Q. 1- Q. 25 carry one mark each.

Q.1 If $v = 2xy$, then the analytic function $f(z) = u + iv$ is

(A) $z^2 + c$ (B) $z^{\ 2} + c$

(C) $z^3 + c$ (D) $z^{\ 3} + c$

Q.2 If $\text{cov}(X, Y) = 10$, $\text{var}(X) = 6.25$ and $\text{var}(Y) = 31.36$, then $\rho(X, Y)$ is

(A) 5/7 (B) 4/5

(C) 3/4 (D) 0.256

Q.3 If $\mathbf{A}$ is a 3-rowed square matrix such that $|\mathbf{A}| = 3$, then $\text{adj}(\text{adj}\mathbf{A})$ is equal to :

(A) 3A (B) 9A

(C) 27A (D) none of these

Q.4 A discrete random variable X has possible values $x_i = i^2$, $i = 1,2,3,4$ which occur with probabilities 0.4, 0.25, 0.15, 0.1,. The mean value $\overline{X} = E[X]$ of X is

(A) 6.85 (B) 4.35

(C) 3.96 (D) 1.42

Q.5 If the modulation index of an AM wave is changed from 0 to 1, the transmitted power

(A) increases by 50% (B) increases by 75%

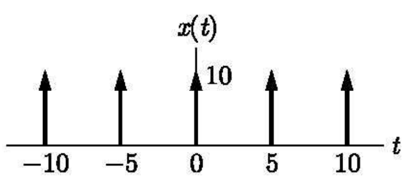
(C) increases by 100% (D) remains unaffected

Q.6 A source has an alphabet $\{a_1, a_2, a_3, a_4, a_5, a_6\}$ with corresponding probabilities $\{0.1, 0.2, 0.3, 0.5, 0.15, 0.2\}$. The entropy of this source is

(A) 9.3 bits/symbol (B) 7.3 bits/symbol

(C) 5.4 bits/symbol (D) 2.4 bits/symbol

Q.7 The Fourier series coefficient for the periodic signal shown below is



(A) 1 (B) $\cos(\frac{\pi}{2}k)$

(C) $\sin(\frac{\pi}{2}k)$ (D) 2

Q.8 The Fourier transform of signal $e^{4|t|}$ is

(A) $\dfrac{8}{16 + \omega^2}$ (B) $\dfrac{-8}{16 + \omega^2}$

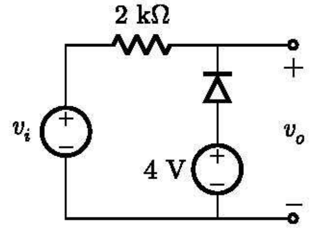
(C) $\dfrac{4}{16 + \omega^2}$ (D) $\dfrac{-4}{16 + \omega^2}$

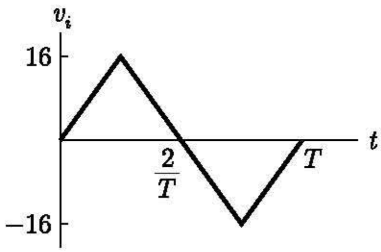
Q.9 The z-transform of a anti causal system is $X(z) = \frac{12 \quad 21z}{3 \quad 7z+12z^2}$ The value of $x[0]$ is

(A) $-7/4$ (B) 0

(C) 4 (D) Does not exist

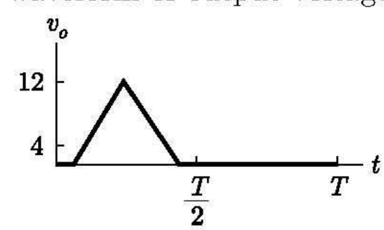
Q.10 Consider the given a circuit and a waveform for the input voltage. The diode in circuit has cutin voltage $V_\gamma = 0$.



