CHAPTER

10.1

EC-03

Duration : Three Hours Maximum Marks : 150

Q.1—30 carry one mark each

1. The minimum number of equations required to analyze the circuit shown in Fig. Q. 1 is

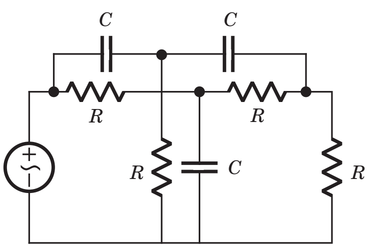


Fig. Q1

(A) 3 (B) 4

(C) 6 (D) 7

2. A source of angular frequency 1 rad/sec has a source impedance consisting of 1Ω resistance in series with 1 H inductance. The load that will obtain the maximum power transfer is

(A) 1 Ω resistance

(B) 1 Ω resistance in parallel with 1 H inductance

(C) 1 Ω resistance in series with 1 F capacitor

(D) 1 Ω resistance in parallel with 1 F capacitor

3. A series RLC circuit has a resonance frequency of 1 kHz and a quality factor $Q = 100$. If each of R, L and C is doubled from its original value, the new Q of the circuit is

(A) 25 (B) 50

(C) 100 (D) 200

4. The Laplace transform of $i(t)$ is given by

$$I(s) = \frac{2}{s(1+s)}$$

As $t \to \infty$, The value of $i(t)$ tends to

(A) 0 (B) 1

(C) 2 (D) ∞

5. The differential equation for the current $i(t)$ in the circuit of Fig. Q.5 is

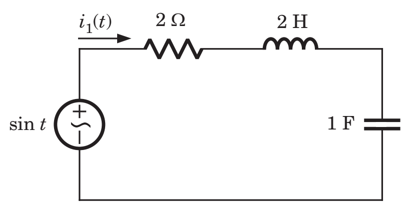


Fig. Q5

(A) $2\frac{d^2i}{dt^2} + 2\frac{di}{dt} + i(t) = \sin t$

(B) $2\frac{d^2i}{dt^2} + 2\frac{di}{dt} + 2i(t) = \cos t$

(C) $2\frac{d^2i}{dt^2} + 2\frac{di}{dt} + i(t) = \cos t$

(D) $2\frac{d^2i}{dt^2} + 2\frac{di}{dt} + 2i(t) = \sin t$

6. n-type silicon is obtained by doping silicon with

(A) Germanium (B) Aluminium

(C) Boron (D) Phosphorus

7. The bandgap of silicon at 300 K is

(A) 1.36 eV (B) 1.10 eV

(C) 0.80 eV (D) 0.67 eV

20. A 0 to 6 counter consists of 3 flip flops and a combination circuit of 2 input gate(s). The combination circuit consists of

(A) one AND gate

(B) one OR gate

(C) one AND gate and one OR gate

(D) two AND gates

21. The Fourier series expansion of a real periodic signal with fundamental frequency f_0 is given by $g_p(t) = \sum_{n=-\infty} c_n e^{j2\pi f_0 t}$. It is given that $c_3 = 3 + j5$. Then c_{-3} is

(A) $5 + j3$ (B) $-3 - j5$

(C) $-5 + j3$ (D) $3 - j5$

22. Let $x(t)$ be the input to a linear, time-invariant system. The required output is $4x(t-2)$. The transfer function of the system should be

(A) $4e^{j4\pi f}$ (B) $2e^{-j8\pi f}$

(C) $4e^{-j4\pi f}$ (D) $2e^{j8\pi f}$

23. A sequence $x(n)$ with the z-transform $X(z) = z^4 + z^2 - 2z + 2 - 3z^{-4}$ is applied as an input to a linear, time-invariant system with the impulse response $h(n) = 2\delta(n-3)$ where

$$\delta(n) = \begin{cases} 1, & n = 0 \\ 0, & \text{otherwise} \end{cases}$$

The output at $n = 4$ is

(A) -6 (B) zero

(C) 2 (D) -4

24. Fig. Q.24 shows the Nyquist plot of the open-loop transfer function $G(s)H(s)$ of a system. If $G(s)H(s)$ has one right-hand pole, the closed-loop system is

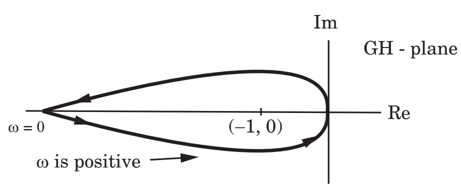


Fig. Q24

(A) always stable

(B) unstable with one closed-loop right hand pole

(C) unstable with two closed-loop right hand poles

(D) unstable with three closed-loop right hand poles

25. A PD controller is used to compensate a system. Compared to the uncompensated system, the compensated system has

(A) a higher type number

(B) reduced damping

(C) higher noise amplification

(D) larger transient overshoot

26. The input to a coherent detector is DSB-SC signal plus noise. The noise at the detector output is

(A) the in-phase component

(B) the quadrature component

(C) zero

(D) the envelope

27. The noise at the input to an ideal frequency detector is white. The detector is operating above threshold. The power spectral density of the noise at the output is

(A) raised-cosine (B) flat

(C) parabolic (D) Gaussian

28. At a given probability of error, binary coherent FSK is inferior to binary coherent PSK by

(A) 6 dB (B) 3 dB

(C) 2 dB (D) 0 dB

29. The unit of $\nabla \times H$ is

(A) Ampere (B) Ampere/meter

(C) Ampere/meter^2 (D) Ampere-meter

30. The depth of penetration of electromagnetic wave in a medium having conductivity σ at a frequency of 1 MHz is 25 cm. The depth of penetration at a frequency of 4 MHz will be

(A) 6.25 cm (B) 12.50 cm

(C) 50.00 cm (D) 100.00 cm

Q.31—90 carry two marks each.

31. Twelve 1 Ω resistance are used as edges to form a cube. The resistance between two diagonally opposite corners of the cube is

(A) $\frac{5}{6}$ Ω (B) 1 Ω

(C) $\frac{6}{5}$ (D) $\frac{3}{2}$ Ω

32. The current flowing through the resistance R in the circuit in Fig. Q.32 has the form $P\cos 4t$, where P is

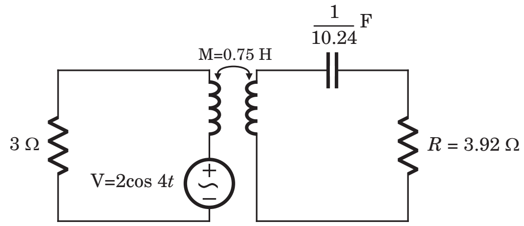


Fig. Q32

(A) $(0.18 + j\,0.72)$ (B) $(0.46 + j\,1.90)$

(C) $-(0.18 + j\,1.90)$ (D) $-(0.192 + j\,0.144)$

The circuit for Q.33–34 are given in Fig. Q.33–34. For both the questions, assume that the switch S is in position 1 for a long time and thrown to position 2 at $t = 0$.

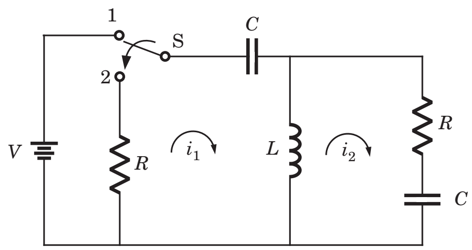


Fig. Q33-34

33. At $t = 0^+$, the current i_1 is

(A) $\frac{-V}{2R}$ (B) $\frac{-V}{R}$

(C) $\frac{-V}{4R}$ (D) zero

34. $I_1(s)$ and $I_2(s)$ are the Laplace transforms of $i_1(t)$ and $i_2(t)$ respectively. The equations for the loop currents $I_1(s)$ and $I_2(s)$ for the circuit shown in Fig. Q.33–34, after the switch is brought from position 1 to position 2 at $t = 0$, are

(A) $\begin{bmatrix} R + Ls + \frac{1}{Cs} & -Ls \\ -Ls & R + \frac{1}{Cs} \end{bmatrix}\begin{bmatrix} I_1 s \\ I_2 s \end{bmatrix} = \begin{bmatrix} \frac{V}{s} \\ 0 \end{bmatrix}$

(B) $\begin{bmatrix} R + Ls + \frac{1}{Cs} & -Ls \\ -Ls & R + \frac{1}{Cs} \end{bmatrix}\begin{bmatrix} I_1 s \\ I_2 s \end{bmatrix} = \begin{bmatrix} -\frac{V}{s} \\ 0 \end{bmatrix}$

(C) $\begin{bmatrix} R + Ls + \frac{1}{Cs} & -Ls \\ -Ls & R + Ls + \frac{1}{Cs} \end{bmatrix}\begin{bmatrix} I_1 s \\ I_2 s \end{bmatrix} = \begin{bmatrix} -\frac{V}{s} \\ 0 \end{bmatrix}$

