EC : ELECTRONIC AND COMMUNICATION ENGINEERING

Duration : Three Hours **Maximum Marks : 100**

Read the following instructions carefully.

1. Do not open the seal of the Question Booklet unlit you are asked to do so by the invigilator.
2. Take out the Optical Response Sheet (**ORS**) from this Question Booklet **without breaking the seal** and read the instruments printed on the ORS carefully. If you find the Question Booklet Code printed at the right hand top corner of this page does not match with the Booklet Code on the ORS, exchange the booklet immediately with a new sealed Question Booklet.
3. On the right half of the **ORS**, using **ONLY a black ink ball point pen**, (i) darken the bubble corresponding to your test paper code and the appropriate bubble under each digit of your registration number and (ii) write your registration number, your name and name of the examination center and put your signature at the specified location.
4. This Question Booklet contain 16 pages including blank pages for rough work. After you are permitted to open the seal, please check all pages and report discrepancies, if any, to the invigilator.
5. There are a total of 65 Question carrying 100 marks. All these questions are of objective type. Each question has only on correct answer. Question must be answered on the left hand side of the **ORS** by darkening the appropriate bubble (marked A, B, C, D) using **ONLY a black ink ball point pen** against the question number. **For each question darken the bubble of the correct answer**. More than on answer bubbled against a question will be treated as an incorrect response.
6. Since bubbles darkened by the black ink ball point pen **cannot** be erased, candidates should darken the bubbles in the **ORS very carefully**.
7. Question Q. 1 Q. 25 carry 1 mark each. Questions Q. 26 - Q. 55 carry 2 marks each. The 2 marks question include two pairs of common data questions and two pairs of linked answer questions. The answer of the second question of the linked answer questions depends on the answer to the first question of the pair. If the first question in the linked pair is wrongly answered or is unattemped, then the answer to the second question in the pair will not be evaluated.
8. Question Q. 56 - Q. 65 belong to General Aptitude (GA) section and carry a total of 15 marks. Question Q. 56 - Q.60 carry 1 mark each, and questions Q. 61 -Q. 65 carry 2 marks each.
9. Unattempted questions will result in zero mark and wrong answer will result in **NEGATIVE** marks. For all 1 mark questions 1/3 mark will be deducted for each wrong answer. For all 2 marks questions, 2/3 mark will be deducted for each wrong answer. However, in the case of the linked answer question pair, there will be negative marks only for wrong answer to the first question and no negative marks for wrong answer to the second question.
10. Calculator is allowed whereas charts, graph sheets or tables are **NOT** allowed in the examination hall.
11. Rough work can be done on the question paper itself. Blank pages are provided at the end of the question paper for rough work.
12. Before the start of the examination, write your name and registration number in the space provided below using a blank ink ball point pen.

Names								
Registration Number	**EC**							

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 adj(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%

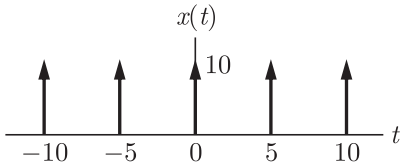
(C) increases by 100% (D) remains unaffected

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) $\cos\left(\frac{\pi}{2}k\right)$

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

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

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

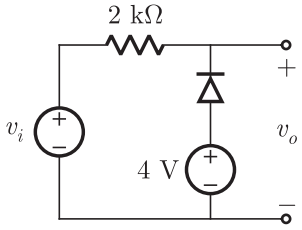
(C) $\dfrac{4}{16+\omega^2}$ (D) $\dfrac{-4}{16+\omega^2}$

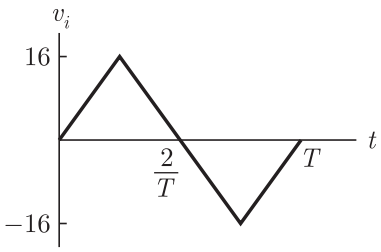
Q.9 The z-transform of a anti causal system is $X(z) = \frac{12-21z}{3-7z+12z^2}$ The value of $x[0]$ is

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

(C) 4 (D) Does not exist

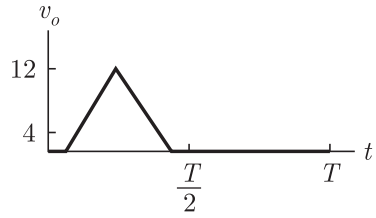
Q.10 Consider the given a circuit and a waveform for the input voltage. The diode in circuit has cutin voltage $V_\gamma = 0$.



