1. What is the adverb for the given word below?
Misogynous
A. Misogynouness B. Misogynity
C. Misogynously D. Misogynous
Answer ||| C
Solution ||| Misogynous is the hatred or dislike of women or girls.
Adverb: Misogynously.

2. Choose the appropriate word-phrase out of the four options given below, to complete the following sentence Dhoni, as well as the other team members of India team present on the occasion
A. Were B. Was
C. Has D. Have
Answer ||| B
Solution ||| The most appropriate word out of given is was.

3. Ram and Ramesh appeared in an interview for two vacancies in the same department. The probability of Ram's selection is 1/6 and that of Ramesh is 1/8. What is the probability that only one of them will be selected?
A. 47/48 B. 1/4
C. 13/48 D. 35/48
Answer ||| B
Solution ||| P(Ram) = 1/6, P(Ramesh = 1/8)
P(only one) = P(Ram) × P(not Ramesh) + P(not Ram) × P(Ramesh)
= 1/6 × 7/8 + 5/6 × 1/8 = 12/40 = 1/4

4. Choose the word most similar in meaning to the given word:
Awkward
A. Inept B. Graceful
C. Suitable D. Dredfull
Answer ||| A
Solution ||| Inept is the word whose meaning is similar to Awkward.

5. An electric bus has onboard instruments that report the total electricity consumed since the start of the trip as well as the total distance covered. During a single day of operation, the bust travels on stretches M, N, O and P, in that order. The cumulative distances traveled and the corresponding electricity consumption are shown in the Table below

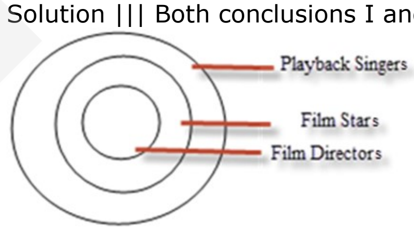
Stretch	Cumulative distance (km)	Electricity used (kWh)
M	20	12
N	45	25
O	75	45
P	100	57

The stretch where the electricity consumption per km is minimum is
A. M B. N
C. O D. P
Answer ||| D
Solution |||

Stretch	Cumulative distance (km)	Electricity used (kWh)	Individual Distance (km)	Individual Electricity (kWH)
M	20	12	20	12
N	45	25	25	13
O	75	45	30	20
P	100	57	25	12

For
M, 12/20 = 0.6
N, 13/25 = 0.52
O, 20/30 = 0.667
P, 12/25 = 0.48.

6. Given below are two statements followed by two conclusions. Assuming these statements to be true, decide which one logically follows.
Statements:
I. All film stars are playback singers
II. All film directors are film stars
Conclusions:
I. All film directors are playback singers.
II. Some film stars film directors.
A. Only conclusion I follow
B. Only conclusion II follows
C. Neither conclusion I nor II follows
D. Both conclusions I and II follows
Answer ||| D
Solution ||| Both conclusions I and II follows



I. All film directors are playback singers ----- correct.
II. Some film stars film directors ----- correct.

7. Lamenting the gradual sidelining of the arts ill school curricula, a group of prominent artist wrote to the Chief Minister last year, asking him to allocate more funds to support arts education in schools. However, no such increases have been announced in this year's Budget. The artists expressed their deep anguish at their request not being approved, but many of them remain optimistic about funding in the future.
Which of the statement (s) below is/are logically valid and can be inferred from the above statements?
(i) The artists expected funding for the arts to increases this year
(ii) The Chief Minister was receptive to the idea of increasing funding of the arts
(iii) The Chief Minister is a prominent artist
(iv) Schools are giving less importance to arts education nowadays
A. (iii) and (iv) B. (i) and (iv)
C. (i), (ii) and (iv) D. (i) and (iii)
Answer ||| B
Solution ||| The artists asked Chief Minister to allocate more funds to support arts education in schools but