(D) $\begin{bmatrix} R + Ls + \frac{1}{Cs} & -Ls \\ -Ls & R + Ls + \frac{1}{Cs} \end{bmatrix}\begin{bmatrix} I_1 s \\ I_2 s \end{bmatrix} = \begin{bmatrix} \frac{V}{s} \\ 0 \end{bmatrix}$

35. An input voltage

$$v(t) = 10\sqrt{2}\cos(t + 10) + 10\sqrt{3}\cos(2 + 10°)\text{ V}$$

is applied to a series combination of resistance $R = 1\Omega$ and an inductance $L = 1$ H. The resulting steady state current $i(t)$ in ampere is

(A) $10\cos(t + 55°) + 10\cos(2t + 10° + \tan^{-1} 2)$

(B) $1 - \cos(t + 55°) + 10\sqrt{\frac{3}{2}}\cos(2t + 55°)$

(C) $10\cos(t - 55°) + 10\cos(2t + 10° - \tan^{-1} 2)$

(D) $1 - \cos(t - 55°) + 10\sqrt{\frac{3}{2}}\cos(2t - 35°)$

36. The driving-point impedance $Z(s)$ of a network has the pole-zero locations as shown in Fig. Q.36. If $Z(0) = 3$, then $Z(s)$ is

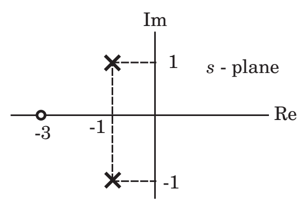


Fig. Q36

(A) $\frac{3(s + 3)}{s^2 + 2s + 3}$ (B) $\frac{2(s + 3)}{s^2 + 2s + 2}$

(C) $\frac{3(s - 3)}{s^2 - 2s - 2}$ (D) $\frac{2(s - 3)}{s^2 - 2s - 3}$

37. The impedance parameters Z_{11} and Z_{12} of the two-port network in Fig. Q.37 are

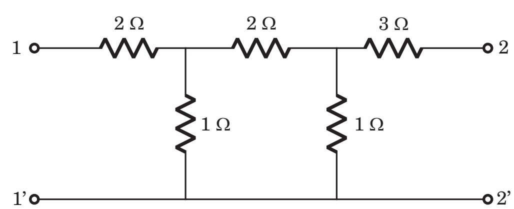


Fig. Q37

(A) $Z_{11} = 2.75\Omega$ and $Z_{12} = 0.25\,\Omega$

(B) $Z_{11} = 3\Omega$ and $Z_{12} = 0.5\,\Omega$

(C) $Z_{11} = 3\Omega$ and $Z_{12} = 0.25\,\Omega$

(D) $Z_{11} = 2.25\,\Omega$ and $Z_{12} = 0.5\,\Omega$

38. An n-type silicon bar 0.1 cm long and 100 μm^2 in cross-sectional area has a majority carrier concentration of 5×10^{20} / m^3 and the carrier mobility is 0.13 m^2/V-s at 300 K. If the charge of an electron is 1.5×10^{-19} coulomb, then the resistance of the bar is

(A) 10^6 Ohm (B) 10^4 Ohm

(C) 10^{-1} Ohm (D) 10^{-4} Ohm

39. The electron concentration in a sample of uniformly doped n-type silicon at 300 K varies linearly from 10^{17} /cm^3 at $x = 0$ to 6×10^{16} /cm^3 at $x = 2$ μm. Assume a situation that electrons are supplied to keep this concentration gradient constant with time. If electronic charge is 1.6×10^{-19} coulomb and the diffusion constant $D_n = 35$ cm^2/s, the current density in the silicon, if no electric field is present, is

(A) zero (B) –112 A/cm^2

(C) +1120 A/cm^2 (D) –1120 A/cm^2

40. Match items in Group 1 with items in Group 2, most suitably.

Group 1	Group 2
P. LED	1. Heavy doping
Q. Avalanche photo diode	2. Coherent radiation
R. Tunnel diode	3. Spontaneous emission
S. LASER	4. Current gain

(A)	(B)	(C)	(D)
P–1	P–2	P–3	P–2
Q–2	Q–3	Q–4	Q–1
R–4	R–1	R–1	R–4
S–3	S–4	S–2	S–3

41. At 300 K, for a diode current of 1 mA, a certain germanium diode requires a forward bias of 0.1435 V, whereas a certain silicon diode requires a forward bias of 0.718 V. Under the conditions stated above, the closest approximation of the ratio of reverse saturation current in germanium diode to that in silicon diode is

(A) 1 (B) 5

(C) 4×10^3 (D) 8×10^3

42. A particular green LED emits light of wavelength 5490 A°. The energy bandgap of the semiconductor material used there is (Plank's constant $= 6.626 \times 10^{-34}$ J – s)

(A) 2.26 eV (B) 1.98 eV

(C) 1.17 eV (D) 0.74 eV

43. When the gate-to-source voltage (V_{GS}) of a MOSFET with threshold voltage of 400 mV, working in saturation is 900 mV, the drain current is observed to be 1 mA. Neglecting the channel width modulation effect and assuming that the MOSFET is operating at saturation, the drain current for an applied V_{GS} of 1400 mV is

(A) 0.5 mA (B) 2.0 mA

(C) 3.5 mA (D) 4.0 mA

44. If P is Passivation, Q is n-well implant, R is metallization and S is source/drain diffusion, then the order in which they are carried out in a standard n-well CMOS fabrication process, is

(A) P–Q–R–S (B) Q–S–R–P

(C) R–P–S–Q (D) S–R–Q–P

45. An amplifier without feedback has a voltage gain of 50, input resistance of 1 kΩ and output resistance of 2.5 kΩ. The input resistance of the current-shunt negative feedback amplifier using the above amplifier with a feedback factor of 0.2, is

(A) 1/11 kΩ (B) 1/5 kΩ

(C) 5 kΩ (D) 11 kΩ

46. In the amplifier circuit shown in Fig. Q.46, the values of R_1 and R_2 are such that the transistor is operating at $V_{CE} = 3$ V and $I_C = 1.5$ mA when its β is 150. For a transistor with β of 200, the operating point (V_{CE}, I_C) is

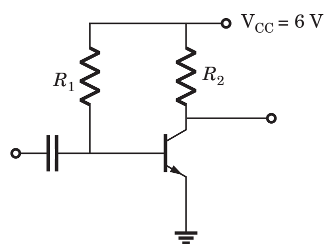


Fig. Q46

(A) (2 V, 2 mA) (B) (3 V, 2 mA)

(C) (4 V, 2 mA) (D) (4 V, 1 mA)

47. The oscillator circuit shown in Fig. Q.47 has an ideal inverting amplifier. its frequency of oscillation (in Hz) is

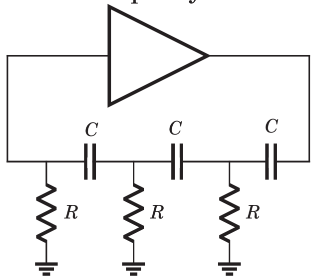


Fig. Q47

(A) $\frac{1}{(2\pi\sqrt{6}RC)}$ (B) $\frac{1}{(2\pi RC)}$

(C) $\frac{1}{(\sqrt{6}RC)}$ (D) $\frac{\sqrt{6}}{(2\pi RC)}$

48. The output voltage of the regulated power supply shown in Fig. Q.48 is

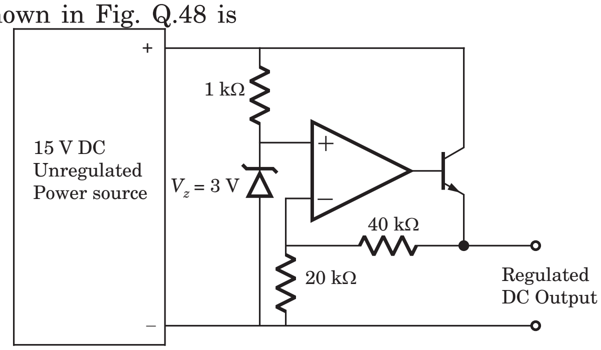


Fig. Q48

(A) 3 V (B) 6 V

(C) 9 V (D) 12 V

49. The action of a JFET in its equivalent circuit can best be represented as a

(A) Current Controlled Current Source

(B) Current Controlled Voltage Source

(C) Voltage Controlled Voltage Source

(D) Voltage Controlled Current Source

50. If the op-amp in Fig. Q.50 is ideal, the output voltage V_{out} will be equal to

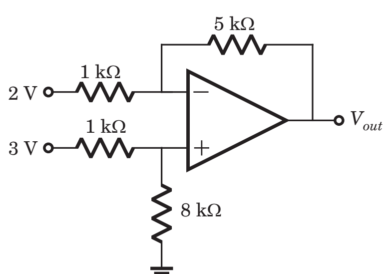


Fig. Q50

(A) 1 V (B) 6 V

(C) 14 V (D) 17 V

51. Three identical amplifiers with each one having a voltage gain of 50, input resistance of 1 kΩ and output resistance of 250 Ω, are cascaded. The open circuit voltage gain of the combined amplifier is