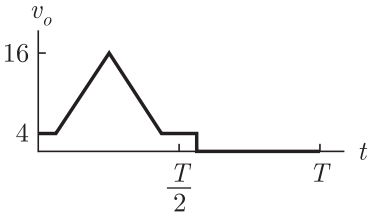


The waveform of output voltage v_o is

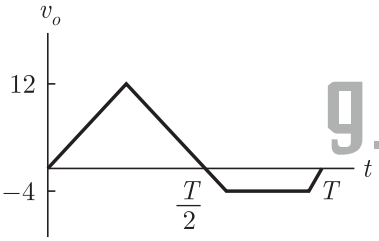
(A)



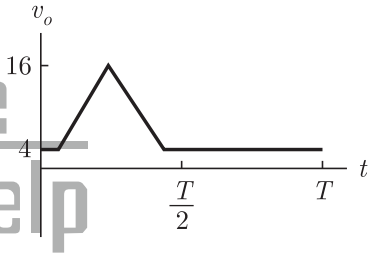
(B)



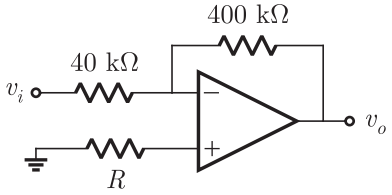
(C)



(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

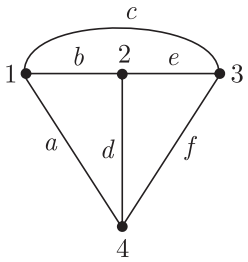
(C) Same (D) Cannot not be determined

Q.13 The buried layer in an integrated circuit is

(A) doped (B) doped

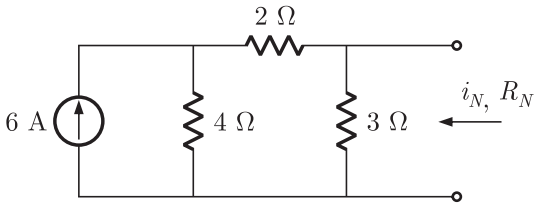
(C) used to reduce the parasitic capacitance (D) located in the base region

Q.14 A tree of the graph shown below is



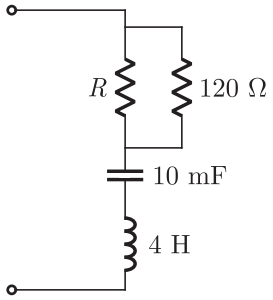
(A) $b\,d\,a$ (B) $a\,d\,f$
(C) $d\,e\,f$ (D) $b\,c\,e$

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

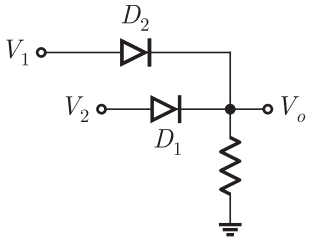
Q.17 In a simple RC high pass filter the desired roll-off frequency is 15 Hz and $C = 10$ μF . The value of R would be

(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

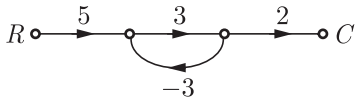


(A) AND
(B) OR
(C) NAND
(D) NOR

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}

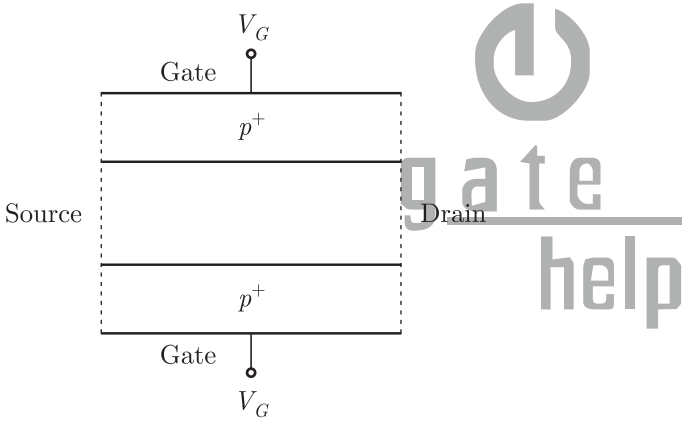
(C) 7.8×10^{14} cm^{-3} (D) 8.4×10^{14} cm^{-3}

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) $1.4 \times 10^{-9}\,A/cm^2$