schools are giving less importance to arts education nowadays

8. A tiger is 50 leaps of its own behind a deer. The tiger takes 5 leaps per minute to the deer's 4. If the tiger and the deer cover 8 meters and 5 meters per leap respectively. What distance in metres will be tiger have to run before it catches the deer?
A. 568 m B. 800 m
C. 400 m D. 200 m
Answer ||| B
Solution ||| Correct answer is 800
One tiger leap = 8 m
So, Tiger Speed = 5 leap/min
= 40 m/min
One deer leap = 5 m
So, Dear Speed = 4 leap/min
= 20 m/min
After time *t* tiger catches the deer. Equating the distances, we obtain
Initial gap = 50 leap of time
= 50 × 8m = 400 m
or 400 m + 20t = 40 × t

$$t = \frac{400}{200} = 20\,\text{min}$$

Hence, total distance = 400 + 20 × 20
= 800 m

9. If $a^2 + b^2 + c^2 = 1$, then ab + ac lies in the interval
A. [1, 2/3] B. [1, -1/2]
C. [−1, 1/2] D. [2, −4]
Answer ||| B
Solution ||| Correct option is B.
We know

$$(a+b+c)^2 = a^2+b^2+c^2+2(ab+bc+ca)$$

Given $a^2+b^2+c^2=1$

So, $(a+b+c)^2 = 1+2(ab+bc+ca)$

Since, square is always positive quantity, so

$$1+2(ab+bc+ca)\geq 0$$

$$ab+bc+ca \geq -\frac{1}{2}$$

10. In the following sentence certain parts are underlined and marked P, Q and R. One of the parts may contain certain error or may not be acceptable in standard written communication. Select the part containing an error. Choose D as your answer if there is no error.
The student corrected <u>all the errors</u> that <u>the instructor marked</u> on the <u>answer book</u>
P Q R
A. P B. Q
C. R D. No error
Answer ||| B
Solution ||| Correct option is B.
In the part Q, the is not required.

11. Le the signal f(t) = 0 outside the interval T_1, T_2 where T_1 and T_2 are finite. Furthermore, $|f\ \ t| < \infty$. The region of convergence (ROC) of the signal's bilateral Laplace transform F(s) is
1. A parallel strip containing the jΩ axis
2. A parallel strip not containing the jΩ axis
3. The entire s-plane
4. A half plane containing the jΩ axis
A. 1 B. 2
C. 3 D. 4
Answer ||| C
Solution ||| Correct option is C.
Given, *f* (*t*) = 0 outside interval T_1, T_2.
and $|f(t)| < \infty$
So, it is a finite duration signal and for the finite duration signal ROC is always entire s-plane.

12. A unity negative feedback system has an open-loop transfer function $G(s) = \frac{K}{s(s+10)}$. The gain K for the system to have a damping ratio of 0.25 is _______.
A. 300 B. 250 C. 400 D. 200
Answer ||| C
Solution ||| $G(s) = \frac{K}{s^2+10s}$

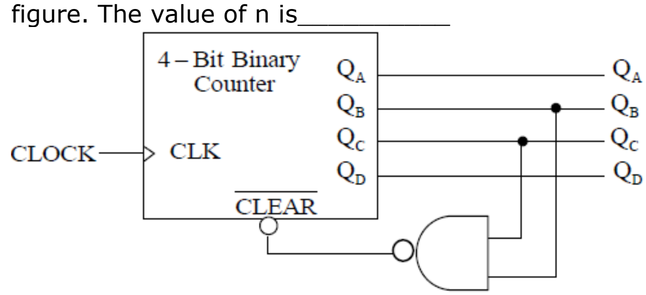
Closed Loop Transfer Function= $\frac{k}{s^2+10s+k}$
ξ = 0.25
k = ω_n^2
$\omega_n = \sqrt{k}$

ξ = $\frac{10}{2\sqrt{k}}$ = 0.25

√k = $\frac{10}{0.5}$ = 20

k= $(20)^2$ = 400.

13. A mod-n counter using a synchronous binary up–counter with synchronous clear input is shown in the figure. The value of n is___________



A. 2 B. 3 C. 5 D. 7
Answer ||| D
Solution ||| Correct answer is 7.
For finding the modular of counter, if the input of NAND gate are 1, 1 then the counter will be clear

Q_A	Q_B	Q_C	Q_D
0	0	0	0
0	0	0	1
0	0	1	0
0	0	1	1
0	1	0	0
0	1	0	1
0	1	1	0
0	1	1	1
1	0	0	0
1	0	0	1
1	0	1	0
1	0	1	1
1	1	0	0
1	1	0	1
1	1	1	0
1	1	1	1

This is the first time when $Q_B - Q_C = 1$ when NAND gate inputs are 1,1 means counter will be clear
Hence it is Modulo-7 counter

14. By performing cascading and/or summing/differencing operations using transfer function blocks $G_1(s)$ and $G_2(s)$, one **CANNOT** realize a transfer function of the form.