(A) 49 dB (B) 51 dB

(C) 98 dB (D) 102 dB

52. An ideal sawtooth voltage waveform of frequency 500 Hz and amplitude 3 V is generated by charging a capacitor of 2 μF in every cycle. The charging requires

(A) constant voltage source of 3 V for 1 ms

(B) constant voltage source of 3 V for 2 ms

(C) constant current source of 3 mA for 1 ms

(D) constant current source of 3 mA for 2 ms

53. The circuit shown in Fig. Q.53 has 4 boxes each described by inputs, P, Q, R and outputs Y, Z with $Y = P \oplus Q \oplus R$, $Z = RQ + \overline{P}R + Q\overline{P}$. The circuit acts as a

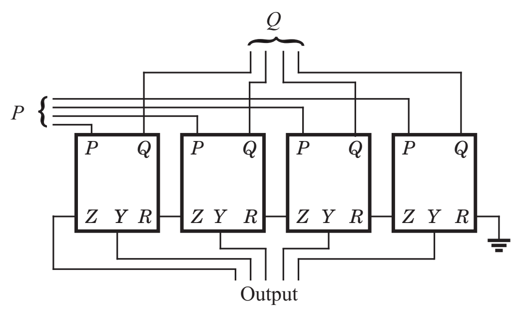


Fig. Q53

(A) 4 bit adder giving $P + Q$

(B) 4 bit substracter giving $P - Q$

(C) 4 bit substracter giving $Q - R$

(D) 4 bit adder giving $P + Q + R$

54. If the functions W, X, Y and Z are as follows

$W = R + \overline{P}Q + \overline{R}S$

$X = PQ\overline{R}\,\overline{S} + \overline{P}\,\overline{Q}\,\overline{R}\,\overline{S} + P\overline{Q}\,\overline{R}\,\overline{S}$

$Y = RS + \overline{PR + P\overline{Q} + \overline{P}\,\overline{Q}}$

$Z = R + S + \overline{PQ + \overline{P}\cdot\overline{Q}\cdot\overline{R} + P\overline{Q}\cdot\overline{S}}$ Then

(A) $W = Z$, $X = \overline{Z}$ (B) $W = Z$, $X = Y$

(C) $W = Y$ (D) $W = Y = \overline{Z}$

55. A 4 bit ripple counter and a 4 bit synchronous counter are made using flip flops having a propagation delay of 10 ns each. If the worst case delay in the ripple counter and the synchronous counter be R and S respectively, then

(A) R =10 n, S =40 ns (B) R =40 ns, S =10 ns

(C) R =10 ns, S =30 ns (D) R =30 ns, S =10 ns

56. The DTL, TTL, ECL and CMOS families of digital ICs are compared in the following 4 columns

	P	Q	R	S
Fanout is minimum	DTL	DTL	TTL	CMOS
Power consumption is minimum	TTL	CMOS	ECL	DTL
Propagation delay is minimum	CMOS	ECL	TTL	TTL

The correct column is

(A) P (B) Q

(C) R (D) S

57. The circuit shown in Fig. Q.57 is a 4 bit DAC. The input bits 0 and 1 are represented by 0 and 5 V respectively. The OP AMP is ideal, but all the resistance and the 5 V inputs have a tolerance of ±10%. The specification (rounded to the nearest multiple of 5%) for the tolerance of the DAC is

(A) ±35% (B) ±20%

(C) ±10% (D) ±5%

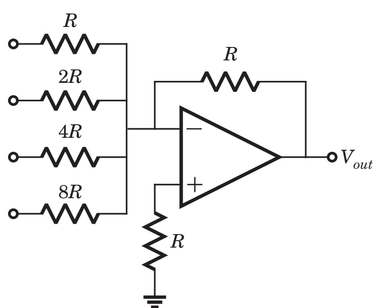


Fig. Q57

58. The circuit shown in Fig. Q.58 converts

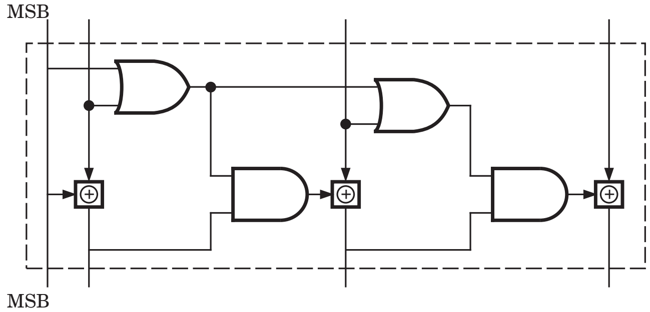


Fig. Q58

(A) BCD to binary code

(B) Binary to excess –3 code

(C) Excess –3 to Gray code

(D) Gray to Binary code

59. In the circuit shown in Fig. Q.59, A is a parallel-in, parallel-out 4 bit register, which loads at the rising edge of the clock C. The input lines are connected to a 4 bit bus, W. Its output acts as the input to a 16 × 4 ROM whose output is floating when the enable input E is 0. A partial table of the contents of the ROM is as follows

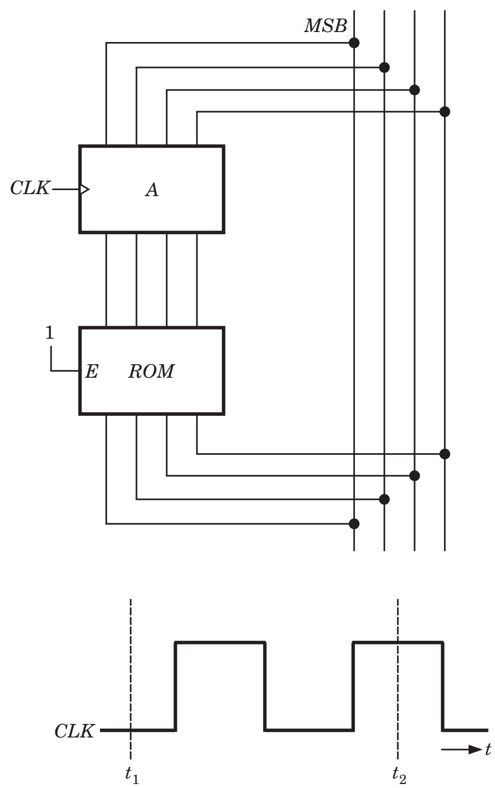


Fig. Q59

Address	Data
0	0011
2	1111
4	0100
6	1010
8	1011
10	1000
12	0010
14	1000

The clock to the register is shown, and the data on the W bus at time t_1 is 0110. The data on the bus at time t_2 is

(A) 1111 (B) 1011

(C) 1000 (D) 0010

60. In an 8085 microprocessor, the instruction CMP B has been executed while the content of the accumulator is less than that of register B. As a result

(A) Carry flag will be set but Zero flag will be reset

(B) Carry flag will be reset but Zero flag will be set

(C) Both Carry flag and Zero flag will be reset

(D) Both Carry flag and Zero flag will be set

61. Let X and Y be two statistically independent random variables uniformly distributed in the ranges $(-1, 1)$ and $((-2, 1)$ respectively. Let $Z = X + Y$. Then the probability that $(Z \leq -2)$ is

(A) zero (B) $\frac{1}{6}$

(C) $\frac{1}{3}$ (D) $\frac{1}{12}$

62. Let P be linearity, Q be time-invariance, R be causality and S be stability. A discrete time system has the input-output relationship,

$$y(n) = \begin{cases} x(n) & n \geq 1 \\ 0, & n = 0 \\ x(n+1) & n \leq -1 \end{cases}$$

where $x(n)$ is the input and $y(n)$ is the output. The above system has the properties

(A) P, S but not Q, R (B) P, Q, S but not R

(C) P, Q, R, S (D) Q, R, S but not P

Data for Q.63–64 are given below. Solve the problems and choose the correct answers.

The system under consideration is an RC low-pass filter (RC-LPF) with $R = 1$ kΩ and $C = 1.0$ μF.

63. Let $H(f)$ denote the frequency response of the RC-LPF. Let f_1 be the highest frequency such that $0 \leq |f| \leq f_1 \frac{|H(f_1)|}{H(0)}$ 0.95. Then f_1 (in Hz) is

(A) 327.8 (B) 163.9

(C) 52.2 (D) 104.4

64. Let $t_g(f)$ be the group delay function of the given RC-LPF and $f_2 = 100$ Hz. Then $t_g(f_2)$ in ms, is

(A) 0.717 (B) 7.17

(C) 71.7 (D) 4.505

Data for Q.65–66 are given below. Solve the problems and choose the correct answers.