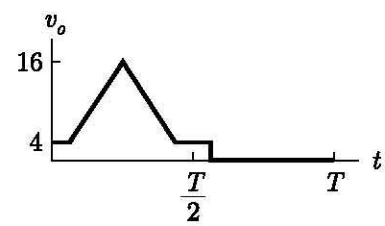


The waveform of output voltage v_o is

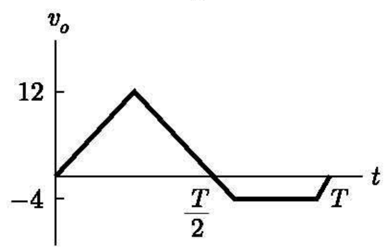
(A)



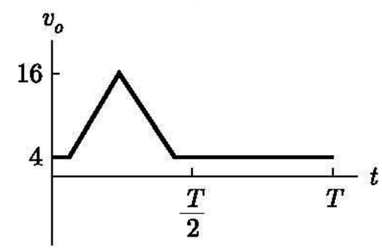
(B)



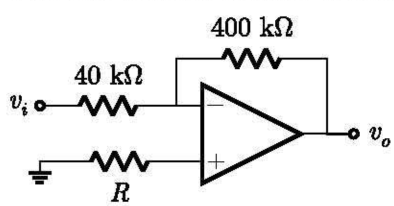
(C)



(D)



Q.11 For the circuit shown below the value of $A_v = \frac{v_o}{v_i}$ is



(A) -10 (B) 10

(C) -11 (D) 11

Q.12 Input impedance of an instrumentation amplifier compared with a difference amplifier is

(A) High (B) Low

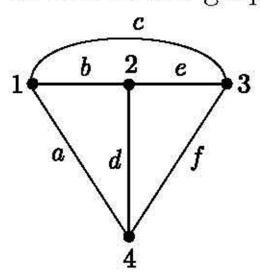
(C) Same (D) Cannot not be determined

Q.13 The buried layer in an integrated circuit is

(A) doped (B) doped

(C) used to reduce the parasitic capacitance (D) located in the base region

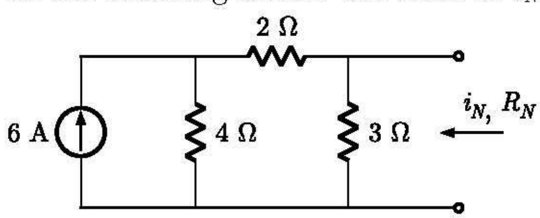
Q.14 A tree of the graph shown below is



(A) $b\,d\,a$ (B) $a\,d\,f$

(C) $d\,e\,f$ (D) $b\,c\,e$

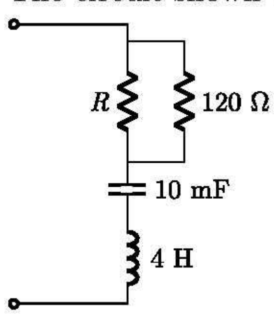
Q.15 In the following circuit the value of i_N and R_N are



(A) 4 A, 3 Ω (B) 2 A, 6 Ω

(C) 2 A, 9 Ω (D) 4 A, 2 Ω

Q.16 The circuit shown below is critically damped. The value of R is



(A) 40 Ω (B) 60 Ω

(C) 120 Ω (D) 180 Ω

Q.17 In a simple RC high pass filter the desired roll-off frequency is 15 Hz and $C = 10$ μF . The value of R would be

(A) 2.12 kΩ (B) 1.06 kΩ

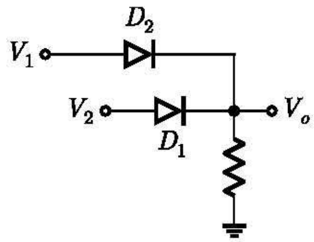
(C) 6.67 kΩ (D) 13.33 kΩ

Q.18 If $X\overline{Y} + \overline{X}Y = Z$ then $X\overline{Z} + \overline{X}Z$ is equal to

(A) $\overline{Y}$ (B) Y

(C) 0 (D) 1

Q.19 The diode logic circuit shown below is a

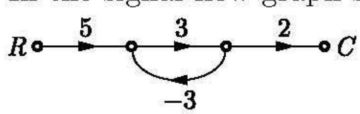


(A) AND
(B) OR
(C) NAND
(D) NOR

Q.20 The open-loop transfer function with *ufb* are given below for different systems. The unstable system is

(A) $\frac{2}{s+2}$
(B) $\frac{2}{s^2(s+2)}$
(C) $\frac{2}{s(s-2)}$
(D) $\frac{2(s+1)}{s(s+2)}$

