GATE 2015 Examination-31st Morning

EC: Electronics & Communications Engineering

***Duration*: 180 minutes** **|** ***Maximum Marks*: 100**

1. To login, enter your Registration Number and password provided to you. Kindly go through the various symbols used in the test and understand their meaning before you start the examination.
2. Once you login and after the start of the examination, you can view all the questions in the question paper, by clicking on the **View All Questions** button in the screen
3. This question paper consists of **2 sections**, General Aptitude (GA) for **15 marks** and the subject specific GATE paper for **85 marks**. Both these sections are compulsory. The GA section consists of **10** questions. Question numbers 1 to 5 are of 1-mark each, while question numbers 6 to 10 are of 2-mark each. The subject specific GATE paper section consists of **55** questions, out of which question numbers 1 to 25 are of 1-mark each, while question numbers 26 to 55 are of 2-mark each.
4. Depending upon the GATE paper, there may be useful common data that may be required for answering the questions. If the paper has such useful data, the same can be viewed by clicking on the **Useful Common Data** button that appears at the top, right hand side of the screen.
5. The computer allotted to you at the examination center runs specialized software that permits only one answer to be selected for multiple-choice questions using a mouse and to enter a suitable number for the numerical answer type questions using the virtual keyboard and mouse.
6. Your answers shall be updated and saved on a server periodically and also at the end of the examination. The examination will **stop automatically** at the end of **180 minutes**.
7. In each paper a candidate can answer a total of 65 questions carrying 100 marks.
8. The question paper may consist of questions of **multiple choice type** (MCQ) and **numerical answer type**.
9. 9. Multiple choice type questions will have four choices against A, B, C, D, out of which only **ONE** is the correct answer. The candidate has to choose the correct answer by clicking on the bubble (◯) placed before the choice.
10. 10. For numerical answer type questions, each question will have a numerical answer and there will not be any choices**. For these questions, the answer should be entered** by using the virtual keyboard that appears on the monitor and the mouse.
11. All questions that are not attempted will result in zero marks. However, wrong answers for multiple choice type questions (MCQ) will result in **NEGATIVE** marks. For all MCQ questions a wrong answer will result in deduction of 1/3 marks for a 1-mark question and 2/3 marks for a 2-mark question.
12. There is **NO NEGATIVE MARKING** for questions of **NUMERICAL ANSWER TYPE**
13. Non-programmable type Calculator is allowed. Charts, graph sheets, and mathematical tables are **NOT** allowed in the Examination Hall. You must use the Scribble pad provided to you at the examination centre for all your rough work. The Scribble Pad has to be returned at the end of the examination.

Declaration by the candidate:

“I have read and understood all the above instructions. I have also read and understood clearly the instructions given on the admit card and shall follow the same. I also understand that in case I am found to violate any of these instructions, my candidature is liable to be cancelled. I also confirm that at the start of the examination all the computer hardware allotted to me are in proper working condition”.

GATE-2015 SET-A(31st Morning) **GENERAL ABILITY**

Q. 1 - Q. 5 carry one mark each

1. Choose the word most similar in meaning to the given word Educe________
(A) Exert (B) Educate (C) Extract (D) Extend

Sol: (C) Extract

2. Choose the appropriate word/phrase, out of the four options given below, to complete the following sentence Frogs ___________________
(A) croak (B) roar (C) hiss (D) patter

Sol: (A) Croak

3. Operators $\square$, $\diamond$ and $\rightarrow$ are defined by: $a \square b = \dfrac{a-b}{a+b}$; $a \diamond b = \dfrac{a+b}{a-b}$; $a \rightarrow b = ab$.

Find the value of $(66 \square 6) \rightarrow (66 \diamond 6)$
(A) –2 (B) –1 (C) 1 (D) 2

Sol: (C) $\left(\dfrac{66-6}{66+6}\right) \cdot \left(\dfrac{66+6}{66-6}\right) = 1$

4. Choose the most appropriate word from the options given below to complete the following sentence.
The principal presented the chief guest with a _____________ as token of appreciation.
(A) momento (B) memento (C) momentum (D) moment

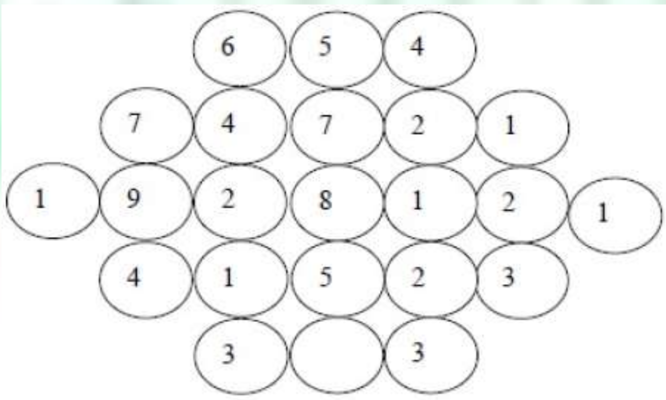
Sol: (B) Memento is an object kept as a reminder of a person or a event.

5. If $\log_x (5/7) = -1/3$, then the value of x is
(A) 343/125 (B) 125/343 (C) –25/49 (D) –49/25

Sol: (A) $\dfrac{5}{7} = x^{-1/3} \quad \Rightarrow \quad 7/5 = x^{1/3} \quad \therefore \quad x = (7/5)^3$

Q.6 - Q.10 carry two marks each

6. Fill in the missing value



Sol: Ans=3

$$\frac{6+4}{2} = 5 \qquad \frac{7+4+2+1}{2} = 7 \qquad \frac{1+9+2+1+2+1}{2} = 8 \quad \frac{4+1+2+3}{2} = 5 \quad \frac{3+3}{2} = 3$$

7. Humpty Dumpty sits on a wall every day while having lunch. The wall sometimes breaks. A person sitting on the wall falls if the wall breaks.

Which one of the statements below is logically valid and can be inferred from the above sentences ?

(A) Humpty Dumpty always falls while having lunch

(B) Humpty Dumpty does not fall sometimes while having lunch

(C) Humpty Dumpty never falls during dinner

(D) When Humpty Dumpty does not sit on the wall, the wall does not break

Sol: (B)

8. The following question presents a sentence, part of which is underlined. Beneath the sentence you find four ways of phrasing the underlined part. Following the requirements of the standard written English, select the answer that produces the most effective sentence. Tuberculosis, together with its effects ranks one of the leading causes of death in India.

(A) ranks as one of the leading causes of death

(B) rank as one of the leading causes of death

(C) has the rank of one of the leading causes of death

(D) are one of the leading causes of death

Sol: (A)

9. A cube of side 3 units is formed using a set of smaller cubes of side 1 unit. Find the proportion of the number of faces of the smaller cubes visible to those which are NOT visible.

(A) 1 : 4 (B) 1 : 3 (C) 1 : 2 (D) 2 : 3

Sol: (C)

10. Read the following paragraph and choose the correct statement.

Climate change has reduced human security and threatened human well being. An ignored reality of human progress is that human security largely depends upon environmental security. But on the contrary, human progress seems contradictory to environmental security. To keep up both at the required level is a challenge to be addressed by one and all. One of the ways to curb the climate change may be suitable scientific innovations while the other may be the Gandhian perspective on small scale progress with focus on sustainability.

(A) Human progress and security are positively associated with environmental security.

(B) Human progress is contradictory to environmental security.

(C) Human security is contradictory to environmental security.

(D) Human progress depends upon environmental security.