$X(t)$ is a random process with a constant mean value of 2 and the autocorrelation function

$$R_X(\tau) = 4[e^{-0.2|\tau|} + 1].$$

65. Let X be the Gaussian random variable obtained by sampling the process at $t = t_i$ and let

$$Q(\alpha) = \int_{\alpha}^{\infty} \frac{1}{\sqrt{2\pi}} e^{-\frac{y^2}{2}} dy$$

The probability that $[x \leq 1]$ is

(A) $1 - Q(0.5)$ (B) $Q(0.5)$

(C) $Q(\frac{1}{2\sqrt{2}})$ (D) $1 - Q(\frac{1}{2\sqrt{2}})$

66. Let Y and Z be the random variables obtained by sampling $X(t)$ at $t = 2$ and $t = 4$ respectively. Let $W = Y - Z$. The variance of W is

(A) 13.36 (B) 9.36

(C) 2.64 (D) 8.00

67. Let $x(t) = 2\cos(800\pi t) + \cos(1400\pi t)$. $x(t)$ is sampled with the rectangular pulse train shown in Fig. Q.67. The only spectral components (in kHz) present in the sampled signal in the frequency range 2.5 kHz to 3.5 kHz are

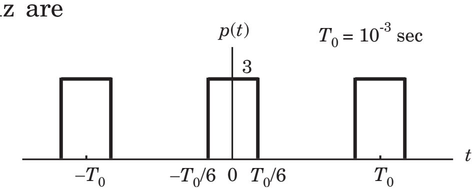


Fig. Q67

(A) 2.7, 3.4 (B) 3.3, 3.6

(C) 2.6, 2.7, 3.3, 3.4, 3.6 (D) 2.7, 3.3

68. The signal flow graph of a system is shown in Fig. Q.68. The transfer function $\frac{C(s)}{R(s)}$ of the system is

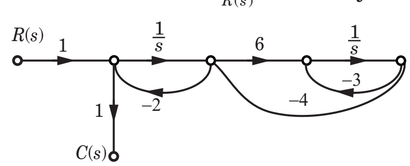


Fig. Q68

(A) $\frac{6}{s^2 + 29s + 6}$ (B) $\frac{6s}{s^2 + 29s + 6}$

(C) $\frac{s(s+2)}{s^2 + 29s + 6}$ (D) $\frac{s(s+27)}{s^2 + 29s + 6}$

69 The root locus of the system

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

has the break-away point located at

(A) $(-0.5, 0)$ (B) $(-2.548, 0)$

(C) $(-4, 0)$ (D) $(-0.784, 0)$

70. The approximate Bode magnitude plot of a minimum phase system is shown in Fig. Q.70. The transfer function of the system is

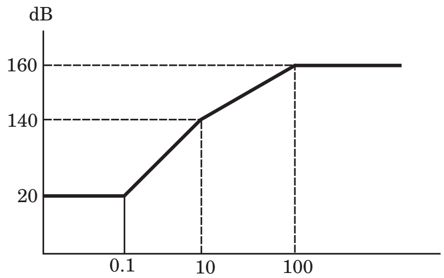


Fig. Q70

(A) $10^8 \frac{(s+0.1)^3}{(s+10)^2(s+100)}$ (B) $10^7 \frac{(s+0.1)^3}{(s+10)(s+100)}$

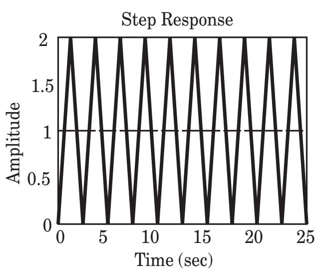
(C) $10^8 \frac{(s+0.1)^2}{(s+10)^2(s+100)}$ (D) $10^9 \frac{(s+0.1)^3}{(s+10)(s+100)^2}$

71. A second-order system has the transfer function

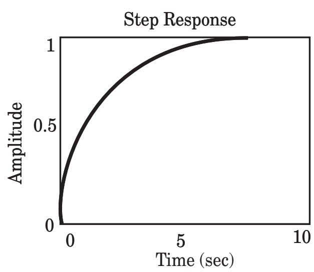
$$\frac{C(s)}{R(s)} = \frac{4}{s^2+4s+4}$$

With $r(t)$ as the unit-step function, the response $c(t)$ of the system is represented by

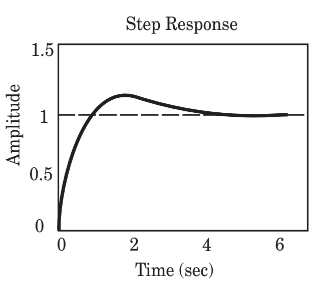
(A)



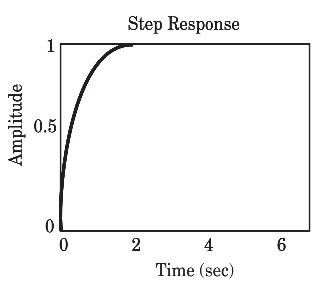
(B)



(C)



(D)



72. The gain margin and the phase margin of a feedback system with

$$G(s)H(s) = \frac{s}{(s+100)^3} \text{ are}$$

(A) - dB, 0° (B) ∞, ∞

(C) ∞, 0° (D) 88.5 dB, ∞

73. The zero-input response of a system given by the state-space equation

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} \text{ and } \begin{bmatrix} x_1(0) \\ x_2(0) \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \end{bmatrix} \text{ is}$$

(A) $\begin{bmatrix} te^t \\ t \end{bmatrix}$ (B) $\begin{bmatrix} e^t \\ t \end{bmatrix}$

(C) $\begin{bmatrix} e^t \\ te^t \end{bmatrix}$ (D) $\begin{bmatrix} t \\ te^t \end{bmatrix}$

74. A DSB-SC signal is to be generated with a carrier frequency $f_c = 1$ MHz using a nonlinear device with the input-output characteristic $v_0 = a_0 v_1 + a_1 v_i^3$ where a_0 and a_1 are constants. The output of the nonlinear device can be filtered by an appropriate band-pass filter. Let $v_i = A_c^l \cos(2\pi f_c^l t) + m(t)$ where $m(t)$ is the message signal. Then the value of f_c^l (in MHz) is

(A) 1.0 (B) 0.333

(C) 0.5 (D) 3.0

The data for Q.75-76 are given below. Solve the problems and choose the correct answers.

Let $m(t) = \cos[(4\pi \times 10^3)t]$ be the message signal and $c(t) = 5\cos[(2\pi \times 10^6)t]$ be the carrier.

75. $c(t)$ and $m(t)$ are used to generate an AM signal. The modulation index of the generated AM signal is 0.5. Then the quantity $\frac{\text{Total side band power}}{\text{Carrier power}}$ is

(A) $\frac{1}{2}$ (B) $\frac{1}{4}$

(C) $\frac{1}{3}$ (D) $\frac{1}{8}$

76. $c(t)$ and $m(t)$ are used to generate an FM signal. If the peak frequency deviation of the generated FM is three times the transmission bandwidth of the AM signal, then the coefficient of the term $\cos[2\pi(1008 \times 10^3 t)]$ in the FM signal (in terms of the Bessel coefficients) is

(A) $5J_4(3)$ (B) $\frac{5}{2}J_8(3)$

86. A uniform plane wave traveling in air is incident on the plane boundary between air and another dielectric medium with $\varepsilon_r = 4$. The reflection coefficient for the normal incidence, is

(A) zero (B) $0.5\ \angle 180°$

(C) $0.333\ \angle 0°$ (D) $0.333\angle 180°$

87. If the electric field intensity associated with a uniform plane electromagnetic wave traveling in a perfect dielectric medium is given by $E(z, t) = 10\cos(2\pi \times 10^7 t - 0.1\pi z)$ volt/m, then the velocity of the traveling wave is

(A) 3.00×10^8 m/sec (B) 2.00×10^8 m/sec

(C) 6.28×10^7 m/sec (D) 2.00×10^7 m/sec

88. A short-circuited stub is shunt connected to a transmission line as shown in Fig. Q.88. If $Z_0 = 50$ ohm, the admittance Y seen at the junction of the stub and the transmission line is