Q.21 In the signal flow graph shown below the transfer function is



(A) 3.75
(B) −3
(C) 3
(D) −3.75

Q.22 If $\mathbf{r} = x\mathbf{u}_x + y\mathbf{u}_y + z\mathbf{u}_z$ then $(r \cdot \nabla) r^2$ is equal to

(A) $2r^2$
(B) $3r^2$
(C) $4r^2$
(D) 0

Q.23 A field $\mathbf{E}$ is given by $\mathbf{E} = 3y^2z^3\mathbf{u}_x + 6xyz^3\mathbf{u}_y + 9xy^2z^2\mathbf{u}_z$. The potential function V is

(A) $3xy^2z^3$
(B) $-3xy^2z^3$
(C) $9x^2y^2z^2$
(D) $-9x^2y^2z^2$

Q.24 If magnetization is given by $\mathbf{H} = \frac{6}{a}(-y\mathbf{u}_x + x\mathbf{u}_y)$ in a cube of size a, the magnetization volume current density is

(A) $\frac{12}{a}\mathbf{u}_z$
(B) $\frac{6}{a}(x-y)$
(C) $\frac{6}{a}\mathbf{u}_z$
(D) $\frac{3}{a}(x-y)$

Q.25 If Rolle's theorem holds for $f(x) = x^3 - 6x^2 + kx + 5$ on $[1,3]$ with $c = 2 + \frac{1}{\sqrt{3}}$, then value of k is

(A) −3
(B) 3
(C) 7
(D) 11

Q. 26- Q. 55 carry two mark each.

Q.26 A silicon crystal having a cross-sectional area of 0.001 cm ^{3} and a length of 20 μm is connected to its ends to a 20 V battery. At $T = 300$ K, we want a current of 100 mA in crystal. The concentration of donor atoms to be added is

(A) 2.4×10^{13} cm ^{3} (B) 4.6×10^{13} cm ^{3}

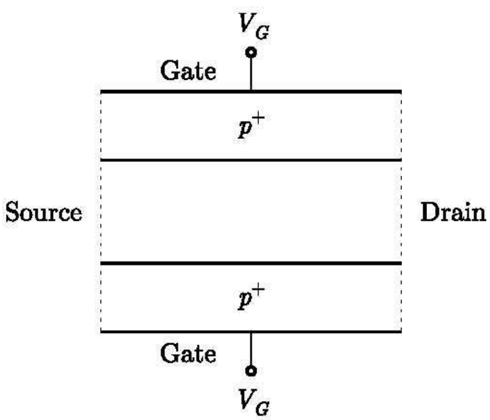
(C) 7.8×10^{14} cm ^{3} (D) 8.4×10^{14} cm ^{3}

Q.27 A gallium arsenide *pn* junction is operating in reverse-bias voltage $V_R = 5$ V. The doping profile are $N_a = N_d = 10^{16}$ cm ^{3}. The minority carrier life time are $\tau_{p0} = \tau_{n0} = \tau_0 = 10^{\ 8}$ s. The reverse-biased generation current density is

(A) $1.9 \times 10^{\ 8}$ A/cm^2 (B) $1.9 \times 10^{\ 9}$ A/cm^2

(C) $1.4 \times 10^{\ 8}$ A/cm^2 (D) $1.4 \times 10^{\ 9}$ A/cm^2

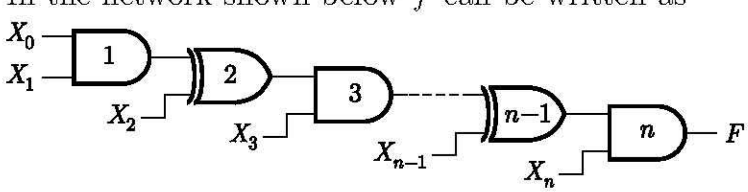
Q.28 The cross section of a JFET is shown in the following fig. Let V_c be -2 V and let V_P be the initial pinch off voltage. If the width W is doubled (with other geometrical parameters and doping levels remaining the same), then the ratio between the mutual trans conductance of the initial and the modified JFET is



(A) 4 (B) $\frac{1}{2}\left(\frac{1-\sqrt{2/V_p}}{1-\sqrt{1/2\,V_p}}\right)$

(C) $\left(\frac{1-\sqrt{2/V_p}}{1-\sqrt{1/2\,V_p}}\right)$ (D) $\frac{1-2(2/\sqrt{V_p})}{1-(1(2\sqrt{V_p}))}$