Sol: (B)

GATE-2015 SET-A(31st Morning) ELECTRONICS AND COMMUNICATION ENGINEERING-EC

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

1. In a $16\,\text{Kb}\,(=16{,}384\,\text{bit})$ memory array is designed as a square with an aspect ratio of one (number of rows is equal to the number of columns). The minimum number of address lines needed for the row decoder is ____

Sol: (7)

$16\text{K} = 2^{14}$

So No. of rows = 2^7

No. of columns = 2^7

Address lines required for decoder = 7

Ref: Based upon basic concept discussed at Page No. 206 in Digital Class notes

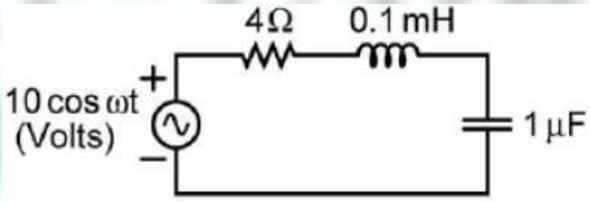
2. In an 8085 microprocessor, the shift registers which store the result of an addition and the overflow bit are, respectively

(A) B and F (B) A and F (C) H and F (D) A and C

Sol: (B)

Ref: Based upon definition of Registers in Microprocessors

3. In the circuit shown, at resonance, the amplitude of the sinusoidal voltage (in Volts) across the capacitor is ________

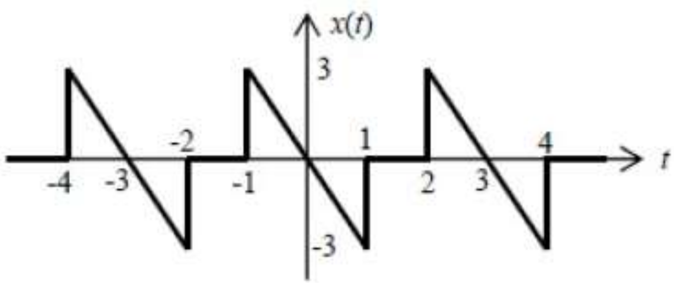


Sol: (25)

$$V_c = Q.V = 10 \times \frac{1}{4}\sqrt{\frac{10^{-4}}{10^{-6}}} = 25V$$

Ref : Exactly same concept question in Network class Notes at Page No. 139

4. The waveform of a periodic signal x(t) is shown in the figure.



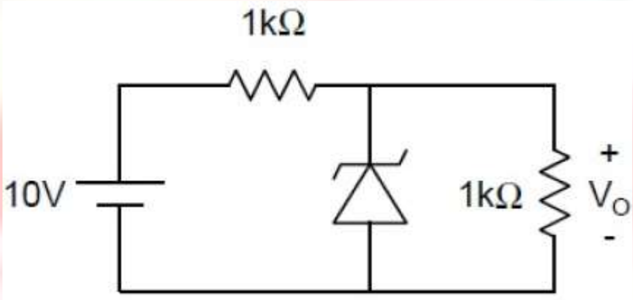
A signal g(t) is defined by $g(t) = x\left(\frac{t-1}{2}\right)$. The average power of g(t) is ________.

Sol: (2)

$$\frac{3^2/3 \times 1 + 0^2 \times 1 + \frac{(-3)^2}{3} \times 1}{3} = 2$$

Ref: Exactly same concept question in Network class Notes at Page No. 68

5. In the circuit shown below, the Zener diode is ideal and the Zener voltage is 6 V. The output voltage V_0 (in volts) is _______.

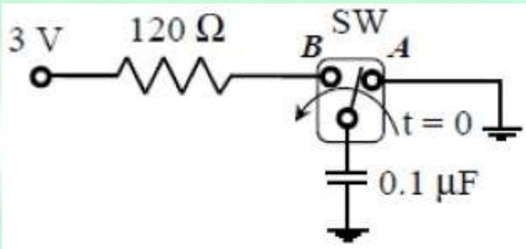


Sol: (5)

Maximum voltage which can appear across zener is $\frac{10}{2} \times 1 = 5V$ which is not sufficient to make zener ON So zener will not be ON & $v_0 = 5$ volt

Ref : Exactly same concept question in EDC class notes at Page No.127

6. In the circuit shown, the switch SW is thrown from position A to position B at time t = 0. The energy (in μJ) taken from the 3 V source to charge the 0.1 μF capacitor from 0 v to 3 V is



(A) 0.3 (B) 0.45 (C) 0.9 (D) 3

Sol: (C)

Energy taken to charge capacitor will be CV^2 out of which 1/2 CV^2 will be stored. So energy supplied by battery is $0.1 \times 9 = (0.9 \mu J)$.

Ref : Exactly same Question in Network Assignment Chapter No.2 Question No.16

7. Suppose A and B are two independent events with probabilities $P(A) \neq 0$ and $P(B) \neq 0$. Let $\bar{A}$ and $\bar{B}$ be their complements. Which one of the following statements is FALSE ?

(A) $P(A \cap B) = P(A)P(B)$ (B) $P(A \mid B) = P(A)$

(C) $P(A \cup B) = P(A) + P(B)$ (D) $P(\bar{A} \cap \bar{B}) = P(\bar{A})P(\bar{B})$

Sol: (C)

Ref: Basic property of Tunnel Diode which Refer Tunneling in EDC class notes at Page No.125

8. A region of negative differential resistance is observed in the current voltage characteristics of a silicon PN junction if

(A) both the P-region and the N-region are heavily doped

(B) the N-region is heavily doped compared to the P-region

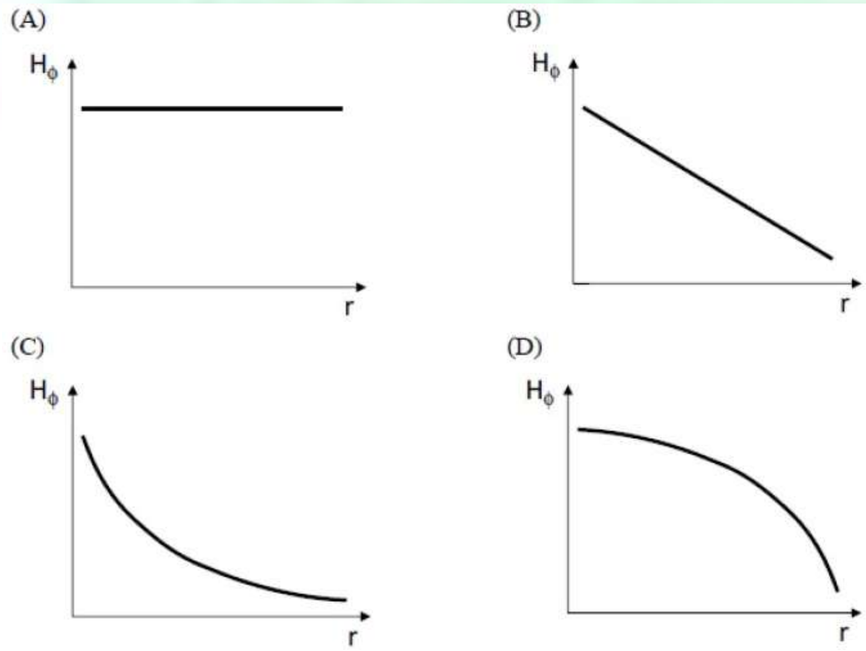
(C) the P-region is heavily doped compared to the N-region

(D) an intrinsic silicon region is inserted between the P-region and the N-region

Sol: (A)

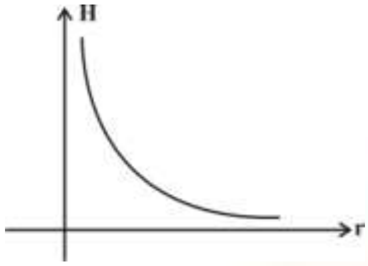
Ref: Basic property of Tunnel Diode which Refer Tunneling in EDC class notes at Page No.125

9. Consider a straight, infinitely long, current carrying conductor lying on the z-axis. Which one of the following plots (in linear scale) qualitatively represents the dependence of H_ϕ on r, where H_ϕ is the magnitude of the azimuthal component of magnetic field outside the conductor and r is the radial distance from the conductor ?