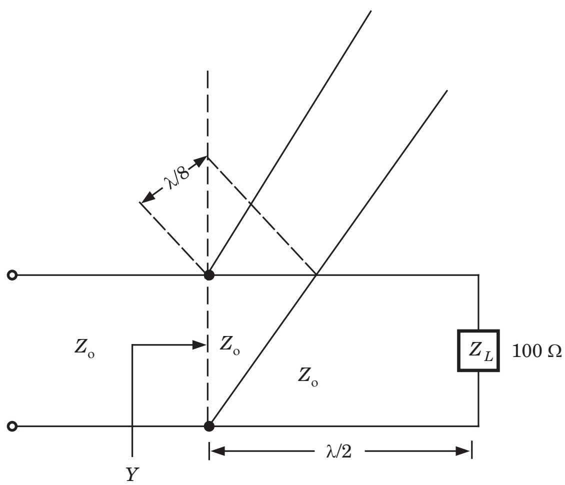


Fig. Q.88

(A) $(0.01 - j0.02)$ mho (B) $(0.02 - j0.01)$ mho

(C) $(0.04 - j0.02)$ mho (D) $(0.02 + j0)$ mho

89. A rectangular metal wave guide filled with a dielectric material of relative permitivity $\varepsilon_r = 4$ has the inside dimensions 3.0 cm $\times$ 1.2 cm. The cut-off frequency for the dominant mode is

(A) 2.5 GHz (B) 5.0 GHz

(C) 10.0 GHz (D) 12.5 GHz

90. Two identical antennas are placed in the $\theta = \pi/2$ plane as shown in Fig. Q.90. The elements have equal amplitude excitation with 180° polarity difference, operating at wavelength λ. The correct value of the magnitude of the far-zone resultant electric field strength normalized with that of a single element, both computed for $\phi = 0$, is

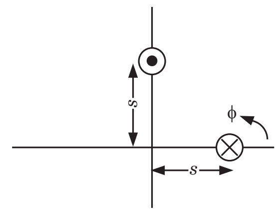


Fig. Q.90

(A) $2\cos\left(\frac{2\pi s}{\lambda}\right)$ (B) $2\sin\left(\frac{2\pi s}{\lambda}\right)$

(C) $2\cos\left(\frac{\pi s}{\lambda}\right)$ (D) $2\sin\left(\frac{\pi s}{\lambda}\right)$

****

ANSWER SHEET

1.	(B)	2.	(C)	3.	(B)	4.	(C)	5.	(C)
6.	(D)	7.	(B)	8.	(A)	9.	(C)	10.	(A)
11.	(B)	12.	(D)	13.	(B)	14.	(C)	15.	(A)
16.	(D)	17.	(C)	18.	(B)	19.	(B)	20.	(D)
21.	(D)	22.	(C)	23.	(B)	24.	(A)	25.	(C)
26.	(A)	27.	(A)	28.	(D)	29.	(B)	30.	(B)
31.	(A)	32.	(*)	33.	(D)	34.	(D)	35.	(C)
36.	(B)	37.	(A)	38.	(C)	39.	(C)	40.	(C)
41.	(C)	42.	(A)	43.	(D)	44.	(B)	45.	(A)
46.	(A)	47.	(A)	48.	(C)	49.	(D)	50.	(B)
51.	(D)	52.	(D)	53.	(B)	54.	(A)	55.	(B)
56.	(C)	57.	(A)	58.	(D)	59.	(C)	60.	(A)
61.	(A)	62.	(A)	63.	(C)	64.	(B)	65.	(A)
66.	(C)	67.	(A)	68.	(A)	69	(D)	70	(A)
71.	(B)	72.	(D)	73.	(C)	74	(A)	75	(D)
76.	(D)	77.	(B)	78.	(A)	79	(C)	80	(D)
81.	(B)	82.	(D)	83.	(B)	84.	(C)	85.	(C)
86.	(D)	87.	(B)	88.	(A)	89	(B)	90.	(D)

5. For the R-L circuit shown in Fig. Q.5, the input voltage $v_i(t) = u(t)$. The current $i(t)$ is

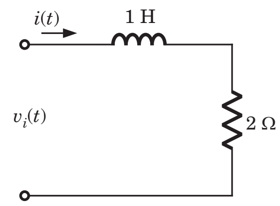
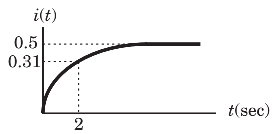
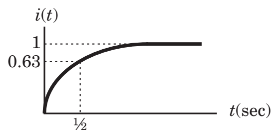


Fig Q.5

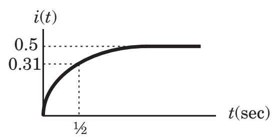
(A)



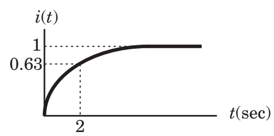
(B)



(C)



(D)



6. The impurity commonly used for realizing the base region of a silicon n-p-n transistor is

(A) Gallium (B) Indium

(C) Boron (D) Phosphorus

7. If for a silicon n-p-n transistor, the base-to-emitter voltage (V_{BE}) is 0.7 V and the collector-to-base voltage (V_{CB}) is 0.2 V, then the transistor is operating in the

(A) normal active mode (B) saturation mode

(C) inverse active mode (D) cutoff mode

8. Consider the following statements S1 and S2.

S1 : The β of a bipolar transistor reduces if the base width is increased.

S2 : The β of a bipolar transistor increases if the doping concentration in the base is increased.

Which one of the following is correct ?

(A) S1 is FALSE and S2 is TRUE

(B) Both S1 and S2 are TRUE

(C) Both S1 and S2 are FALSE

(D) S1 is TRUE and S2 is FALSE

9. An ideal op-amp is an ideal

(A) voltage controlled current source

(B) voltage controlled voltage source

(C) current controlled current source

(D) current controlled voltage source

10. Voltage series feedback (also called series-shunt feedback) results in

(A) increase in both input and output impedances

(B) decrease in both input and output impedances

(C) increase in input impedance and decrease in output impedance

(D) decrease in input impedance and increase in output impedance

11. The circuit in Fig. Q.11 is a

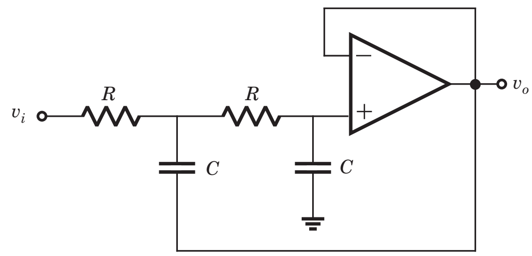


Fig Q.11

(A) low-pass filter (B) high-pass filter

(C) band-pass filter (D) band-reject filter

12. Assuming $V_{CEsat} = 0.2$ V and $\beta = 50$, the minimum base current (I_B) required to drive the transistor in Fig. Q.12 to saturation is

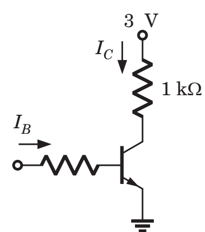


Fig Q12.

(A) 56 μA (B) 140 mA

(C) 60 μA (D) 3 mA

13. A master-slave flip-flop has the characteristic that

(A) change in the input is immediately reflected in the output

(B) change in the output occurs when the state of the master is affected

(C) change in the output occurs when the state of the slave is affected

(D) both the master and the slave states are affected at the same time

14. The range of signed decimal numbers that can be represented by 6-bit 1's complement numbers is

(A) –31 to +31 (B) –63 to +64

(C) –64 to +63 (D) –32 to +31

15. A digital system is required to amplify a binary-encoded audio signal. The user should be able to control the gain of the amplifier from a minimum to a maximum in 100 increments. The minimum number of bits required to encode, in straight binary, is

(A) 8 (B) 6

(C) 5 (D) 7

16. Choose the correct one from among the alternatives A, B, C, D after matching an item from Group 1 with the most appropriate item in Group 2.