Q.29 In the network shown below f can be written as



(A) $X_0X_1X_3X_5 + X_2X_4X_5...X_{n\ 1} + ...X_{n\ 1}X_n$

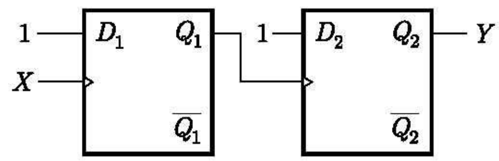
(B) $X_0X_1X_3X_5 + X_2X_3X_4...X_n + ...X_{n\ 1}X_n$

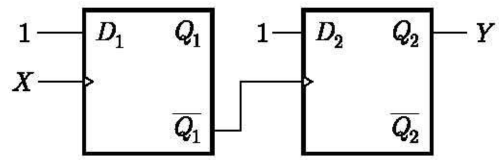
(C) $X_0X_1X_3X_5...X_n + X_2X_3X_5 + ...X_n + ... + X_{n\ 1}X_n$

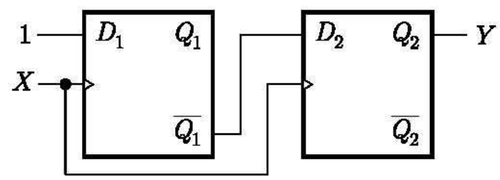
(D) $X_0 X_1 X_3 X_5 ... X_{n\ 1} + X_2 X_3 X_5 ... X_n + ... + X_{n\ 1} X_{n\ 2} + X_n$

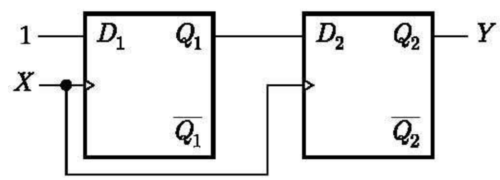
Q.30 The digital block shown below realized using two positive edge triggered D-flip-flop. Assume that for $t < t_0$, $Q_1 = Q_2 = 0$

The circuit in the digital block is given by

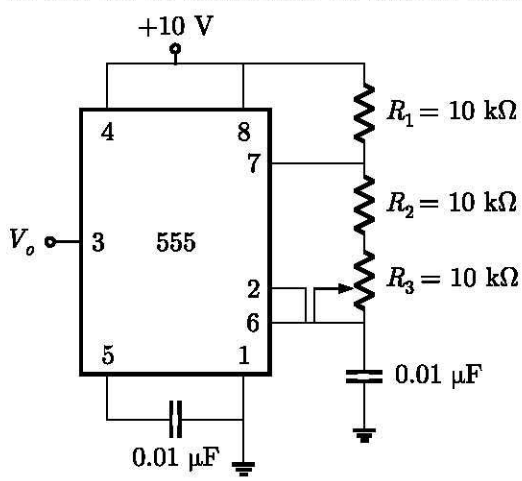
(A) 

(B) 

(C) 

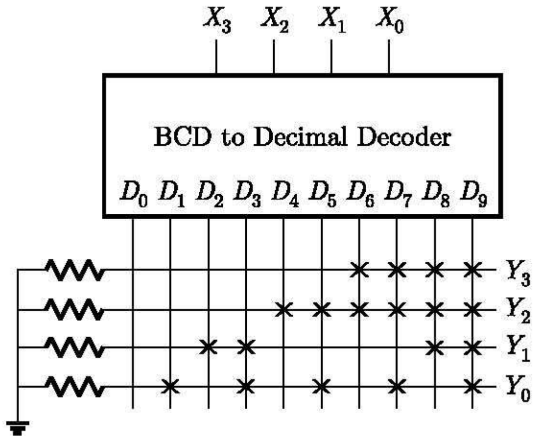
(D) 

Q.31 A 555 IC is connected as shown below. The range of oscillation frequency is



(A) 607 kHz $< f <$ 1.41 kHz
(B) 208 kHz $\leq f \leq$ 496 kHz
(C) 627 Hz $\leq f \leq$ 4.81 kHz
(D) 5 kHz $\leq f \leq$ 9.4 kHz

Q.32 If the input $X_3X_2X_1X_0$ to the ROM shown below are $8-4-2-1$ BCD numbers, then output $Y_3\,Y_2\,Y_1\,Y_0$ are