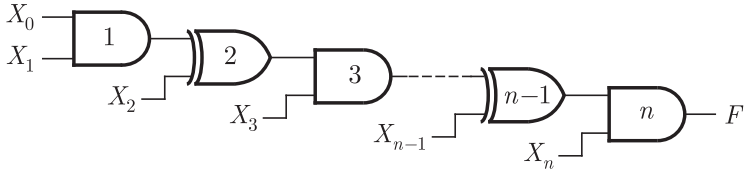
Q.28 The cross section of a JFET is shown in the following fig. Let V_c be -2 V and let V_P be the initial pinch off voltage. If the width W is doubled (with other geometrical parameters and doping levels remaining the same), then the ratio between the mutual trans conductance of the initial and the 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) $X_0X_1X_3X_5 + X_2X_4X_5...X_{n-1} + ...X_{n-1}X_n$

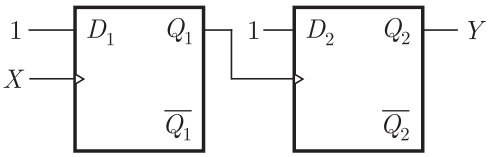
(B) $X_0X_1X_3X_5 + X_2X_3X_4...X_n + ...X_{n-1}X_n$

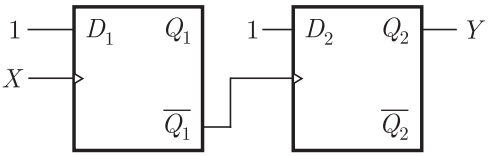
(C) $X_0X_1X_3X_5...X_n + X_2X_3X_5 + ...X_n + ... + X_{n-1}X_n$

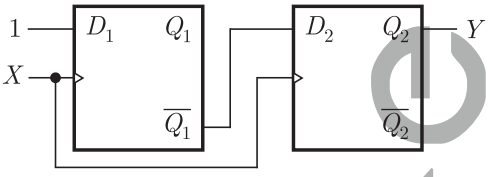
(D) $X_0X_1X_3X_5...X_{n-1} + X_2X_3X_5...X_n + ... + X_{n-1}X_{n-2} + X_n$

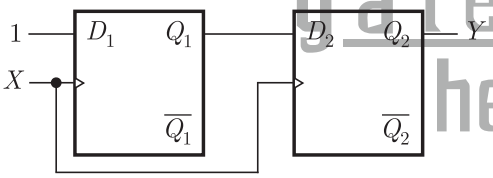
Q.30 The digital block shown below realized using two positive edge triggered D-flip-flop. Assume that for $t < t_0, Q_1 = Q_2 = 0$

The circuit in the digital block is given by

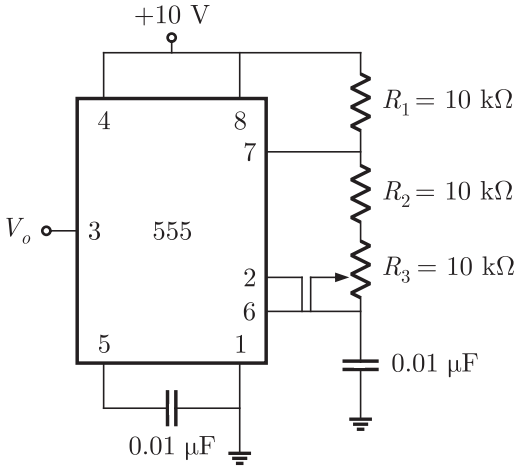
(A)


(B)


(C)


(D)


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



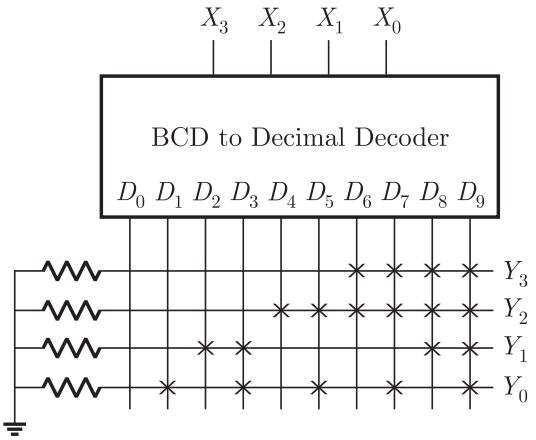
(A) 607 kHz $< f <$ 1.41 kHz

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

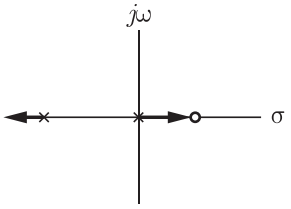
Consider the following response

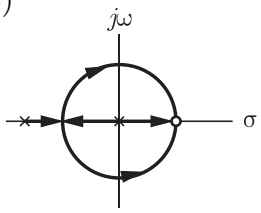
1. Over damped
2. Under damped
3. Under damped
4. Critically damped