Sol: (C)

$$H = \frac{I}{2\pi r}$$



Ref: Discussed same concept in EMT class notes at page No. 48

10. A silicon sample is uniformly doped with donor type impurities with a concentration of $10^{16}/cm^3$. The electron and hole mobilities in the sample are $1200\,cm^2/V-s$ and $400\,cm^2/V-s$ respectively. Assume complete ionization of impurities. The charge of an electron is $1.6\times10^{-19}C$. The resistivity of the sample (in Ω-cm) is ________

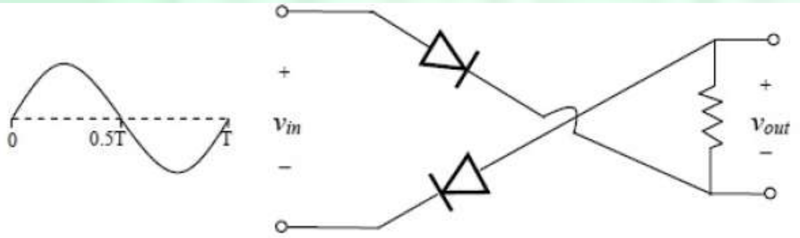
Sol: (0.5208)

$$\sigma = N_D\, e\mu_n = \frac{10^{16}}{cm^3}\times1.6\times10^{-19}c\times\frac{1200\,cm^2}{v\sec}$$

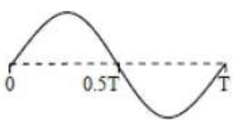
$$\rho = \frac{1}{\sigma} = 0.5208(\Omega cm)$$

Ref : Exactly same concept questions in EDC class notes at Page No.29-30

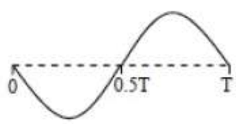
11. For the circuit with ideal diodes shown in the figure, the shape of the output (v_{out}) for the given sine wave input (v_{in}) will be



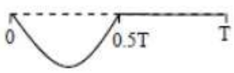
(A)



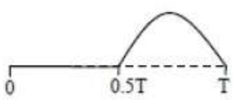
(B)



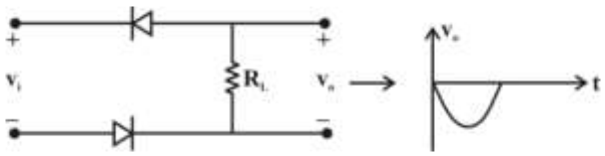
(C)



(D)

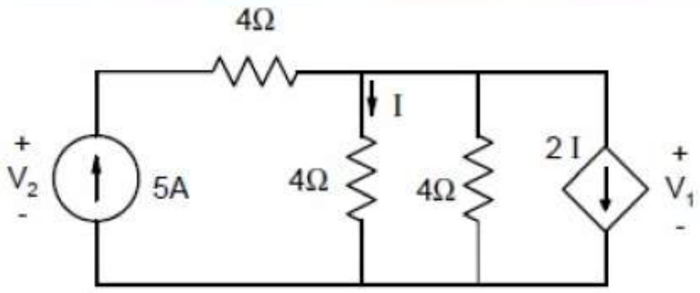


Sol: (C) Circuit will be :



Ref: Basic concepts of diode

12. In the given circuit, the values of V_1 and V_2 respectively are



(A) 5 V, 25 V (B) 10 V, 30 V (C) 15 V, 35 V (D) 0 V, 20 V

Sol: (A)

13. Let $z = x + iy$ be a complex variable. Consider that contour integration is performed along the unit circle in anticlockwise direction. Which one of the following statements is NOT TRUE ?

(A) The residue of $\frac{z}{z^2 - 1}$ at $z = 1$ is 1/2 (B) $\oint_C z^2 dz = 0$

(C) $\frac{1}{2\pi i}\oint_C \frac{1}{z} dz = 1$ (D) $\bar{z}$ (complex conjugate of z) is an analytical function

Sol: (D)

$\bar{z} = x - jy \qquad u = x \rightarrow \frac{du}{dx} = 1$

$v = -y \rightarrow \frac{dv}{dy} = -1 \qquad \because \qquad \frac{du}{dx} \neq \frac{dv}{dy}$ here it is not analytic function.

Ref : Discussed many such type of Qs in Maths class as it is basic Question.

14. A sinusoidal signal of 2 kHz frequency is applied to a delta modulator. The sampling rate and step-size Δ of the delta modulator are 20, 000 samples per second and 0.1 V, respectively.
To prevent slope overload, the maximum amplitude of the sinusoidal signal (in Volts) is

(A) $\frac{1}{2\pi}$ (B) $\frac{1}{\pi}$ (C) $\frac{2}{\pi}$ (D) π

Sol: (A)

If $\quad f_S = 20{,}000\,\text{Hz}, \qquad S = 0.1\,\text{Volt}$

$m(t) = A m \cos \omega_m t \qquad (\text{Where } \omega_m = 4000\pi)$

To avoid slope overload problem

$$A_m \omega_m > S f_s \quad \Rightarrow \quad A_m = \frac{0.1 \times 20{,}000}{4000\,\pi} = \frac{1}{2\pi}$$

Ref: Exactly same concept question in Communication class notes at Page No. 208

15. Consider the signal $s(t)=m(t)\cos(2\pi f_c t)+\hat{m}(t)\sin(2\pi f_c t)$ where $\hat{m}(t)$ denotes the Hilbert transform of m(t) and the bandwidth of m(t) is very small compared to f_c. The signal s(t) is a

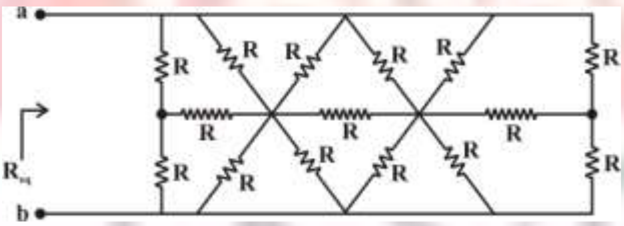
(A) high-pass signal
(B) low-pass signal
(C) band-pass signal
(D) double sideband suppressed carrier signal

Sol: (C) It is Band pass signal because it is SSB-SC (LSB) and frequency component present is from $f_c - f_m$ to f_c.

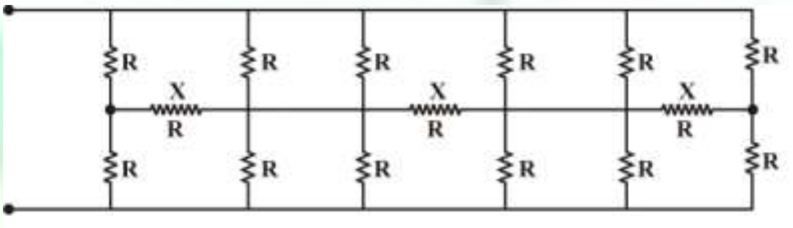
Ref: Page-95 class notes of Communication system . Discussed same concept in filter method

16. In the network shown in the figure, all resistors are identical with R = 300 Ω. The resistance R_{ab} (in Ω) of the network is ___________

Where R = 300 Ω



Sol: (100)



Ref: Exactly same concept question in Network class notes at Page No.13-15

17. Consider a system of linear equations :

$$x-2y+3z=-1,$$
$$x-3y+4z=1, \text{ and}$$
$$-2x+4y-6z=k.$$

The value of k for which the system has infinitely many solutions is ____________

Sol: (2) Make determinant equal to zero.

