total Bandwidth $= 12f_m$
 $= 12 \times 4$
 $= 48\text{kHz}$

108. When the modulating frequency is doubled, the modulation index is halved, and the modulating voltage remains constant. The modulation system is
- Amplitude modulation
 - Phase modulation
 - Frequency modulation
- Select the correct answer from the codes given below:
- (A) 1 only (B) 2 only
(C) 3 only (D) 1, 2 and 3

Key: (C)

Sol: Modulation index $\beta = \frac{\Delta f}{f_m}$

$\Delta f = k_f A_m$

$\beta = \frac{k_f A_m}{f_m}$

if f_m is double, β is $\frac{1}{2}$

This is a case of FM.

109. What is the modulation index of an FM signal having a carrier swing of 100kHz and modulating frequency of 8kHz ?
- (A) 4.75 (B) 5.50 (C) 6.25 (D) 7.50

Key: (C)

Sol: Total carrier swing $= 2\Delta f$
 $\Rightarrow 2\Delta f = 100\text{kHz}$

$\Rightarrow \Delta f = 50\text{kHz}$

$\beta = \frac{\Delta f}{f_m} = \frac{50\text{kHz}}{8\text{kHz}} = 6.25$

110. In a pulse code modulated system, the number of bits is increased from 7 to 8 bits. The improvement in signal to quantization noise ratio will be
(A) 2dB (B) 4dB (C) 6dB (D) 8dB

Key: (C)

Sol: $(SNR)_q = 6n + \alpha$ dB

n is number of bits

Thus 1 bit change SNR change is 6dB.

111. In the process of modulation
(A) Some characteristics of a high frequency sine wave varied in accordance with the instantaneous value of a low frequency signal
(B) Parameters of carrier wave are held constant
(C) For proper and efficient radiation, the receiving antennas should have heights comparable to half-wavelength of the signal received
(D) The signal is converted first within the range of 10 Hz to 20Hz

Key: (A)

112. If the sampling is carried out at a rate higher than twice the highest frequency of the original signal (f_{max}), then it is possible to receive the original signal from the sampled signal by passing it through
(A) A high-pass filter with the cut-off frequency equal to f_{max}
(B) A low-pass filter with the cut-off frequency equal to f_{max}
(C) A high-pass filter with the cut-off frequency greater than f_{max}
(D) A low-pass filter with the cut-off frequency greater than f_{max}

Key: (D)

113. The open-loop transfer function of a unity feedback system is $G(s) = \frac{10(1+0.2s)}{(1+0.5s)}$. The phase shift at $\omega = 0$ and $\omega = \infty$, will be respectively
(A) -90° and 180° (B) 0° and 180°
(C) -90° and 90° (D) 0° and 0°

Key: (D)

Sol: $G(s) = \frac{10(1+0.2s)}{(1+0.5s)}$

The phase shift at $\omega = 0$ and $\omega = \infty$

$$\phi_{sys}(\omega) = -\tan^{-1}[0.5\omega] + \tan^{-1}[0.2\omega]$$

$$\omega = 0 ; \phi = 0$$

$$\omega = \infty ; \phi = 0$$

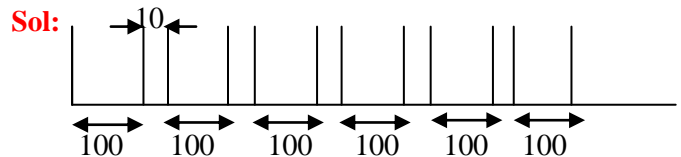
114. The conversion time for a 10-bit successive approximation A/D converter, for a clock frequency of 1MHz is
(A) $1\mu s$ (B) $5\mu s$ (C) $10\mu s$ (D) $15\mu s$

Key: (C)

Sol: $T = \frac{1}{f} = \frac{1}{1\text{MHz}} = 1\mu\text{sec}$

115. The minimum bandwidth of the link needed for a guard band of 10 kHz frequency to prevent interference between six channels, each with 100kHz frequency, is
(A) 425kHz (B) 575 kHz
(C) 650 kHz (D) 725 kHz

Key: (C)



Total bandwidth =

$$100+10+100+10+100+10+100+10+100+10+100 = 650\text{kHz}$$

116. The different access methods which permit many satellite users to operate in parallel through a single transponder without interfering with each other are

1. Frequency Division Multiple Access (FDMA)
2. Time Division Multiple Access (TDMA)
3. Code Division Multiple Access (CDMA)

Which of the above are correct?

- (A) 1 and 2 only (B) 1 and 3 only
(C) 2 and 3 only (D) 1, 2 and 3

Key: (B)

117. In an optical fibre, the pulse dispersion effect is minimized by

1. Using a high frequency light source
2. Using plastic cladding
3. Minimizing the core diameter

Which of the above statement is/are correct?

- (A) 1 only (B) 2 only
(C) 3 only (D) 1,2 and 3

Key: (C)

118. Consider the following statements:

As compared to short-circuited stubs, open circuited stubs are not preferred because the latter

1. Are of different characteristics impedance
2. Have a tendency to radiate

Which of the above statements is/are correct?

- (A) 1 only (B) 2 only
(C) Both 1 and 2 (D) Neither 1 nor 2

Key: (B)

119. Consider the following statements for multiple access system in a satellite earth station:

1. Access to same repeater sub-systems and same RF channel is possible
2. Frequency division multiple access is used.
3. Several carries are not amplified by same TWT.

Which of the above statements are correct?

- (A) 2 and 3 only (B) 1 and 3 only
(C) 1 and 2 only (D) 1, 2 and 3

Key: (C)

120. The Bode plot of the open-loop transfer function of a system is described as follows:

- Slope – 40dB/decade $\omega < 0.1$ rad/s
- Slope– 20dB/decade $0.1 < \omega < 10$ rad/s
- Slope 0 $\omega > 10$ rad/s

The system described will have

- (A) 1 pole and 1 zeros
(B) 2 poles and 2 zeros
(C) 2 pole and 1 zero
(D) 1 pole and 1 zeros

Key: (B)

Sol: Slope –40dB/dec $\omega < 0.1$ rad/sec

Slope –20dB/dec $0.1 < \omega < 10$

Slope 0 $\omega > 10$

2 poles at origin

At $\omega = 0.1$ slope change

– 40 to – 20

\therefore single zero

At $\omega = 10$ slope change –20 to 0

\therefore single zero

Total 2 poles and zeros