(A) $2-4-2-1$ BCD number (B) gray code number

(C) excess 3 code converter (D) none of the above

Q.33 Consider the following assembly language program:

```
         MVI B, 87H
         MOV A, B
START :  JMP NEXT
         MVI B, 00H
         XRA B
         OUT PORT1
         HLT
NEXT :   XRA B
         JP START1
         OUT PORT2
         HLT
```

The execution of the above program in an 8085 will result in

(A) an output of 87H at PORT1

(B) an output of 87H at PORT2

(C) infinite looping of the program execution with accumulator data remaining at 00H

(D) infinite looping of the program execution with accumulator data alternating between 00H and 87H.

Q.34 Consider the following system

a. $T(s) = \dfrac{5}{(s+3)(s+6)}$ b. $T(s) = \dfrac{10(s+7)}{(s+10)(s+20)}$

c. $T(s) = \dfrac{20}{s^2+6s+44}$ d. $T(s) = \dfrac{s+2}{s^2+9}$

e. $T(s) = \dfrac{(s+5)}{(s+10)^2}$

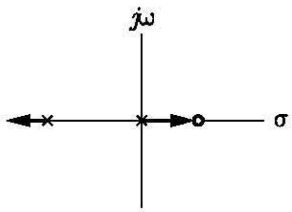
Consider the following response

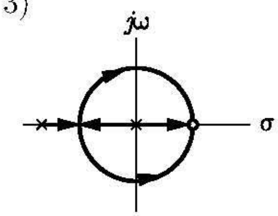
1. Over damped
2. Under damped
3. Under damped
4. Critically damped

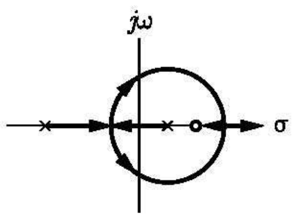
The correct match is

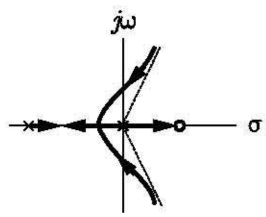
	1	2	3	4
(A)	a	c	d	e
(B)	b	a	d	e
(C)	c	a	e	d
(D)	c	b	e	d

Q.35 An ufb system is given as $G(s) = \dfrac{K(1-s)}{s(s+3)}$ Indicate the correct root locus diagram.

(A)


(B)


(C)


(D)


Q.36 For $dy/dx = x + y^2$, given that $y = 1$ at $x = 0$. Using Runge Kutta fourth order method the value of y at $x = 0.2$ is $(h = 0.2)$

(A) 1.2735
(B) 2.1635
(C) 1.9356
(D) 2.9468

Q.37 The general solution of $\dfrac{d^2y}{dx^2} - \dfrac{dy}{dx} - 2y = 10\cos x$ is

(A) $y = c_1 e^{\;x} + c_2 e^{2x} - 3\cos x - \sin x$
(B) $y = c_1 e^{x} + c_2 e^{2x} - 3\cos x$
(C) $y = c_1 e^{\;x} + c_2 e^{2x} - 3x + \sin x$
(D) $y = c_1 e^{x} + c_2 e^{\;2x} - 3\cos x - \sin x$

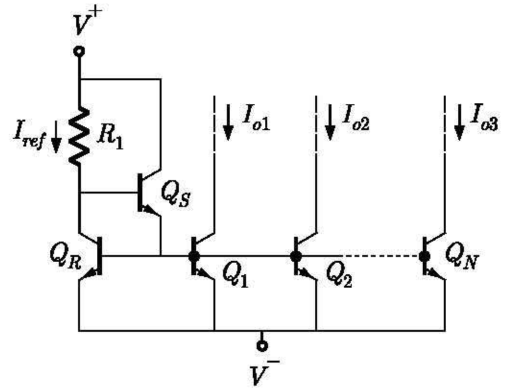
Q.38 $\displaystyle\int_0^{\frac{\pi}{2}} \frac{e^x}{2}\left(\sec^2\frac{x}{2} + 2\tan\frac{x}{2}\right)dx$ is equal to

(A) e^{π}
(B) $e^{\frac{\pi}{2}}$
(C) e
(D) $e^{\frac{\pi}{4}}$

Q.39 A speaks truth in 75% and B in 80% of the cases. In what percentage of cases are they likely to contradict each other narrating the same incident?