18. A function $f(x)=1-x^2+x^3$ is defined in the closed interval $[-1,1]$. The value of x, in the open interval (–1, 1) for which the mean value theorem is satisfied, is

(A) –1/2 (B) –1/3 (C) 1/3 (D) 1/2

Sol: (B)

19. Negative feedback in a closed-loop control system DOES NOT

(A) reduce the overall gain (B) reduce bandwidth

(C) improve disturbance rejection (D) reduce sensitivity to parameter variation

Sol: (B)

Negative Feedback reduces gain but Bandwidth is (↑)

Ref : Exactly same concept question in Analog class Notes at Page No. 151

20. The value of p such that the vector $\begin{bmatrix}1\\2\\3\end{bmatrix}$ is an eigenvector of the matrix $\begin{bmatrix}4 & 1 & 2\\ p & 2 & 1\\ 14 & -4 & 10\end{bmatrix}$ is _______

Sol: (17)

21. The electric field component of a plane wave traveling in a lossless dielectric medium is given by $\vec{E}(z,t)=\hat{a}_y 2\cos\left(10^8 t-\frac{z}{\sqrt{2}}\right)$ V/m. The wavelength (in m) for the wave is ________

Sol: (8.88)

$$\beta=\frac{1}{\sqrt{2}}=\frac{2\pi}{\lambda} \quad \therefore \quad \lambda=2\pi\sqrt{2}\text{ meter} \qquad \lambda=8.88\text{ meter}$$

Ref : Exactly same type of many questions in class notes of EMT at page No.72

22. The result of the convolution $x(-t)*\delta(-t-t_0)$ is

(A) $x(t+t_0)$ (B) $x(t-t_0)$ (C) $x(-t+t_0)$ (D) $x(-t-t_0)$

Sol: (D)

$$x(-t)\otimes\delta(-t-t_0)=x(-t)\otimes\delta(t+t_0)=x(-t-t_0)$$

Ref: Basic property of Impulse Page-30 Class Notes of Signal&System

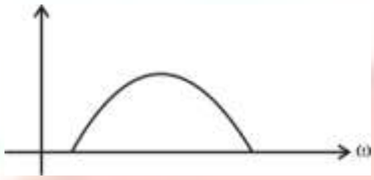
23. The polar plot of the transfer function $G(s)=\dfrac{10(s+1)}{s+10}$ for $0\le\omega<\infty$ will be in the

(A) first quadrant (B) second quadrant (C) third quadrant (D) fourth quadrant

Sol: (A)

At $\omega=0\to G(s)H(s)=1$

$\omega=\infty\to G(s)H(s)=10$



Ref : Basic Question of Polar Plot discussed same Question in class notes in polar plot

24. A unity negative feedback system has the open-loop transfer function $G(s)=\dfrac{k}{s(s+1)(s+3)}$. The value of the gain K(>0) at which the root locus crosses the imaginary axis is _______

Sol: (12)

$1+G(s)H(s)=0$

$\therefore \quad 1+\dfrac{k}{s(s+1)(s+3)}=0$

$s^3+4s^2+3s+k=0$

$$\begin{array}{ccc} s^3 & 1 & 3 \\ s^2 & 4 & k \\ s^1 & \dfrac{12-k}{4} & 0 \\ s^0 & k & 0 \end{array}$$

To cut imaginary axis $\dfrac{12-k}{4}=0 \Rightarrow k=12$

Ref: Very Easy questions /exactly same concept many questions

25. Consider a four bit D to A converter. The analog value corresponding to digital signals of values 0000 and 0001 are 0 V and 0.0625 V respectively. The analog value (in Volts) corresponding to the digital signal 1111 is ___________

Sol. (0.9375)

$V_0=(2^4-1)\times 0.0625 = 15\times 0.0625 = 0.9375$ volt

Ref: Exactly same concept question in Digital class Notes at Page No. 183

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

26. A vector $\vec{P}$ is given by $\vec{P} = x^3y\vec{a}_x - x^2y^2\vec{a}_y - x^2yz\vec{a}_z$. Which one of the following statements is TRUE ?

(A) $\vec{P}$ is solenoidal, but not irrotational (B) $\vec{P}$ is irrotational, but not solenoidal

(C) $\vec{P}$ is neither solenoidal nor irrotational (D) $\vec{P}$ is both solenoidal and irrotational

Sol: (A)

$$P = x^3y\overrightarrow{a_x} - x^2y^2\overrightarrow{a_y} - x^2yz\overrightarrow{a_z}$$

$$\nabla \cdot P = 3x^2y - 2x^2y - x^2y = 0$$

$\nabla \times P \neq 0 \quad \Rightarrow$ it is solenoidal but not rotational.

Ref: Same Concept question on Page No. 16 in EMT Notes

27. For silicon diode with long P and N regions, the accepter and donor impurity concentrations are $1\times10^{17}\,\text{cm}^{-3}$ and $1\times10^{15}\,\text{cm}^{-3}$, respectively. The lifetimes of electrons in P region and holes in N region are both 100 μs. The electron and hole diffusion coefficients are 49 cm^2/s and 36 cm^2/s, respectively. Assume kT/q = 26 mV, the intrinsic carrier concentration is $1\times10^{10}\,\text{cm}^{-3}$, and $q = 1.6\times10^{-19}\,\text{C}$. When a forward voltage of 208 mV is applied across the diode, the hole current density (in nA/cm^2) injected from P region to N region is _____________

Sol: (28.608)

Use Formula $J_p = \left(\dfrac{qD_p n_i^2}{N_D L_p}\right)\left(e^{\frac{V}{V_T}} - 1\right)$ where $\left(L_P^2 = D_p\tau_p\right)$

Ref: Concept and formula is derived at Page No. 89 in EDC class notes

28. The electric field intensity of a plane wave traveling in free space is given by the following expression $E(x,t) = a_y\, 24\pi\cos(\omega t - k_0x)\ (\text{V/m})$

In this field, consider a square area 10 cm × 10 cm on a plane x + y = 1. The total time-averaged power (in mW) passing through the square area is ______

Sol: (53.3)

$$P_{av} = \frac{E_m^2}{2\eta} = \frac{(24\pi)^2}{240\pi}\vec{a}_x\left(\text{W/m}^2\right) \qquad \overrightarrow{ds} = 100\text{cm}^2\frac{\left(\vec{a}_x + \vec{a}_y\right)}{\sqrt{2}}$$

$$P_{total} = \frac{(24\pi)^2}{240\pi} \times \frac{100\times10^{-4}\text{m}^2}{\sqrt{2}} = \frac{(24\pi)\times10^{-3}}{\sqrt{2}}(\text{Watt})$$

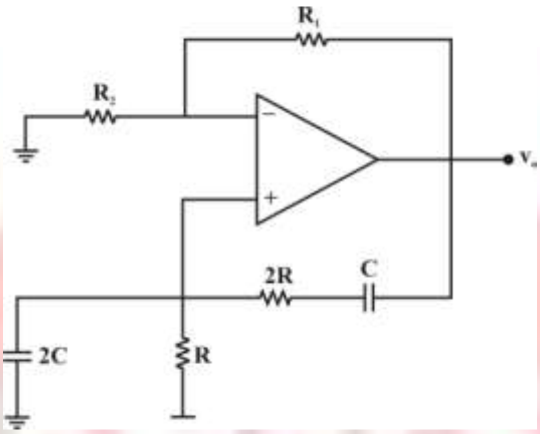
Ref: Exactly same question in GATE -2015 test series

29. A plant transfer function is given as $G(s) = \left(K_P + \dfrac{K_I}{s}\right)\dfrac{1}{s(s+2)}$. When the plant operates in a unity feedback configuration, the condition for the stability of the closed loop system is

(A) $K_P > \frac{K_I}{2} > 0$ (B) $2K_I > K_P > 0$ (C) $2K_I < K_P$ (D) $2K_I > K_P$

Sol: (A) Use RH criterion to solve this problem

30. The circuit shown in the figure has an ideal opamp. The oscillation frequency and the condition to sustain the oscillations respectively are