A. $G_1(s)\ G_2(s)$

B. $\dfrac{G_1(s)}{G_2(s)}$

C. $G_1(s)\left(\dfrac{1}{G_1(s)}+G_2(s)\right)$

D. $G_1(s)\left(\dfrac{1}{G_1(s)}-G_2(s)\right)$

Answer ||| B

Solution ||| Correct option is B.

Division of two transfer function can't be performed by performing cascading and/or summing/differencing operation.

15. The electric field of a uniform plane electromagnetic wave is

$$\vec{E}\left(\vec{a}_x + j4\vec{a}_y\right)\exp\left[j\left(2\pi\times10^7 t - 0.2z\right)\right]$$

The polarization of the wave is

A. Right handed circular

B. Right handed elliptical

C. Left handed circular

D. Left handed elliptical

Answer ||| D

Solution ||| Correct option is D.

$$\vec{E} = (\vec{a}_x + j4\vec{a}_y)\exp[j(2\pi\times10^7 t - 0.2z)]$$

For finding polarization, put Z = 0 so that polarization can be seen in my plane.

Let finding polarization, put Z = 0 so that polarization can be seen in my plane.

Let

$$E_x = \cos\omega t$$

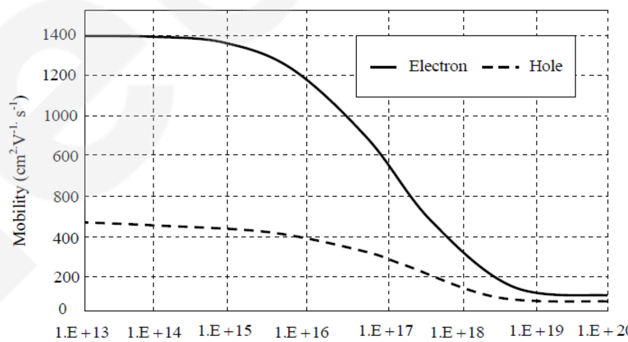
$$\omega = 2\pi\times10^7 t$$

$$E_y = 4\cos\left(\omega+\frac{\pi}{2}\right) = -4\sin\omega t$$

As *y* direction component is multiplied by j, so it is $\dfrac{\pi}{2}$ shifted. Hence, it is left hand elliptical polarization.

16. A piece of silicon is doped uniformly with phosphorous with a doping concentration 10^{16} /cm^3. The expected value of mobility versus doping concentration for silicon assuming full dopant ionization is shown below. The charge of an electron is 1.6×10^{-19} C. The conductivity (in S cm^{-1}) of the silicon sample at 300 K is_____

Hole and Electron Mobility in Silicon at 300 K



Doping concentration (cm^{-3})

A. 1.82 B. 1.92 C. 192 D. 150.2

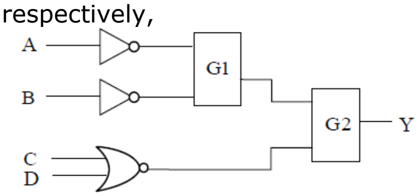
Answer ||| B

Solution ||| From graph, mobility of electrons at the concentration 10^{16}/cm^3 = 1200 cm^2/V-s.

So, μ_n = 1200 cm^2/V-s

$\sigma_n = N_D q \mu_n = 1\ 0^{16} \times 1.6\times10^{-19}\times 1200 = 1.92$ S cm^{-1} .

17. In the figure shown, the output Y is required to be Y = AB + $\bar{C}\bar{D}$. The gates G1 and G2 must be, respectively,



A. NOR, OR B. OR, NAND

C. NAND, OR D. AND, NAND

Answer ||| A

Solution ||| Correct option is A.