Group 1	Group 2
P: Shift register	1: Frequency division
Q: Counter	2: Addressing in memory chips
R: Decoder	3: Serial to parallel data conversion

(A)	(B)	(C)	(D)
P–3	P–3	P–2	P–1
Q–2	Q–1	Q–1	Q–3
R–1	R–2	R–3	R–2

17. Fig. Q.17 shows the internal schematic of a TTL AND-OR-Invert (AOI) gate. For the inputs shown in Fig. Q.17, the output Y is

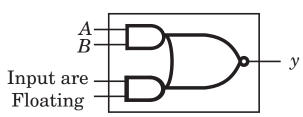


Fig Q.17

(A) 0 (B) 1

(C) AB (D) $\overline{AB}$

18. Fig. Q.18 is the voltage transfer characteristic of

(A) an NMOS inverter with enhancement mode transistor as load

(B) an NMOS inverter with depletion mode transistor as load

(C) a CMOS inverter

(D) a BJT inverter

19. The impulse response $h[n]$ of a linear time-invariant system is given by

$$h[n] = u[n+3] + u[n-2] - 2u[n-7]$$

where $u[n]$ is the unit step sequence. The above system is

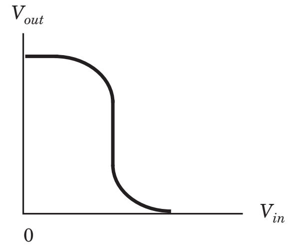


Fig Q.18

(A) stable but not causal

(B) stable and causal

(C) causal but unstable

(D) unstable and not causal

20. The distribution function $F_X(x)$ of a random variable X is shown in Fig. Q.20. The probability that $X = 1$ is

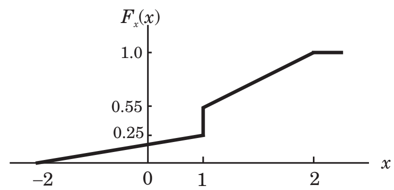


Fig Q.20

(A) zero (B) 0.25

(C) 0.55 (D) 0.30

21. The z-transform of a system is

$$H(z) = \frac{z}{z - 0.2}$$

If the ROC is $|z| < 0.2$, then the impulse response of the system is

(A) $(0.2)^n u[n]$ (B) $(0.2)^n u[-n-1]$

(C) $-(0.2)^n u[n]$ (D) $-(0.2)^n u[-n-1]$

22. The Fourier transform of a conjugate symmetric function is always

(A) imaginary (B) conjugate anti-symmetric

(C) real (D) conjugate symmetric

33. Consider the Bode magnitude plot shown in Fig. Q.33. The transfer function $H(s)$ is

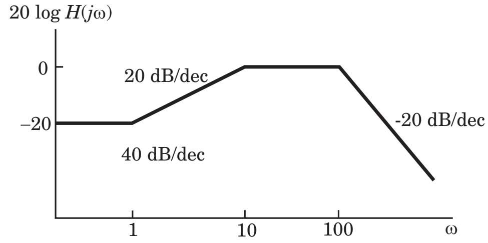


Fig Q.33

(A) $\dfrac{(s+10)}{(s+1)(s+100)}$ (B) $\dfrac{10(s+1)}{(s+10)(s+100)}$

(C) $\dfrac{10^2(s+1)}{(s+10)(s+100)}$ (D) $\dfrac{10^3(s+100)}{(s+1)(s+10)}$

34. The transfer function $H(s) = \dfrac{V_o(s)}{V_i(s)}$ of an R–L–C circuit is given by

$$H(s) = \frac{10^6}{s^2 + 20s + 10^6}$$

The Quality factor (Q-factor) of this circuit is

(A) 25 (B) 50

(C) 100 (D) 5000

35. For the circuit shown in Fig. Q.35, the initial conditions are zero. Its transfer function $H(s) = V_C(s)/V_i(s)$ is

(A) $\dfrac{1}{s^2 + 10^3 s + 10^6}$ (B) $\dfrac{10^6}{s^2 + 10^3 s + 10^6}$

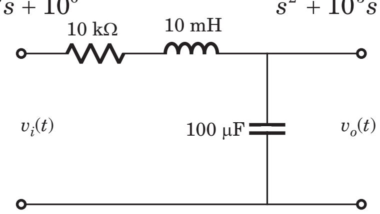


Fig Q35.

(C) $\dfrac{10^3}{s^2 + 10^3 s + 10^6}$ (D) $\dfrac{10^6}{s^2 + 10^6 s + 10^6}$

36. A system described by the following differential equation

$$\frac{d^2y}{dt^2} + 3\frac{dy}{dt} + 2y = x(t)$$

is initially at rest. For input $x(t) = 2u(t)$, the output $y(t)$ is

(A) $(1 - 2e^{-t} + e^{-2t})u(t)$ (B) $(1 + 2e^{-t} - e^{-2t})u(t)$

(C) $(0.5 + e^{-t} + 1.5e^{-2t})u(t)$ (D) $(0.5 + 2e^{-t} + 2e^{-2t})u(t)$

37. Consider the following statements S1 and S2.

S1 : At the resonant frequency the impedance of a series R–L–C circuit is zero.

S2 : In a parallel G–L–C circuit, increasing the conductance G results in increase in its Q factor.

Which one of the following is correct ?

(A) S1 is FALSE and S2 is TRUE

(B) Both S1 and S2 are TRUE

(C) S1 is TRUE and S2 is FALSE

(D) Both S1 and S2 are FALSE

38. In an abrupt p–n junction, the doping concentrations on the p-side and n-side are $N_A = 9 \times 10^{16}/\text{cm}^3$ respectively. The p-n junction is reverse biased and the total depletion width is 3 μm. The depletion width on the p-side is

(A) 2.7 μm (B) 0.3 μm

(C) 2.25 μm (D) 0.75 μm

39. The resistivity of a uniformly doped n-type silicon sample is 0.5 Ω-cm. If the electron mobility (μ_n) is 1250 cm²/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) $5 \times 10^{15}/\text{cm}^3$

40. Consider an abrupt p-n junction. Let V_{bi} be the built-in potential of this junction and V_R be the applied reverse bias. If the junction capacitance (C_j) is 1 pF for $V_{bi} + V_R = 1$ V, then for $V_{bi} + V_R = 4$ V, C_j will be

(A) 4 pF (B) 2 pF

(C) 0.25 pF (D) 0.5 pF

41. Consider the following statements S1 and S2.

S1 : The threshold voltage (V_T) of a MOS capacitor decreases with increase in gate oxide thickness.

S2 : The threshold voltage (V_T) of a MOS capacitor decreases with increase in substrate doping concentration.

Which one of the following is correct ?

(A) S1 is FALSE and S2 is TRUE

(B) Both S1 and S2 are TRUE

(C) Both S1 and S2 are FALSE

(D) S1 is TRUE and S2 is FALSE

42. The drain of an n-channel MOSFET is shorted to the gate so that $V_{GS} = V_{DS}$. The threshold voltage (V_T) of the MOSFET is 1 V. If the drain current (I_D) is 1 mA for $V_{GS} = 2$ V, then for $V_{GS} = 3$ V, I_D is

(A) 2 mA (B) 3 mA

(C) 9 mA (D) 4 mA

43. The longest wavelength that can be absorbed by silicon, which has the bandgap 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 bandgap of this material is

(A) 1.416 eV (B) 0.886 eV

(C) 0.854 eV (D) 0.706 eV

44. The neutral base width of a bipolar transistor, biased in the active region, is 0.5 μm. The maximum electron concentration and the diffusion constant in the base are $10^{14}/\text{cm}^3$ and $D_n = 25\,\text{cm}^2/\text{sec}$ respectively. Assuming negligible recombination in the base, the collector current density is (the electron charge is 1.6×10^{-19} Coulomb)

(A) 800 A/cm^2 (B) 9 A/cm^2

(C) 200 A/cm^2 (D) 2 A/cm^2

45. Assume that the β of the transistor is extremely large and $V_{BE} = 0.7$ V, I_C and V_{CE} in the circuit shown in Fig. Q.45 are

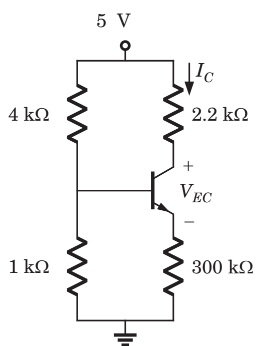


Fig Q.45

(A) $I_C = 1$ mA, $V_{CE} = 4.7$ V

(B) $I_C = 0.5$ mA, $V_{CE} = 3.75$ V

(C) $I_C = 1$ mA, $V_{CE} = 2.5$ V

(D) $I_C = 0.5$ mA, $V_{CE} = 3.9$ V

46. A bipolar transistor is operating in the active region with a collector current of 1 mA. Assuming that the β of the transistor is 100 and the thermal voltage (V_T) is 25 mV, the transconductance (g_m) and the input resistance (r_π) of the transistor in the common emitter configuration, are

(A) $g_m = 25$ mA/V and $r_\pi = 15.625$ kΩ

(B) $g_m = 40$ mA/V and $r_\pi = 4.0$ kΩ

(C) $g_m = 25$ mA/V and $r_\pi = 2.5$ kΩ

(D) $g_m = 40$ mA/V and $r_\pi = 2.5$ kΩ

47. The value of C required for sinusoidal oscillations of frequency 1 kHz in the circuit of Fig. Q.47 is

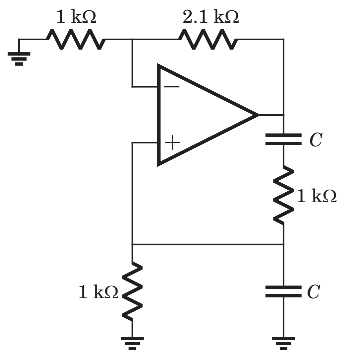


Fig Q.47

(A) $\frac{1}{2\pi}$ μF (B) 2π μF

(C) $\frac{1}{2\pi\sqrt{6}}$ μF (D) $2\pi\sqrt{6}$ μF

48. In the op-amp circuit given in Fig. Q.48, the load current i_L is

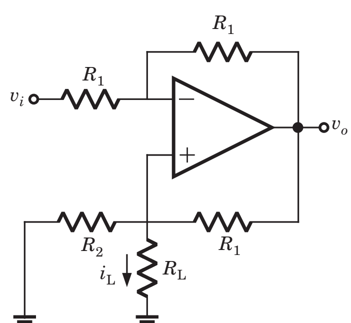


Fig Q.48

(A) $-\frac{v_s}{R_2}$ (B) $\frac{v_s}{R_2}$

(C) $-\frac{v_s}{R_L}$ (D) $\frac{v_s}{R_1}$

57. Consider the sequence of 8085 instructions given below

LXI H, 9258

MOV A, M

CMA

MOV M , A

Which one of the following is performed by this sequence?