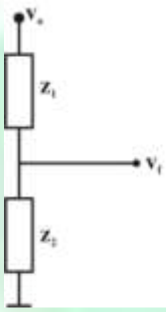


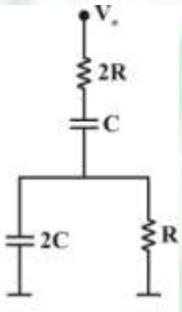
(A) $\frac{1}{CR}$ and $R_1 = R_2$ (B) $\frac{1}{CR}$ and $R_1 = 4R_2$

(C) $\frac{1}{2CR}$ and $R_1 = R_2$ (D) $\frac{1}{2CR}$ and $R_1 = 4R_2$

Sol: (D)

$$\omega_0 = \frac{1}{2RC} \& (R_1 = 4R_2)$$





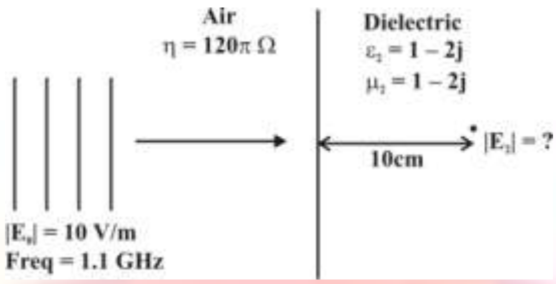
Frequency of Wein bridge is $\omega_0 = \frac{1}{RC}$ but here Time constant is doubled so frequency becomes halved $\Rightarrow$ $\omega_0 = \frac{1}{2RC}$ $z_1 = 2R + \frac{1}{j\omega C} = 2(R - jR)$

$$z_2 = \frac{R \times \frac{1}{2j\omega C}}{R + \frac{1}{2j\omega C}} = \frac{\frac{R}{\cancel{2}} \times \frac{1}{j} \times \cancel{2}R}{R + jR}$$

$\beta = \frac{z_2}{z_1 + z_2} = \frac{1}{5}$ Now $A = 5$ $1 + \frac{R_1}{R_2} = 5$ $(R_1 = 4R_2)$

Ref: Exactly same question in Analog class notes at Page No. 187

31. Consider a uniform plane wave with amplitude (E_0) of 10 V/m and 1.1 GHz frequency traveling in air and incident normally on a dielectric medium with complex relative permittivity (ε_r) and permeability (μ_r) as shown in the figure.



The magnitude of the transmitted electric field component (in V/m) after it has traveled a distance of 10 cm inside the dielectric region is _________

Sol: (0.1)

$$P = \sqrt{jw\mu(\sigma + jw\varepsilon)} \qquad \sigma = 0$$

$$P = \sqrt{jw\mu(0 + jw\varepsilon)} = jw(1-2j)\sqrt{\mu_0\varepsilon_o}$$

$$\alpha = 2w\sqrt{\mu_0\varepsilon_0}\ \&\ \beta = w\sqrt{\mu_0\varepsilon_0}$$

$$\alpha = 2w\sqrt{\mu_0\varepsilon_0} = 2\times 2\pi\times 1.1\times 10^9 \times \frac{1}{3}\times 10^{-8} = 46.02\,\text{Np/m}$$

$$\eta_1 = \eta_2 \quad \text{so} \quad \frac{E_{t_0}}{E_{i_0}} = \frac{2\eta_2}{\eta_1+\eta_2} = 1$$

$$|E_t| = E_{t_0}e^{-\alpha Z} = 10e^{-46.02\times 0.1} = 0.1\,\text{V/m}$$

32. The Boolean expression $F(X,Y,Z) = \bar{X}Y\bar{Z} + X\bar{Y}\bar{Z} + XY\bar{Z} + XYZ$ converted into the canonical product of sum (POS) form is

(A) $(X+Y+Z)(X+Y+\bar{Z})(X+\bar{Y}+\bar{Z})(\bar{X}+Y+\bar{Z})$

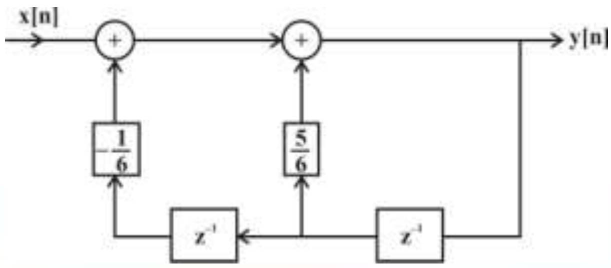
(B) $(X+\bar{Y}+Z)(\bar{X}+Y+\bar{Z})(\bar{X}+\bar{Y}+Z)(\bar{X}+\bar{Y}+\bar{Z})$

(C) $(X+Y+Z)(\bar{X}+Y+\bar{Z})(X+\bar{Y}+Z)(\bar{X}+\bar{Y}+\bar{Z})$

(D) $(X+\bar{Y}+\bar{Z})(\bar{X}+Y+Z)(\bar{X}+\bar{Y}+Z)(X+Y+Z)$

Sol: (A)

33. For the discrete-time system shown in the figure, the poles of the system transfer function are located at



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

Sol: (C)

$$X(z) - \frac{1}{6}z^{-2}Y(z) + \frac{5}{6}z^{-1}Y(z) = Y(z)$$

$$\frac{Y(z)}{X(z)} = \frac{1}{1 - \frac{5}{6}z^{-1} + \frac{1}{6}z^{-2}} = \frac{z^2}{z^2 - \frac{5}{6}z + \frac{1}{6}} = \frac{z^2}{\left(z - \frac{1}{2}\right)\left(z - \frac{1}{3}\right)}$$

Poles are located at $\left(\frac{1}{2}, \frac{1}{3}\right)$

Ref: Exactly same concept question in Signal class notes at Page No. 271

34. The longitudinal component of the magnetic field inside an air-filled rectangular waveguide made of a perfect electric conductor is given by the following expression

$$H_z(x, y, z, t) = 0.1\cos(25\pi x)\cos(30.3\pi y)\cos\left(12\pi \times 10^9 t - \beta z\right) \ (\text{A/m})$$

The cross-sectional dimensions of the waveguide are given as a = 0.08 m and b = 0.033 m. The mode of propagation inside the waveguide is

(A) TM_{12} (B) TM_{21} (C) TE_{21} (D) TE_{12}

Sol: (C) Since wave is propagating in z direction & H_z is also present so it can be TE_{mn} mode only and no chance of TM_{mn}.

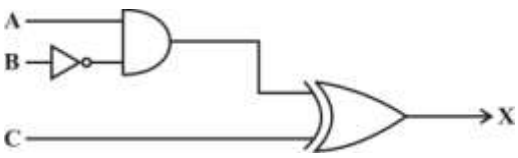
$$\frac{m\pi x}{a} = 25\pi x \quad \Rightarrow \quad m = 25 \times 0.08 = 2$$

$$\frac{n\pi \cancel{y}}{b} = 30.3\pi \cancel{y} \quad \Rightarrow n = 0.033 \times 30.3 = 1$$

So Possible mode is TE_{21} only.

Ref: : Exactly same concept question in EMT class Notes at Page No. 136

35. All the logic gates shown in the figure have a propagation delay of 20 ns. Let A = C = 0 and B = 1 until time t = 0. At t = 0, all the inputs flip (i.e., A = C = 1 and B = 0) and remain in that state. For $t > 0$, output Z = 1 for a duration (in ns) of



Sol: (40)

For t < 0

A	B	C	O / P
0	(1)	0	X = 0
↓	↓	↓	
1	0	(1)	

Ref: Exactly same concept question asked in IES Exam.