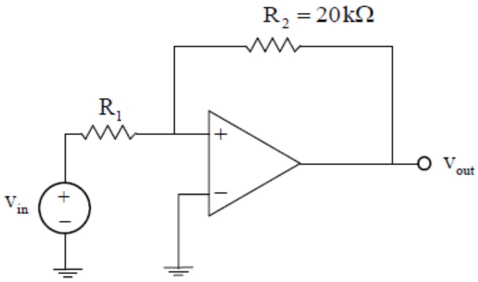
We need $Y = AB + \bar{C}\,\bar{D}$

As Y' is sum of two literals, so G_2 should be OR gate.

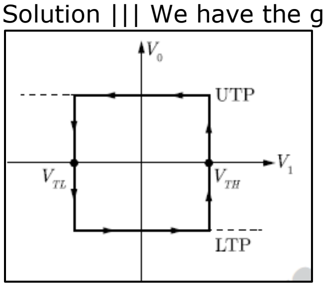
Again, to get AB literal G^2 should be NOR-gate, i.e.

$$= \overline{\overline{A} + \overline{B}}$$
$$= AB$$

18. In the bistable circuit shown, the ideal opamp has saturation level of ±5V. The value of R_1 (in kΩ) that gives a hysteresis width of 500 mV is ________.



A. 1K B. 5K
C. 3K D. 2.5K
Answer ||| A
Solution ||| We have the graph for threshold values as



Hysteresis = $V_{TH} - V_{TL} = -L_{-}\left(\frac{R1}{R2}\right) + L_{+}\left(\frac{R1}{R2}\right)$

500mV = $-(-5)\left(\frac{R1}{20k}\right) + (5)\left(\frac{R1}{20k}\right) = \left(\frac{R1}{2k}\right)$

Therefore, $R_1 = 500 \times 2 \times 10^3 \times 10^{-3} = 1000\ \Omega = 1k\ \Omega$.

19. Two casual discrete – time signal x[n] and y[n] are related as $y[n] = \sum_{m=0}^{n} x[m]$ is the z-transform of y[n] is $\frac{2}{z(z-1)^2}$, the value of x [2] is___
A. 0 B. 1 C. 2 D. 2.2
Answer ||| A
Solution ||| Correct answer is option A.

Given $y[n] = \sum$

This is accumulation property given as
$$y[n] = u[n]x[n]$$
By z-transformation,
$$Y(z) = \frac{Y(z)}{(1-z^{-1})}$$

Since, $Y(z) = \frac{2}{z(1-z)^2}$

So, $\frac{2}{z(z-1)^2} = \frac{X(z)z}{(z-1)}$

or $X|(z) = \frac{2z^{-2}}{(z-1)}$

$$= \frac{2z^{-3}}{(1-z^{-1})}$$

Again, taking inverse z-transform
$$x[n] = 2u[n-3]$$
Hence, $x[2] = 0$

20. The bilateral Laplace transform a function
$$f(t) = x\begin{cases} 1 \text{ if } a \le t \le b \\ 0 \text{ other wise} \end{cases}$$

A. $\frac{a-b}{s}$ B. $\frac{e^2(a-b)}{s}$

C. $\frac{e^{-as} - e^{-bs}}{s}$ D. $\frac{e^{s(a-b)}}{s}$

Answer ||| C
Solution ||| Correct option is C.

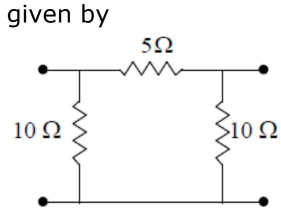
Given $f(t) = \begin{cases} 1, & 0 \le t \le b \\ 0, & otherwise \end{cases}$

So, $F(s) = \int_0^{\infty} 1e^{-st} dt$

$$= \left[\frac{e^{-st}}{-s}\right]_a^b$$

$$= \frac{e^{-as} - e^{-bs}}{s}$$

21. The 2-port admittance matrix of the circuit shown is given by



A. $\begin{bmatrix} 0.3 & -0.2 \\ -0.2 & 0.3 \end{bmatrix}$ B. $\begin{bmatrix} 15 & 5 \\ 5 & 15 \end{bmatrix}$

C. $\begin{bmatrix} 3.33 & 5 \\ 5 & 3.33 \end{bmatrix}$ D. $\begin{bmatrix} 0.3 & 0.4 \\ 0.4 & 0.3 \end{bmatrix}$

Answer ||| A
Solution ||| The admittance matrix is defined as

$$\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} y_{11} & y_{12} \\ y_{21} & y_{22} \end{bmatrix} \begin{bmatrix} V_1 \\ V_{2l} \end{bmatrix}$$