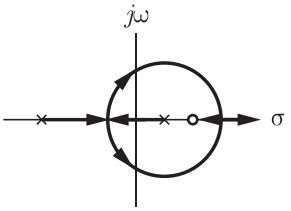
The correct match is

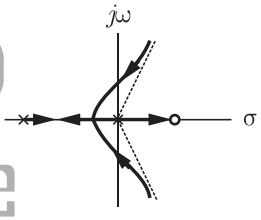
	1	2	3	4
(A)	a	c	d	e
(B)	b	a	d	e
(C)	c	a	e	d
(D)	c	b	e	d

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) $y = c_1 e^{x} + c_2 e^{-2x} - 3\cos x - \sin x$

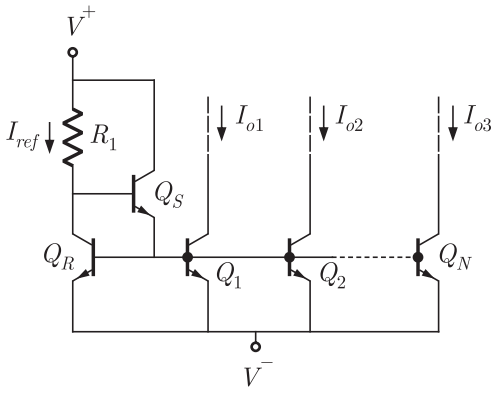
Q.38 $\displaystyle\int_0^{\frac{\pi}{2}} \frac{e^x}{2}\left(\sec^2\frac{x}{2} + 2\tan\frac{x}{2}\right)dx$ is equal to

(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



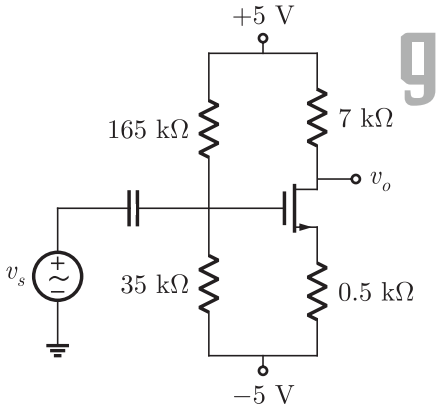
(A) $\dfrac{I_{ref}}{\left(1+\dfrac{(1+N)}{\beta(\beta+1)}\right)}$

(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

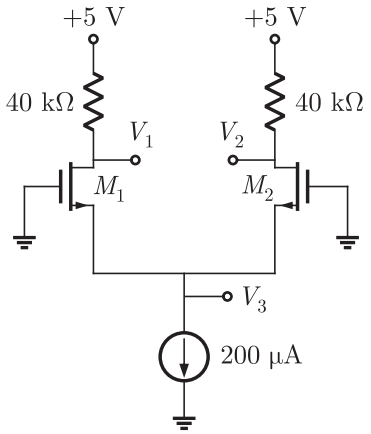
(D) -3.28

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,

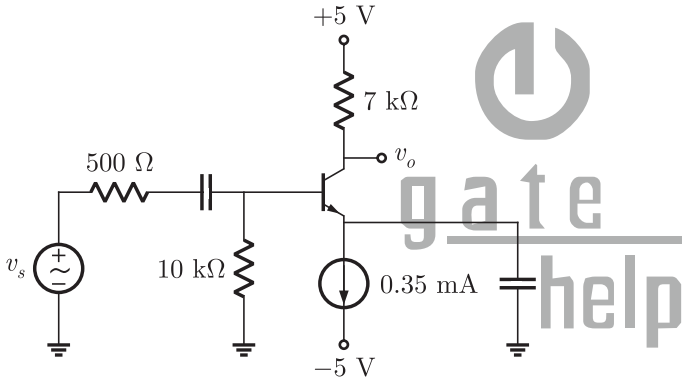
$(K_n')_1 = (K_n')_2 = 100\,\mu\text{A/V}^2$



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

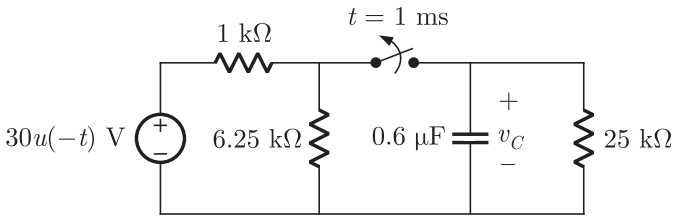
Q.44 Two random variable X and Y have the density function

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

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.