36. A MOSFET in saturation has a drain current of 1 mA for $V_{DS} = 0.5\,V$. If the channel length modulation coefficient is $0.05\,V^{-1}$ the output resistance (in kΩ) of the MOSFET is ______

Sol: (20.5)

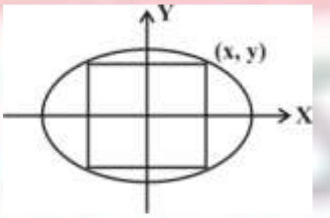
$$I_D = k(V_{GS} - V_T)^2 (1 + \lambda V_{DS})$$

$$\frac{\partial I_D}{\partial V_{DS}} = k(V_{GS} - V_T)^2 \cdot \lambda \qquad \therefore \qquad r_{ds} = \frac{1}{k\lambda (V_{GS} - V_T)^2} = 20.5\,k\Omega$$

Ref: Exactly same concept question in EDC class notes at Page No. 305 (Here λ is due to channel length modulation)

37. The maximum area (in square units) of a rectangle whose vertices lie on the ellipse $x^2 + 4y^2 = 1$ is__

Sol: (1)



area of Rectangle $A = 4xy$

$$\therefore \qquad A = 4 \times x \times \frac{1}{2}\sqrt{1 - x^2} \quad \Rightarrow \left(x = \frac{1}{\sqrt{2}} \right)$$

For Maxima or Minima $\frac{dA}{dx} = 0 \qquad \therefore \qquad (A = 1)$

38. The open-loop transfer function of a plant in a unity feedback configuration is given as $G(s) = \frac{K(s+4)}{(s+8)(s^2-9)}$. The value of the gain K(> 0) for which $-1 + j2$ lies on the root locus is ________

Sol: (25.54)

If $\quad G(s) = \frac{K(s+2)}{(s+8)(s^2-9)}, \; H(s) = 1$

Make $|G(s)H(s)| = 1 \Rightarrow \qquad K = 25.54 \qquad$ Or can be solved by use of characteristic equation also.

Ref: Easy basic Question

28A/11 Ground Floor Jia Sarai (Near IIT)- Hauz Khas Metro Station New Delhi-110016
Helpline No.: 09811382221, 011-32662945
Website: www.panaceainstitute.org.in, E-mail: panacea.institute@gmail.com

39. A source emits bit 0 with probability $\frac{1}{3}$ and bit 1 with probability $\frac{2}{3}$. The emitted bits are communicated to the receiver. The receiver decides for either 0 or 1 based on the received value R. It is given that the conditional density functions of R are as

$$f_{R|0}(r)=\begin{cases}\frac{1}{4}, & -3\le x\le 1,\\ 0, & \text{otherwise,}\end{cases} \quad \text{and} \quad f_{R|1}(r)=\begin{cases}\frac{1}{6}, & -1\le x\le 5,\\ 0, & \text{otherwise}\end{cases}.$$

The minimum decision error probability is

(A) 0 (B) 1/12 (C) 1/9 (D)1/6

Sol: (D)

40. Two sequences $[a,b,c]$ and $[A, B, C]$ are related as,

$$\begin{bmatrix}A\\B\\C\end{bmatrix}=\begin{bmatrix}1 & 1 & 1\\ 1 & W_3^{-1} & W_3^{-2}\\ 1 & W_3^{-2} & W_3^{-4}\end{bmatrix}\begin{bmatrix}a\\b\\c\end{bmatrix} \quad \text{where } W_3=e^{j\frac{2\pi}{3}}$$

If another sequence [p, q, r] is derived as,

$$\begin{bmatrix}p\\q\\r\end{bmatrix}=\begin{bmatrix}1 & 1 & 1\\ 1 & W_3^{1} & W_3^{-2}\\ 1 & W_3^{2} & W_3^{4}\end{bmatrix}\begin{bmatrix}1 & 0 & 0\\ 0 & W_3^{2} & 0\\ 0 & 0 & W_3^{4}\end{bmatrix}\begin{bmatrix}A/3\\B/3\\C/3\end{bmatrix},$$

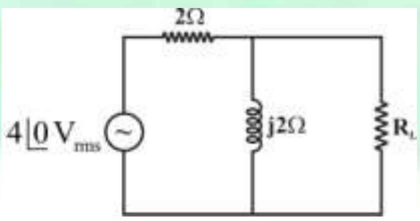
Then the relationship between the sequences [p, q, r] and [a, b, c] is

(A) [p, q, r] = [b, a, c] (B) [p, q, r] = [b, c, a]

(C) $[p,q,r]=[c,a,b]$ (D) $[p,q,r]=[c,b,a]$

Sol: (C)
$$\begin{bmatrix}p\\q\\r\end{bmatrix}=\begin{bmatrix}1 & W_3^{2} & W_3^{4}\\ 1 & W_3^{3} & W_3^{6}\\ 1 & W_3^{4} & W_3^{8}\end{bmatrix}\begin{bmatrix}A/3\\B/3\\C/3\end{bmatrix}=\begin{bmatrix}1 & W_3^{-1} & W_3^{1}\\ 1 & 1 & 1\\ 1 & W_3^{1} & W_3^{2}\end{bmatrix}\begin{bmatrix}A/3\\B/3\\C/3\end{bmatrix}=-\begin{bmatrix}1 & 1 & 1\\ 1 & W_3^{-1} & W_3^{-2}\\ 1 & W_3^{-2} & W_3^{-4}\end{bmatrix}\begin{bmatrix}A/3\\B/3\\C/3\end{bmatrix}$$

41. In the given circuit, the maximum power (in Watts) that can be transferred to the load R_L is ________



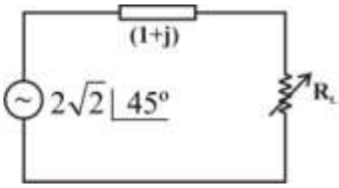
Sol (1.66)

1st calculate V_{Th} & Z_{Th} :

$$V_{OC}=\frac{4\lfloor 0^\circ \times j2}{2+j2}=\frac{8\lfloor 90^\circ}{2\sqrt{2}\lfloor 45^\circ}$$

$$V_{Th}=2\sqrt{2}\lfloor 45^\circ \qquad Z_{Th}=2\,||\,j2=\frac{2\times j2}{2+j2}=\frac{j2}{1+j}$$

$$Z_{Th} = \frac{j2(1-j)}{2} = j - j^2 = (1+j)$$



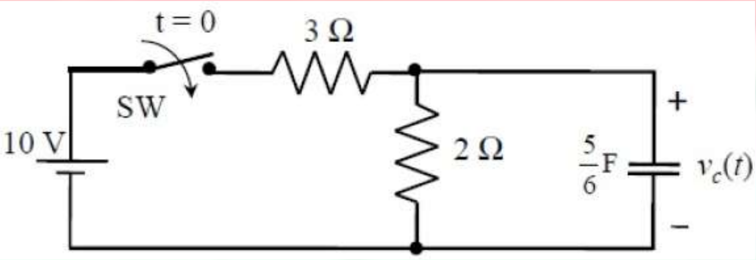
$$R_L = \sqrt{1+1} = \sqrt{2}$$

$$I = \left(\frac{2\sqrt{2}}{\sqrt{\left(1+\sqrt{2}\right)^2 + 1}} \right)$$

$$P = I^2 \times R_L = \frac{\left(2\sqrt{2}\right)^2}{\left(4+2\sqrt{2}\right)} \times \sqrt{2} = \frac{8\sqrt{2}}{\left(4+2\sqrt{2}\right)} = 1.66$$

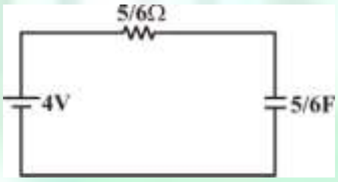
Ref: Same Q with little change in values was asked in GATE 2015 Test series.