(A) Contents of location 9258 are moved to the accumulator

(B) Contents of location 9258 are compared with the contents of the accumulator

(C) Contents of location 8529 are complemented and stored in location 8529

(D) Contents of location 5892 are complemented and stored in location 5892

58. A Boolean function f of two variables x and y is defined as follows :

$$f(0,0)=f(0,1)=f(1,1)=1;\quad f(1,0)=0$$

Assuming complements of x and y are not available, a minimum cost solution for realizing f using only 2-input NOR gates and 2-input OR gates (each having unit cost) would have a total cost of

(A) 1 unit　　(B) 4 units

(C) 3 units　　(D) 2 units

59. It is desired to multiply the numbers 0AH by 0BH and store the result in the accumulator. The numbers are available in registers B and C respectively. A part of the 8085 program for this purpose is given below:

```
        MVI A, 00H
LOOP:   __________
        __________
        __________
        HLT
        END
```

The sequence of instructions to complete the program would be

(A) JNZ LOOP, ADD B, DCR C

(B) ADD B, JNZ LOOP, DCR C

(C) DCR C, JNZ LOOP, ADD B

(D) ADD B, DCR C, JNZ LOOP

60. A 1 kHz sinusoidal signal is ideally sampled at 1500 samples /sec and the sampled signal is passed through an ideal low-pass filter with cut-off frequency 800 Hz. The output signal has the frequency

(A) zero Hz　　(B) 0.75 kHz

(C) 0.5 kHz　　(D) 0.25 kHz

61. A rectangular pulse train $s(t)$ as shown in Fig. Q.61 is convolved with the signal $\cos^2(4\pi\times 10^3 t)$. The convolved signal will be a

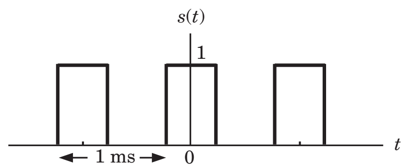


Fig Q.61

(A) DC　　(B) 12 kHz sinusoid

(C) 8 kHz sinusoid　　(D) 14 kHz sinusoid

62. Consider the sequence

$$x[n]=[-4-j5\quad \underset{\uparrow}{1+j2}\quad 5]$$

The conjugate anti-symmetric part of the sequence is

(A) $[-4-j2.5\quad j2\quad 4-j2.5]$

(B) $[-j2.5\quad 1\quad j2.5]$

(C) $[-j2.5\quad j2\quad 0]$

(D) $[-4\quad 1\quad 4]$

63. A causal LTI system is described by the difference equation

$$2y[n]=\alpha y[n-2]-2x[n]+\beta x[n-1]$$

The system is stable only if

(A) $|\alpha|=2,\ |\beta|<2$

(B) $|\alpha|>2,\ |\beta|>2$

(C) $|\alpha|<2,$ any value of β

(D) $|\beta|<2,$ any value of α

64. A causal system having the transfer function

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

is excited with $10u(t)$. The time at which the output reaches 99% of its steady state value is

(A) 2.7 sec　　(B) 2.5 sec

(C) 2.3 sec　　(D) 2.1 sec

65. The impulse response $h[n]$ of a linear time invariant system is given as

$$h[n] = \begin{cases} -2\sqrt{2} & n = 1, -1 \\ 4\sqrt{2} & n = 2, -2 \\ 0 & \text{otherwise} \end{cases}$$

If the input to the above system is the sequence $e^{j\pi n/4}$, then the output is

(A) $4\sqrt{2}e^{j\pi n/4}$ (B) $4\sqrt{2}e^{-j\pi n/4}$

(C) $4e^{j\pi n/4}$ (D) $-4e^{j\pi n/4}$

66. Let $x(t)$ and $y(t)$ with Fourier transforms $F(f)$ and $Y(f)$ respectively be related as shown in Fig. Q.66. Then $Y(f)$ is

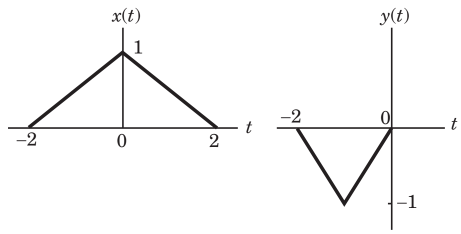


Fig Q.66

(A) $-\frac{1}{2}X(f/2)e^{-j2\pi f}$ (B) $-\frac{1}{2}X(f/2)e^{j2\pi f}$

(C) $-X(f/2)\,e^{j2\pi f}$ (D) $-X(f/2)\,e^{-j2\pi f}$

67. 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°

68. Consider the signal flow graph shown in Fig. Q.68. The gain $\frac{x_5}{x_1}$ is

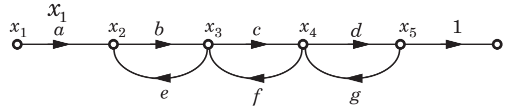


Fig Q.68

(A) $\dfrac{1-(be+cf+dg)}{abcd}$

(B) $\dfrac{bedg}{1-(be+cf+dg)}$

(C) $\dfrac{abcd}{1-(be+cf+dg)+bedg}$

(D) $\dfrac{1-(be+cf+dg)+bedg}{abcd}$

69. If $\mathbf{A} = \begin{bmatrix} -2 & 2 \\ 1 & -3 \end{bmatrix}$, then $\sin At$ is

(A) $\begin{bmatrix} \sin(-4t)+2\sin(-t) & -\sin(-4t)+2\sin(-t) \\ -\sin(-4t)+\sin(-t) & 2\sin(-4t)+\sin(-t) \end{bmatrix}$

(B) $\begin{bmatrix} \sin(-2t) & \sin(2t) \\ \sin(t) & \sin(-3t) \end{bmatrix}$

(C) $\begin{bmatrix} \sin(4t)+2\sin(t) & 2\sin(-4t)-2\sin(-t) \\ -\sin(-4t)+\sin(t) & 2\sin(4t)+\sin(t) \end{bmatrix}$

(D) $\begin{bmatrix} \cos(-t)+2\cos(t) & 2\cos(-4t)-2\sin(-t) \\ -\cos(-4t)+\sin(-t) & -2\cos(4t)+\cos(t) \end{bmatrix}$

70. The open-loop transfer function of a unity feedback system is

$$G(s) = \frac{K}{s(s^2+s+2)(s+3)}$$

The range of K for which the system is stable is

(A) $\frac{21}{4} > K > 0$ (B) $13 > K > 0$

(C) $\frac{21}{4} < K < \infty$ (D) $-6 < K < \infty$

71. For the polynomial

$$P(s) = s^5 + s^4 + 2s^3 + 2s^2 + 3s + 15$$

the number of roots which lie in the right half of the s-plane is

(A) 4 (B) 2

(C) 3 (D) 1

72. The state variable equations of a system are :

$$\dot{x}_1 = -3x_1 - x_2 = u, \ \dot{x}_2 = 2x_1 \quad , \quad y = x_1 + u$$

The system is

(A) controllable but not observable

(B) observable but not controllable

(C) neither controllable nor observable

(D) controllable and observable

73. Given $\mathbf{A} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$, the state transition matrix e^{At} is given by

(A) $\begin{bmatrix} 0 & e^{-t} \\ e^{-t} & 0 \end{bmatrix}$ (B) $\begin{bmatrix} 0 & e^{t} \\ e^{t} & 0 \end{bmatrix}$

(C) $\begin{bmatrix} e^{-t} & 0 \\ 0 & e^{-t} \end{bmatrix}$ (D) $\begin{bmatrix} e^{t} & 0 \\ 0 & e^{t} \end{bmatrix}$

74. Consider the signal $x(t)$ shown in Fig. Q.74. Let $h(t)$ denote the impulse response of the filter matched to $x(t)$, with $h(t)$ being non-zero only in the interval 0 to 4 sec. The slope of $h(t)$ in the interval $3 < t < 4$ sec is