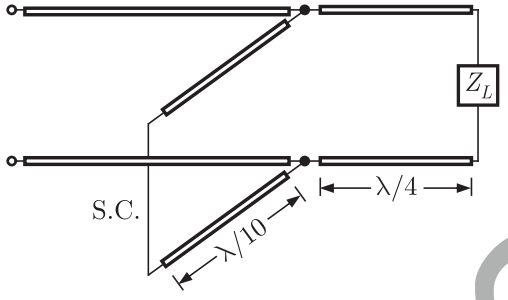


At $t = 4$ ms the $v_C(4\text{ ms})$ is

(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) $300 - j413$

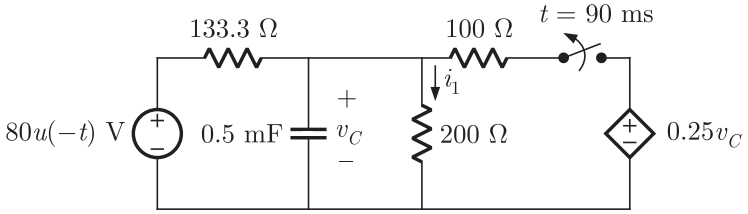
Q.47 The collector current of bipolar is $I_C = 2$ mA. If output resistance is greater than 10 kΩ. Then what is the value of early voltage V_A

(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) $\begin{bmatrix} 1 & 1 \\ -1 & -2 \end{bmatrix}$

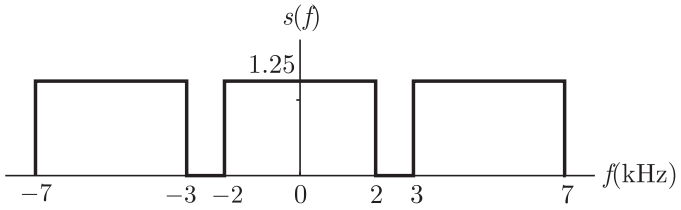
(C) $\begin{bmatrix} 2 & 1 \\ -1 & -1 \end{bmatrix}$ (D) $\begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$

Statement for Linked Answer Q. 54-55:

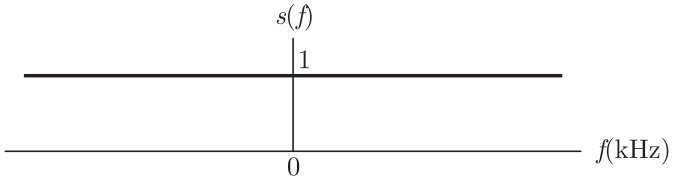
A signal $x(t) = \sin c(4000t)$ is ideally sampled with a sampling interval $T_s = 0.25$ ms

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

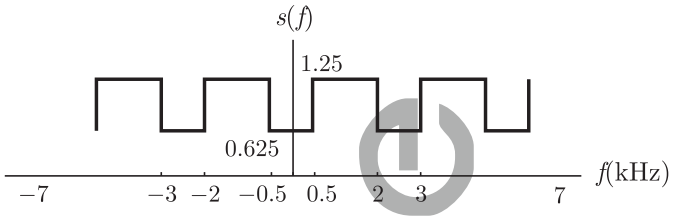
(A)



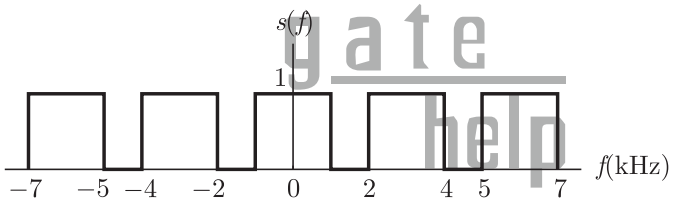
(B)



(C)

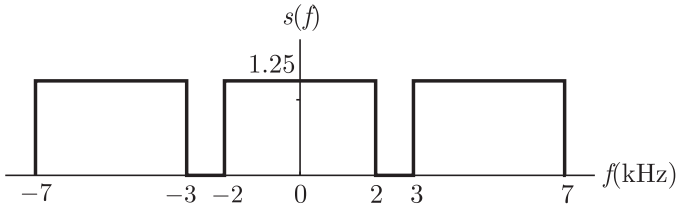


(D)