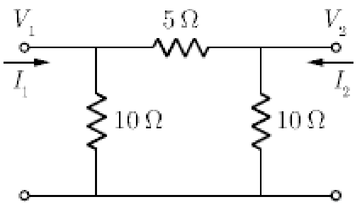
$$I_1 = y_{11}V_1 + y_{12}V_2$$

$$I_2 = y_{21}V_2 + y_{22}V_2$$

Now, from the given circuit we have

$$I_1 = \frac{V_1}{10} + \frac{V_1 - V_2}{5}$$

$$I_1 = 0.3V_1 - 0.2V_2$$



Also

$$I_2 = \frac{V_2}{10} + \frac{V_2 - V_1}{5}$$

$$I_2 = \frac{V_2}{10} + \frac{V_2}{5} - \frac{V_1}{5}$$

$$I_2 = -0.2V_1 + 0.3V_2$$

Hence, the admittance matrix is

$$Y = \begin{bmatrix} 0.3 & -0.2 \\ -0.2 & 0.3 \end{bmatrix}$$

Thus, we can observe that any of the options is not correct.

22. The value of x for which all the eigen – value of the matrix given below are real is $\begin{bmatrix} 10 & 5+j & 4 \\ x & 20 & 2 \\ 4 & 2 & -10 \end{bmatrix}$

A. 5 + j B. 5 – j
C. 1 – 5j D. 1 + 5j

Answer ||| B
Solution ||| Correct option is B.

Given $A = \begin{bmatrix} 10 & 5+j & 4 \\ x & 20 & 2 \\ 4 & 2 & -10 \end{bmatrix}$

and eigen values are real.

For real eigen value, A is Hermitian matrix, i.e.

$$A = (\bar{A})^T \qquad ...(1)$$

$$Here,\ \bar{A} = \begin{bmatrix} 10 & 5-4 & 4 \\ x & 20 & 2 \\ 4 & 2 & -10 \end{bmatrix}$$

$$and,\ (\bar{A})^T = \begin{bmatrix} 10 & x & 4 \\ 5-j & 20 & 2 \\ 4 & 2 & -10 \end{bmatrix}$$

Using equation (1), we get x = 5 – j

23. The signal cos $\left(10\pi t + \frac{\pi}{4}\right)$ is ideally sampled at a sampling frequency of 15 Hz. The sampled signal is passed through a filter with impulse response $\left(\frac{\sin(\pi t)}{\pi t}\right)\cos\left(40\pi t - \frac{\pi}{2}\right)$. The filter output is

A. $\frac{15}{2}\cos\left(40\pi t - \frac{\pi}{4}\right)$

B. $\frac{15}{2}\left(\frac{\sin(\pi t)}{\pi t}\right)\cos\left(10\pi t + \frac{\pi}{4}\right)$

C. $\frac{15}{2}\cos\left(10\pi t - \frac{\pi}{4}\right)$

D. $\frac{15}{2}\left(\frac{\sin(\pi t)}{\pi \tau}\right)\cos\left(40\pi t - \frac{\pi}{2}\right)$

Answer ||| A
Solution ||| Correct option is A.
Given continuous time signal,

$$x(t) = \cos\left(10\pi t + \frac{\pi}{4}\right)$$

Here, we neglect the phase-shift □/4, as it can be inserted in the final result. So, we have the Fourier transform pair.

$$x_1(t) = \cos 10\pi t \xrightarrow{L} X_1(f)$$

$$= \frac{1}{2}[\delta(f-5) + \delta(f+5)]$$

Given filter impulse response,

$$h(t) = \left(\frac{\sin \pi t}{\pi t}\right)\cos\left(40\pi t - \frac{\pi}{2}\right)$$