42. In the circuit shown, switch SW is closed at t = 0. Assuming zero initial conditions, the value of $v_c(t)$ (in Volts) at t = 1 sec is __________



Sol: (2.528)

By Thevenin-theorem



Here cap. Is charging

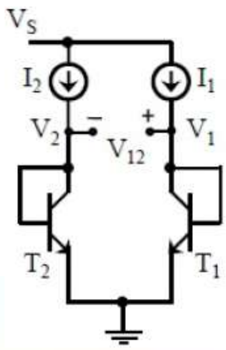
So $V_c(t) = 4\left(1 - e^{-t/\tau}\right)$

Here $\tau = RC = 1\text{sec}$

$V_c(1) = 4\left(1 - e^{-1}\right)$

Ref: Exactly same concept question in Network class notes at Page No. 210

43. In the circuit shown, $I_1 = 80\,\text{mA}$ and $I_2 = 4\,\text{mA}$. Transistors T_1 and T_2 are identical. Assume that the thermal voltage V_T is 26 mV at 27ºC. At 50ºC, the value of the voltage $V_{12} = V_1 - V_2$ (in mV) is __________



Sol: (83.4)

Since base and collector are connected so it will work like a diode.

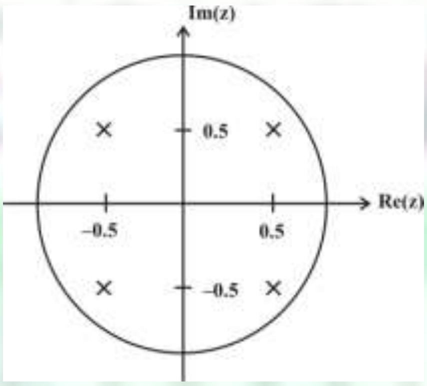
Value of V_T at 50ºC $\quad V_T = \dfrac{323}{11600} = 27.84\text{mV}$

$$4 = I_0\, e^{\frac{V_2}{V_T}} \;\&\; 80 = I_0\, e^{\frac{V_1}{V_T}}$$

$$\therefore e^{\left(\frac{V_1 - V_2}{V_T}\right)} = 20 \;\&\; \frac{V_1 - V_2}{V_T} = \ln(20) \Rightarrow V_1 - V_2 = 83.4$$

Ref: Based upon basic concept of diode

44. The pole-zero diagram of a causal and stable discrete-time system is shown in the figure. The zero at the origin has multiplicity 4. The impulse response of the system is h[n]. If h[0] = 1, we can conclude



(A) h[n] is real for all n
(B) h[n] is purely imaginary for all n
(C) h[n] is real for only even n
(D) h[n] is purely imaginary for only odd n

Sol: (C)

$$H(z) = \frac{z^4}{\left((z+0.5)^2 + 0.25\right)\left((z-0.5)^2 + 0.25\right)} = \frac{z^4}{z^4 + 0.25}$$

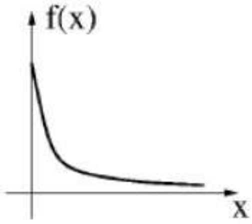
$$= \frac{z^4}{z^4 + 0.25} = \frac{z^4}{z^4(1 + 0.25z^{-4})} = (1 + 0.25z^{-4})^{-1}$$

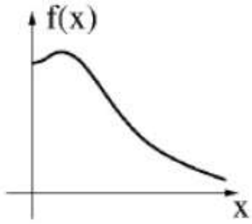
$$= (1 - 0.25z^{-4} + 0.0625z^{-8} - 0.015625z^{-12} + ...)$$

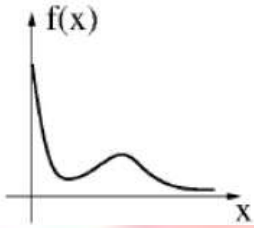
$$h[n] = \delta(n) - 0.25\delta(n-4) + 0.0625\delta(n-8) - 0.015625\delta(n-12) +$$

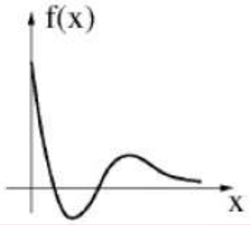
Ref: Similar type of Q was asked in IES paper and is available in assignment and was discussed in class.

45. Which one of the following graphs describes the function $f(x) = e^{-x}(x^2 + x + 1)$?

(A)


(B)


(C)


(D)


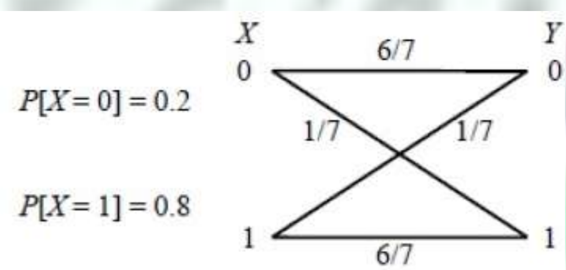
Sol: (B)

Just check by values

$f(0) = 1$

$f(1) = 3/e = 1.1$

46. The input X to the Binary Symmetric Channel (BSC) shown in the figure is '1' with probability 0.8. The cross-over probability is 1/7. If the received bit Y = 0, the conditional probability that '1' was transmitted is ________



Sol: (0.4)

$$P(Y = 0/X = 1) = \frac{0.8 \times 1/7}{0.2 \times 6/7 + 0.8 \times 1/7} = \frac{0.8}{2} = 0.4$$

Ref: Same Concept question on Page No.250 In communication class notes

47. A 3-input majority gate is defined by the logic function $M(a,b,c) = ab + bc + ca$. Which one of the following gates is represented by the function $M\left(\overline{M(a,b,c)}, M(a,b,\bar{c}), c\right)$

(A) 3-inlput NAND gate
(B) 3-input XOR gate
(C) 3-input NOR gate
(D) 3-input NXOR gate

Sol: (B)

Let $\overline{W} = \overline{M(a,b,c)}$ where $W = M(a,b,c)$

$X = M(a,b,\bar{c})$

$Z = c$

a \ bc	00	01	11	10
0		1	1	
1		1	1	

$$W = ab + bc + ca = \sum(3,5,6,7)$$

$$\overline{W} = \sum(0,1,2,4) \qquad c = \sum(1,3,5,7) \qquad X = \sum(2,4,6,7)$$

So $\left(\sum(0,1,2,4), \sum(2,4,6,7), \sum(1,3,5,7)\right) = \sum(2,4) + \sum(7) + \sum(1) = \sum(1,2,4,7) = a \oplus b \oplus c$

a \ bc	00	01	11	10
0		1		1
1	1		1	

48. The transmitted signal in a GSM system is of 200 kHz bandwidth and 8 users share a common bandwidth using TDMA. If at a given time 12 users are talking in a cell, the total bandwidth of the signal received by the base station of the call will be at least (in kHz) _________.

Sol: (400)

For 8 users we need 200KHz and for 16 users we need 400KHz. Here 12 users are using so 400KHz is required. Since 12 Calls are talking so 200KHz extra bandwidth is required. So total bandwidth is 400KHz

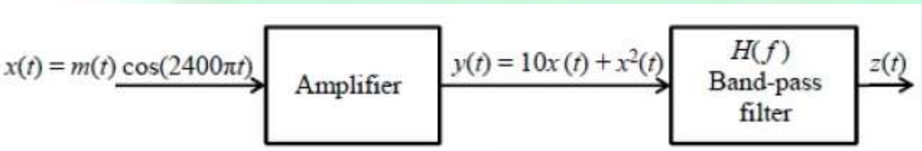
49. A lead compensator network includes a parallel combination of R and C in the feed-forward path. If the transfer function of the compensator is $G_c(s) = \frac{s+2}{s+4}$, the value of RC is _______.