(A) 5%
(B) 45%
(C) 35%
(D) 15%

Q.40 All transistor in the N output mirror shown below are matched with a finite gain β and early voltage $V_A = \infty$. The expression for each load current is



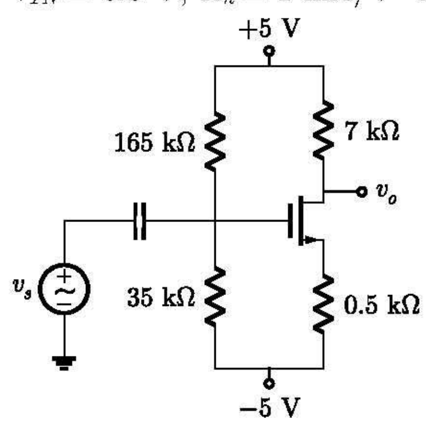
(A) $\dfrac{I_{ref}}{\left(1+\dfrac{(1+N)}{\beta(\beta+1)}\right)}$

(B) $\dfrac{I_{ref}}{\left(1+\dfrac{N}{(\beta+1)}\right)}$

(C) $\dfrac{\beta I_{ref}}{\left(1+\dfrac{(1+N)}{(\beta+1)}\right)}$

(D) $\dfrac{\beta I_{ref}}{\left(1+\dfrac{N}{\beta+1}\right)}$

Q.41 Consider the common-source circuit shown below The transistor parameters are $V_{TN} = 0.8$ V, $K_n = 1$ mA/V^2 and $\lambda = 0$. The small-signal voltage gain is



(A) -10.83

(B) -8.96

(C) -5.76

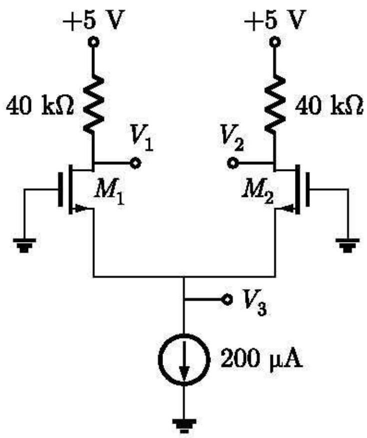
(D) -3.28

Q.42 In the following circuit, transistors Q_1 and Q_2 has following parameters

$\left(\dfrac{W}{L}\right)_1 = \left(\dfrac{W}{L}\right)_2 = 20,$

$(V_{TH})_1 = (V_{TH})_2 = 1$ V,

$(K'_n)_1 = (K'_n)_2 = 100\,\mu\text{A/V}^2$



The voltage V_1, V_2 and V_3 respectively are

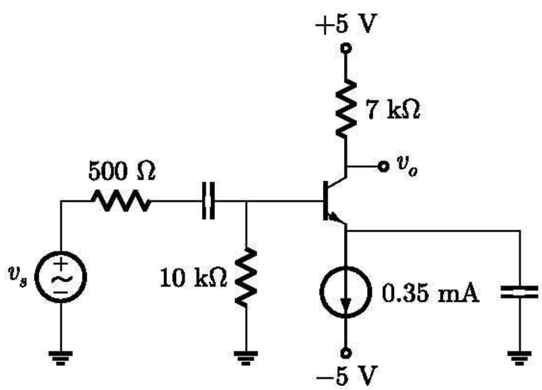
(A) 1 V, 1 V, -1.1 V V

(B) 1 V, 2 V, 1 V

(C) 2 V, 1 V, 1.32 V

(D) 1 V, 1 V, -1.32 V

Q.43 The parameters of the transistor in the circuit shown below are $\beta = 100$ and $V_A = 100$ V.