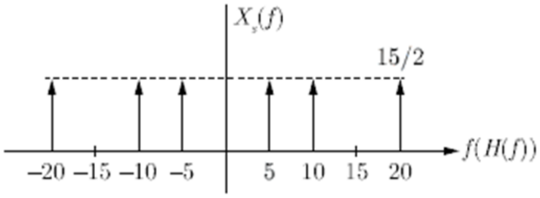
$$= (\sin ct)\sin(40\pi t)$$

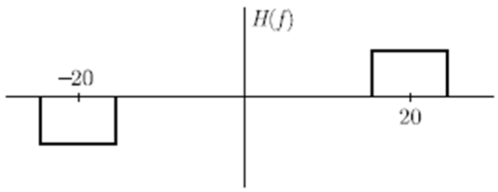
Taking its Fourier transform,

$$H(f) = rect\ f * \frac{1}{2j}[\delta(f-20) - \delta(f+20)]$$

$$= \frac{1}{2j}[rect(f-20) - rect(f+20)]$$

Now, $X_1(f)$ repeats with a value f_0 = 15 Hz and each impulse value is 15/2. Thus, the sampled signal spectrum and the spectrum of the filter is





Hence, we get

$$X_s(f)H(f) = \frac{15}{4j}[\delta(f-20) - \delta(f+20)]$$

$$x_r(t) = \frac{15}{2}\sin(40\pi t)$$

$$= \frac{15}{2}\cos\left(40\pi t - \frac{\pi}{2}\right)$$

This is recovered signal. Hence, applying phase shift □/4, we get

$$x_r(t) = \frac{15}{2}\cos\left(40\pi t - \frac{\pi}{2} + \frac{\pi}{4}\right)$$

$$= \frac{15}{2}\cos\left(\cos\pi t - \frac{\pi}{4}\right)$$

24. A sinusoidal signal of amplitude A is quantized by a uniform quantizer Assume that the signal utilizes all the representation levels of the quantizer. If the signal to quantization noise ratio is 31.8 dB the number of levels in the quantizer is __________-

A. 32 Levels B. 65 Levels C. 80 Levels D. 33 Levels

Answer ||| A

Solution ||| Correct answer is 32.

SNR_q = (1.76 + 6n) dB

where n = number of bits

Given SNR = 31.8 dB

So, 1.76 + 6n = 31.8 dB

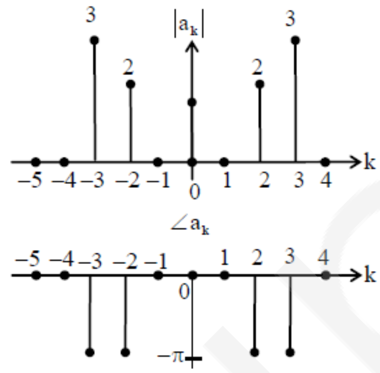
or 6n + 30

or n = 5

Hence, Levels = $2^n = 2^5 = 32$

= 32 levels

25. The magnitude and phase of the complex Fourier series coefficients a_k of a periodic signal x(t) are shown in the figure. Choose the correct statement from the four choices given. Notation: C is the set of complex numbers, R is the set of purely real numbers, and P is the set purely imaginary numbers.



A. X(t) ∊ R

B. x (t) ∊ P

C. x (t) ∊ (C – R)

D. The information given is not sufficient to draw any conclusion about x(t)

Answer ||| A

Solution ||| $\angle \quad = -\pi$ only changes the sign of the magnitude $|a_k|$. Since the magnitude spectrum $|a_k|$ is even

the corresponding time-domain signal is real.

26. The general solution of the differential equation $\frac{dy}{dx} = \frac{1+\cos 2y}{1-\cos 2x}$ is

A. tan y – cot x = c (c is a constant)

B. tan x – cot y = c (c is a constant)

C. tan y + cot x = c (c is a constant)

D. tan x + cot y = c (c is a constant)

Answer ||| C

Solution ||| Correct option is C.