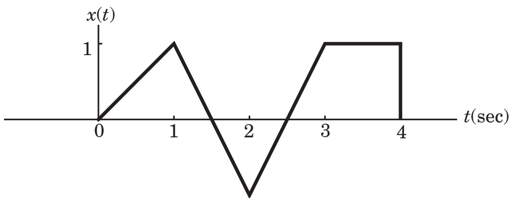


Fig. Q.74

(A) ½ sec^{-1} (B) -1 sec^{-1}

(C) $-1/2$ sec^{-1} (D) 1 sec^{-1}

75. A 1 mW video signal having a bandwidth of 100 MHz is transmitted to a receiver through a cable that has 40 dB loss. If the effective one-sided noise spectral density at the receiver is 10^{-20} Watt/Hz, then the signal-to-noise ratio at the receiver is

(A) 50 dB (B) 30 dB

(C) 40 dB (D) 60 dB

76. A 100 MHz carrier of 1V amplitude and a 1 MHz modulating signal of 1V amplitude are fed to a balanced modulator. The output of the modulator is passed through an ideal high-pass filter with cut-off frequency of 100 MHz. The output of the filter is added with 100 MHz signal of 1V amplitude and 90° phase shift as shown in Fig. Q.76. The envelope of the resultant signal is

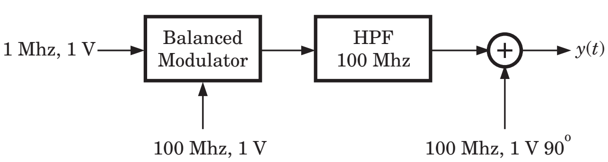


Fig Q.76

(A) constant (B) $\sqrt{1+\sin(2\pi\times 10^6 t)}$

(C) $\sqrt{5/4-\sin(2\pi\times 10^6 t)}$ (D) $\sqrt{5/4+\cos(2\pi\times 10^6 t)}$

77. Two sinusoidal signals of same amplitude and frequencies 10 kHz and 10.1 kHz are added together. The combined signal is given to an ideal frequency detector. The output of the detector is

(A) 0.1 kHz sinusoid (B) 20.1 kHz sinusoid

(C) a linear function of time (D) a constant

78. Consider a binary digital communication system with equally likely 0's and 1's. When binary 0 is transmitted the voltage at the detector input can lie between the levels -0.25 V and $+0.25$ V with equal probability; when binary 1 is transmitted, the voltage at the detector can have any value between 0 and 1 V with equal probability. If the detector has a threshold of 0.2V (i.e. if the received signal is greater than 0.2V, the bit is taken as 1), the average bit error probability is

(A) 0.15 (B) 0.2

(C) 0.05 (D) 0.5

79. A random variable X with uniform density in the interval 0 to 1 is quantized as follows:

$$\text{if } 0 \le X \le 0.3, \quad x_q = 0$$
$$\text{if } 0.3 \le X \le 1, \quad x_q = 0.7$$

where x_q is the quantized value of X. The root-mean square value of the quantization noise is

(A) 0.573 (B) 0.198

(C) 2.205 (D) 0.266

80. Choose the correct one from among the alternatives A, B, C, D after matching an item from Group 1 with the most appropriate item in Group 2.

Group 1	**Group 2**
1 : FM	P : Slope overload
2 : DM	Q : μ-law
3 : PSK	R : Envelope detector
4 : PCM	S : Capture effect
	T : Hilbert transfer
	U : Matched filter

(A)	(B)	(C)	(D)
1–T	1–S	1–S	1–U
2–P	2–U	2–P	2–R
3–U	3–P	3–U	3–S
4–S	4–T	4–Q	4–Q

81. Three analog signals, having bandwidth 1200 Hz, 600 Hz and 600 Hz, are sampled at their respective Nyquist rates, encoded with 12 bit words, and time division multiplexed. The bit rate for the multiplexed signal is

(A) 1, 15.2 kbps (B) 28.8 kbps

(C) 27.6 kbps (D) 38.4 kbps

82. Consider a system shown in Fig. Q.82. Let $X(f)$ and $Y(f)$ denote the Fourier transforms of $x(t)$ and $y(t)$ respectively. The ideal HPF has the cutoff frequency 10 kHz.

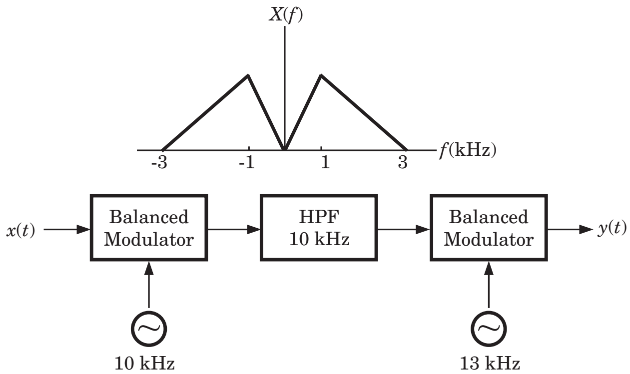


Fig Q.82

The positive frequencies where $Y(f)$ has spectral peaks are

(A) 1 kHz and 24 kHz (B) 2 kHz and 24 kHz

(C) 1 kHz and 14 kHz (D) 2 kHz and 14 kHz

83. A parallel plate air-filled capacitor has plate area of 10^{-4} m^2 and plate separation of 10^{-3} m. It is connect- ed to a 0.5 V, 3.6 GHz source. The magnitude of the displacement current is ($\varepsilon_o = 1/36\pi \times 10^{-9}$ F/m)

(A) 10 mA (B) 100 mA

(C) 10 A (D) 1.59 mA

84. A source produces binary data at the rate of 10 kbps. The binary symbols are represented as shown in Fig.Q.84

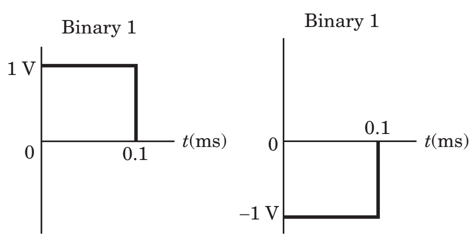


Fig Q.84

The source output is transmitted using two modulation schemes, namely Binary PSK (BPSK) and Quadrature PSK (QPSK). Let B_1 and B_2 be the bandwidth requirements of BPSK respectively. Assuming that the bandwidth of the above rectangular pulses is 10 kHz, B_1 and B_2 are

(A) B_1 = 20 kHz, B_2 = kHz

(B) B_1 = 10 kHz, B_2 = 10 kHz

(C) B_1 = 20 kHz, B_2 = 10 kHz

(D) B_1 = 10 kHz, B_2 = 10 kHz

85. Consider a 300 Ω, quarter-wave long (at 1 GHz) transmission line as shown in Fig. Q.85. It is connected to a 10 V, 50Ω source at one end and is left open circuited at the other end. The magnitude of the voltage at the open circuit end of the line is

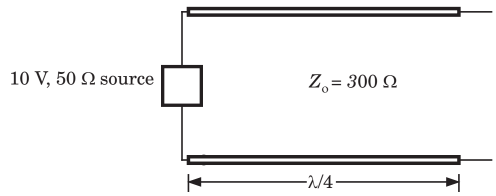


Fig Q.85

(A) 10 V (B) 5 V

(C) 60 V (D) 60/7 V

86. In a microwave test bench, why is the microwave signal amplitude modulated at 1 kHz ?

(A) To increase the sensitivity of measurement

(B) To transmit the signal to a far-off place

(C) To study amplitude modulation

(D) Because crystal detector fails at microwave frequencies

87. If $\vec{\mathbf{E}} = (\hat{\mathbf{a}}_x + j\hat{\mathbf{a}}_y)e^{jkz-j\omega t}$ and $\vec{\mathbf{H}} = (k/\omega\mu)(\hat{\mathbf{a}}_y + j\hat{\mathbf{a}}_x)e^{jkz-j\omega t}$,the time-averaged Poynting vector is

(A) null vector (B) $(k/\omega\mu)\hat{\mathbf{a}}_z$

(C) $(2k/\omega\mu)\hat{\mathbf{a}}_z$ (D) $(k/2\omega\mu)\hat{\mathbf{a}}_z$

88. Consider an impedance $Z = R + jX$ marked with point P in an impedance Smith chart as shown in Fig. Q.88. The movement from point P along a constant resistance circle in the clockwise direction by an angle 45° is equivalent to

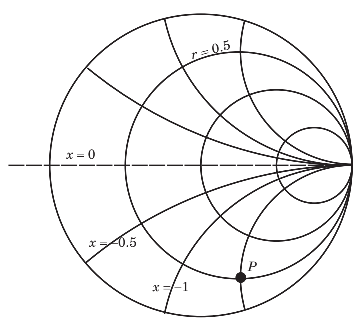


Fig. Q.88