The small-signal voltage gain $A_v = v_o/v_s$ is

(A) 80

(B) -80

(C) 40

(D) -40

Q.44 Two random variable X and Y have the density function

$$f_{X,Y}(x,y) = \begin{cases} \frac{xy}{9}, & 0 < x < 2 \text{ and } 0 < y < 3 \\ 0 & \text{elsewhere} \end{cases}$$

The X and Y are

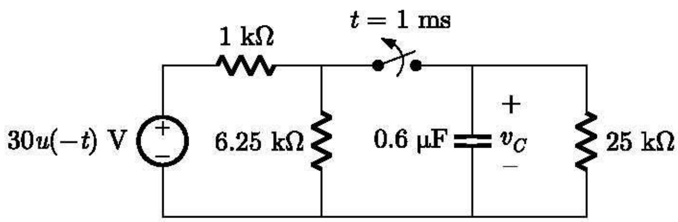
(A) Correlated but statistically independent

(B) Uncorrelated but statistically independent

(C) Correlated but statistically dependent

(D) Uncorrelated but statistically dependent

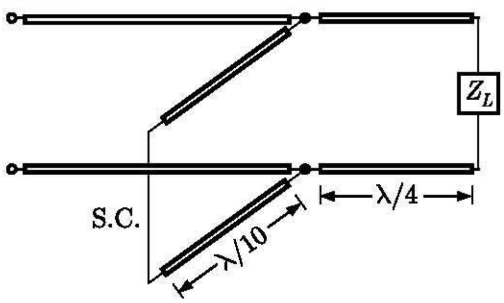
Q.45 In the following circuit the 30 V source has been applied for a long time. The switch is opened at $t = 1$ ms.



At $t = 4$ ms the $v_C(4\text{ ms})$ is

(A) 8.39 mV
(B) 2.59 V
(C) 1.13 mV
(D) 2.77 V

Q.46 The 300 Ω lossless line shown in fig. is matched to the left of the stub. The value of Z_L is



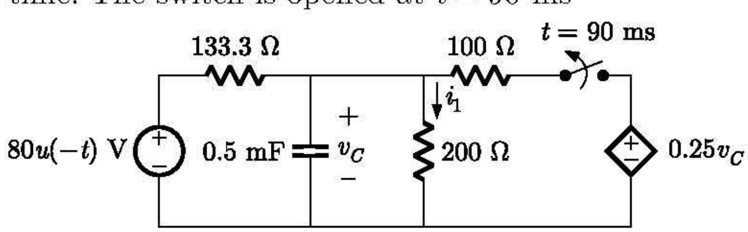
(A) $1 - j1.37$
(B) $1 + j1.37$
(C) $300 + j413$
(D) $300 - j413$

Q.47 The collector current of bipolar is $I_C = 2\text{ mA}$. If output resistance is greater than 10 kΩ. Then what is the value of early voltage V_A

(A) $V_A < 20$ V
(B) $V_A < 10$ V
(C) $V_A > 10$ V
(D) $V_A > 20$ V

Common data for Question 48-49 :

In the following circuit shown below, the 80 V source has been applied for a long time. The switch is opened at $t = 90$ ms



Q.48 At $t = 0^+$ the current $i_1(0^+)$ is

(A) 0.25 A
(B) 0.17 A
(C) 0.05 A
(D) 0.2 A

Q.49 At $t = 80$ ms the current $i_1(80 \text{ ms})$ is

(A) 20.3 mA
(B) 8.25 mA
(C) 1.84 mA
(D) 6.98 mA

Common data for Q. 50-51

A random noise $X(t)$ having a power spectrum $\rho_{XX}(\omega) = \dfrac{3}{49 + \omega^2}$ is applied to a differentiator that has a transfer function $H(\omega) = j\omega$.
The output is applied to a network for which $h(t) = u(t)\, t^2 e^{\ 7t}$

Q.50 The average power in $X(t)$ is

(A) 5/21
(B) 5/24
(C) 5/42
(D) 3/14

Q.51 The power spectrum of $Y(t)$ is

(A) $\dfrac{4\omega^2}{(49 + \omega^2)^3}$
(B) $\dfrac{12\omega^2}{(49 + \omega^2)^4}$
(C) $\dfrac{42\omega^3}{(49 + \omega^2)^2}$
(D) None of the above

Statement for Linked Answer Q. 52-53 :

Consider a linear system whose state space representation is $\dot{x}(t) = Ax(t)$. If the initial state vector of the system is $x(0) = \begin{bmatrix} 1 \\ -2 \end{bmatrix}$, then the system response is $x(t) = \begin{bmatrix} e^{\ 2x} \\ -2e^{\ 2t} \end{bmatrix}$. If the initial state vector of the system changes to $x(0) = \begin{bmatrix} 1 \\ -2 \end{bmatrix}$, then the system response becomes $x(t) = \begin{bmatrix} e^{\ t} \\ -e^{\ t} \end{bmatrix}$