Sol: (0.5)

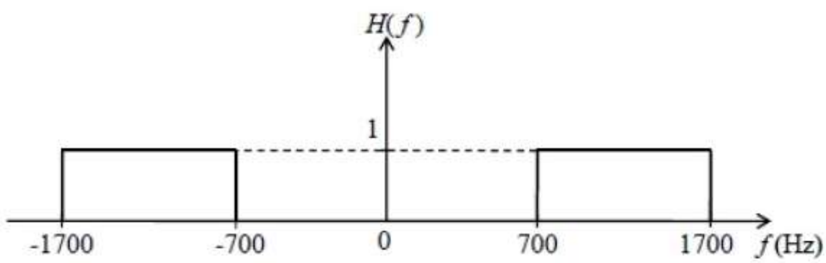
$$\frac{1}{RC} = 2 \;\&\; \frac{1}{\alpha RC} = 4 \quad \Rightarrow \quad RC = 0.5\,\text{sec}$$

Ref: Same Q asked in IES paper and discussed in class.

50. In the system shown in Figure (a), m(t) is a low-pass signal with bandwidth W Hz. The frequency response of the band-pass filter H(f) is shown in Figure (b). If it is desired that the output signal $z(t) = 10x(t)$, the maximum value of W (in Hz) should be strictly less than ______.



(a)

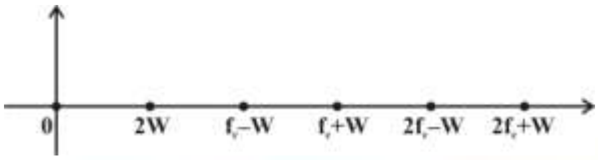


(b)

Sol: (350)

Since m(t) has maximum frequency (W)

O/P y(t) will have following +ve frequency



O/P requires only $y(t) = 10x(t)$

So $2W < 700 \Rightarrow \boxed{W < 350}$

51. The built-in potential of an abrupt p-n junction is 0.75 V. If its junction capacitance (C_J) at a reverse bias (V_R) of 1.25 V is 5 pF, the value of C_J (in pF) when $V_R = 7.25\,V$ is _________

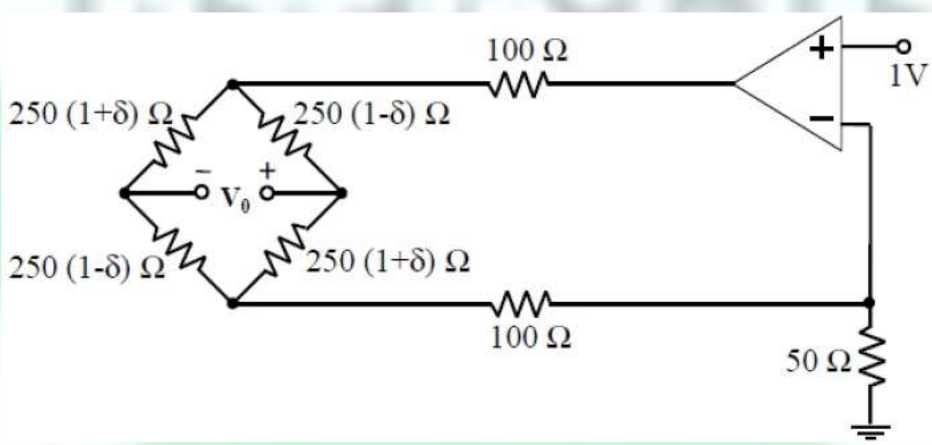
Sol: (2.5)

$$\frac{C_1}{C_2} = \sqrt{\frac{V_{R_2} + V_0}{V_{R_1} + V_0}}$$

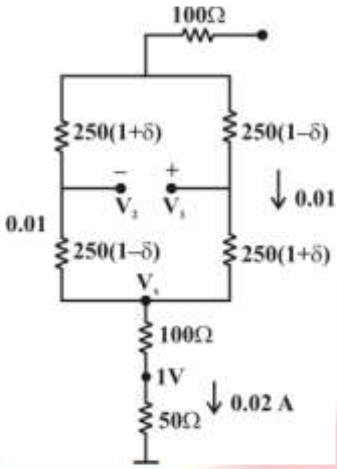
$$\frac{5}{C_2} = \sqrt{\frac{7.25 + 0.75}{1.25 + 0.75}} = \frac{2}{1} \quad \therefore \quad C_2 = 2.5\,\text{pF}$$

Ref: Exactly same concept question in EDC class notes at Page No.100

52. In the circuit shown, assume that the opamp is ideal. The bridge output voltage V_0 (in mV) for $\delta = 0.05$ is _________.



Sol: (250)



$$V_x - 1 = 100 \times 0.02$$

$$V_x = 3V$$

$$V_1 - V_x = 250(1+\delta) \times 0.01 \ \& \ V_2 - V_x = 250(1-\delta) \times 0.01$$

$$\Rightarrow \quad V_1 - V_2 = 2.5(1+\delta-1+\delta) = 5\delta = 5 \times 0.05 = 0.25V.$$

Ref: Same Type of Question was given in GATE-2015 test series .

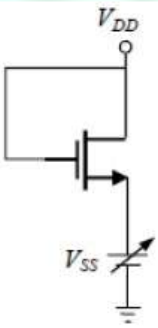
53. The solution of the differential equation $\frac{d^2y}{dt^2} + 2\frac{dy}{dt} + y = 0$ with $y(0) = y'(0) = 1$ is

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

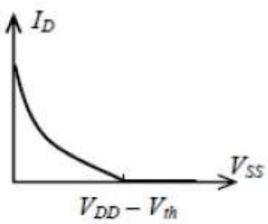
Sol: (B)

Ref: Basic Laplace Q discussed many type of Questions.

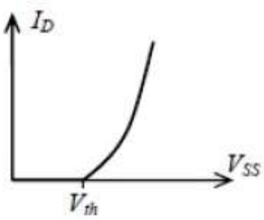
54. For the NMOSFET in the circuit shown, the threshold voltage is V_{th}, where $V_{th} > 0$. The source voltage V_{SS} is varied from 0 to V_{DD}. Neglecting the channel length modulation, the drain current I_D as a function of V_{SS} is represented by



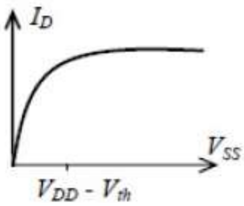
(A)



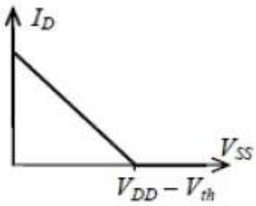
(B)



(C)



(D)

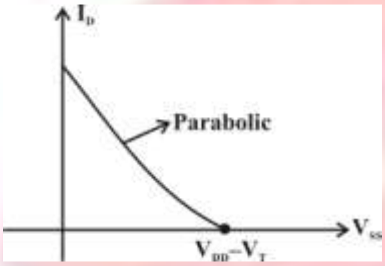


Sol: (A)

Now $V_{DS} > V_{GS} - V_T$ hence MOS will be in saturation.

$$I_D = k(V_{GS} - V_T)^2 = k(V_{DS} - V_T)^2 = k(V_{DD} - V_{SS} - V_T)^2$$

$$I_D = k(V_{DD} - V_T - V_{SS})^2$$



55. The damping ratio of series RLC circuit can be expressed as

(A) $\frac{R^2C}{2L}$ (B) $\frac{2L}{R^2C}$ (C) $\frac{R}{2}\sqrt{\frac{C}{L}}$ (D) $\frac{2}{R}\sqrt{\frac{L}{C}}$

Sol: (C)

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

Ref : Exactly same question in Network class Notes at Page No.142

END OF THE QUESTION PAPER