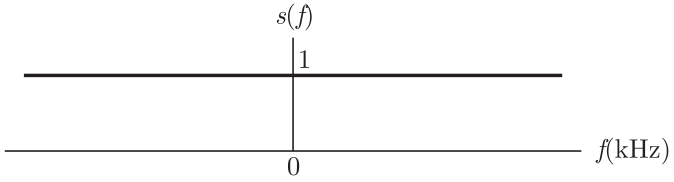


Q.55 In the above question if sampling interval $T_s = 0.4$ ms. then output spectrum will be

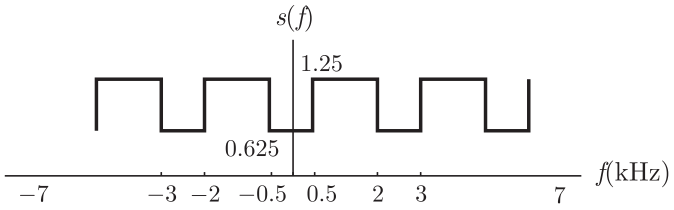
(A)



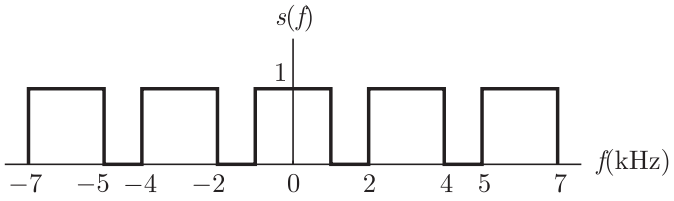
(B)



(C)



(D)



General Aptitude(GA)Questions

Q.56- Q 60 carry one mark each

Q.56 Which one of the following is the Antonym of the word PROFESSIONAL ?

(A) conservative (B) liberal

(C) amateur (D) legal

Q.57 Which one of the following is the synonym of the word DISPARAGE ?

(A) separate (B) compare

(C) refuse (D) belittle

Q.58 One of the four words given in the four options does not fit the set of words. The odd word from the group is

(A) Smog (B) Marsh

(C) Haze (D) Mist

Q.59 A pair of CAPITALIZED words shown below has four pairs of words. The pair of words which best expresses the relationship similar to that expressed in the capitalized pair is

ATMOSPHERE : STRATOSPHERE

(A) Nimbus : Cloud (B) Instrument : Calibration

(C) Aircraft : Jet (D) Climate : Rain

Q.60 In the following sentence, a part of the sentence is left unfinished. Four different ways of completing the sentence are indicated. The best alternative among the four is

....., the more they remain the same

(A) The more the merrier

(B) The less the dynamism

(C) The more things change

(D) The more pronounced the transformation.

Q. 61-65 carry two marks each

Q.61 $2^{73} - 2^{72} - 2^{71}$ is the same as

(A) 2^{69} (B) 2^{70}

(C) 2^{71} (D) 2^{72}

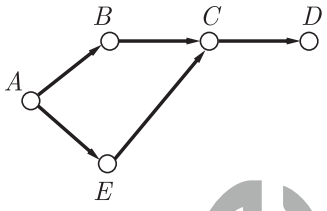
Q.62 Let $u_{n+1} = 2u_{n+1}$, $(n = 0,1,2,.....)$ and $u_0 = 0$. Then, u_{10} would be nearest to :

(A) 1023 (B) 2047

(C) 4095 (D) 8195

Common data for Q. 63 to Q. 65

Answer these questions based on the pipeline diagram given :



The following sketch shows the pipelines carrying material from one location to another. Each location has a demand for material. The demand at B is 800, at C is 800, at D is 1400, and at E is 400. Each arrow indicates the direction of material flow through the pipeline. The flow from B to C is 600. The quantity of material flow is such that the demands at all these location are exactly met. The capacity of each pipeline is 2000.

Q.63 The quantity moved from A to E is :

(A) 400 (B) 1600

(C) 1400 (D) 2000

Q.64 The free capacity available in the A-B pipeline is :

(A) 0 (B) 200

(C) 400 (D) 600

Q.65 What is the free capacity available in the E-C pipeline ?

(A) 600 (B) 400

(C) 200 (D) 0

END OF THE QUESTION PAPER

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