Q.52 The eigenvalue and eigenvector pairs (λ_i, v_i) for the system are

(A) $\left(-1, \begin{bmatrix} 1 \\ -1 \end{bmatrix}\right)$ and $\left(-2, \begin{bmatrix} 1 \\ -2 \end{bmatrix}\right)$
(B) $\left(-1, \begin{bmatrix} 1 \\ -1 \end{bmatrix}\right)$ and $\left(2, \begin{bmatrix} 1 \\ -2 \end{bmatrix}\right)$
(C) $\left(-1, \begin{bmatrix} 1 \\ -1 \end{bmatrix}\right)$ and $\left(-2, \begin{bmatrix} 1 \\ -2 \end{bmatrix}\right)$
(D) $\left(-2, \begin{bmatrix} 1 \\ -1 \end{bmatrix}\right)$ and $\left(1, \begin{bmatrix} 1 \\ -2 \end{bmatrix}\right)$

Q.53 The system matrix A is

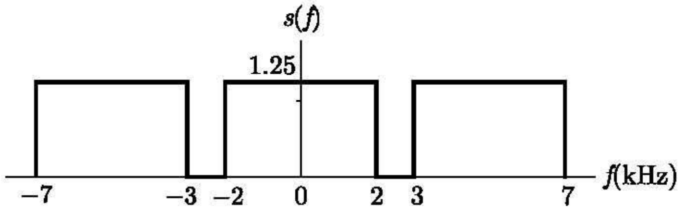
(A) $\begin{bmatrix} 0 & 1 \\ -1 & 1 \end{bmatrix}$
(B) $\begin{bmatrix} 1 & 1 \\ -1 & -2 \end{bmatrix}$
(C) $\begin{bmatrix} 2 & 1 \\ -1 & -1 \end{bmatrix}$
(D) $\begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$

Statement for Linked Answer Q. 54-55:

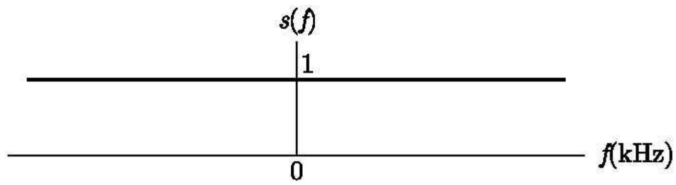
A signal $x(t) = \sin c(4000t)$ is ideally sampled with a sampling interval $T_s = 0.25$ ms

Q.54 Which of the following is spectrum of the sampled signal $s(f)$

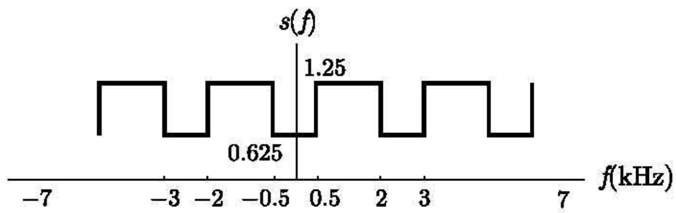
(A)



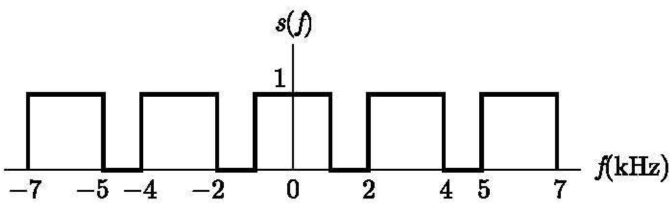
(B)



(C)

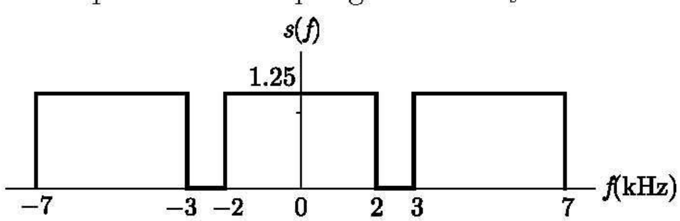


(D)



Q.55 In the above question if sampling interval $T_s = 0.4$ ms. then output spectrum will be

(A)



(B)