Given $\frac{dy}{dx} = \frac{1+\cos 2y}{1-\cos 2x}$

$$\frac{dy}{1+\cos 2y} = \frac{dx}{1-\cos 2x}$$

$$\frac{dy}{2\cos^2 y} = \frac{dx}{2\sin^2 x}$$

$$\int \sec^2 y dy = \int \mathrm{cosec}^2 y dy$$

$$\tan y + k = -\cot x$$

$$\tan y + \cot x = c$$

27. An n-type silicon sample is uniformly illuminated with light which generates 10^{20} electron hole pairs per cm^3 second. The minority carrier lifetime in the sample is 1 μs. In the steady state, the hole concentration in the sample is approximately 10^x, where x is an integer. The value of x is____

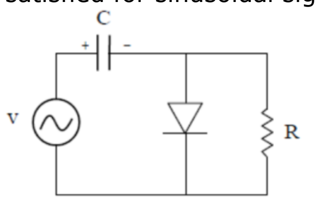
A. 4 B. 14 C. 2 D. 12

Answer ||| B

Solution ||| Correct answer is 14.

Rate of generation is
= 10^{20} electron hole pairs per cm^3 per second.
At steady state (at the end of lifetime) t = 1□ sec,
concentration of hole-electron pair in 1 □ sec is
= $10^{20} \times 10^{-6} = 10^{14}$
So, x = 14

28. If the circuit shown has to function as a clamping circuit, which one of the following conditions should be satisfied for sinusoidal signal of period T?



A. RC << T B. RC = 0.35T
C. RC ≈ T D. RC >> T
Answer ||| D
Solution ||| Correct option is D.
Time constant = t = RC
If RC >> T = period of sinusoid
Then the capacitor will not play its role and clamping will take place.

29. In a source free region in vacuum, if the electrostatic potential φ = $2x^2 + y^2 + cz^2$, the value of constant c must be________________
A. -2 B. -3 C. -4 D. -5
Answer ||| B
Solution ||| Correct answer is −3.
Given electrostatic potential

$$\phi = 2x^2 + y^2 + cz^2$$

So, the electric field is obtained as

$$\vec{E} = -\nabla\phi$$

$$= -(4x\vec{a}_x + 2y\vec{a}_y + 2Cz\vec{a}_z) \text{ ...(1)}$$

In source free region,

$$\nabla \cdot \vec{E} = 0$$

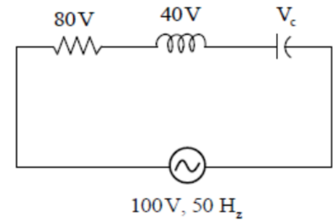
Substituting equation (1), we get

$$\nabla \cdot \left(-4x\vec{a}_x - 2y\vec{a}_y - 2Cz\vec{a}_z\right) = 0$$

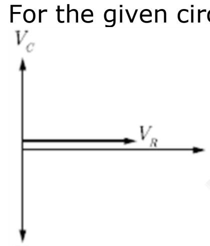
or – 4 –2 – 2C = 0
or C = – 3

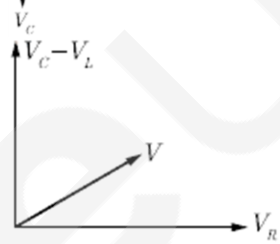
30. In an 8085 microprocessor, which one of the following instructions changes the content of the accumulator?
A. MOV B, M B. PCHL
C. RNZ D. SBI BEH
Answer ||| D
Solution ||| Generally arithmetic or logical instructions update the data of accumulator and flags. So, in the given option only SBT BE H is arithmetic instruction.
SBI BEH: Add the content of accumulator with immediate data BE H and store the result in accumulator.

31. The voltage (V_c) across the capacitor (in Volts) in the network shown is _______



A. 150V B. 100V
C. 50V D. 200V
Answer ||| B
Solution ||| Correct answer is 100.
For the given circuit, we have





$$V = \sqrt{V_R^2 + (V_C - V_L)^2}$$

$$(100)^2 = (80)^2 + (V_C - 40)^2$$

$$(100)^2 - (80)^2 = (V_C - 40)^2$$

$$(180)(20) = (V_C - 40)^2$$

$$V_C - 40 = \pm\sqrt{(180 \times 20)}$$

$$= \pm 10\sqrt{136}$$

$$V_C - 40 = \pm 60$$

$$V_C = 40 \pm 60$$

$$V_C = 100V$$

32. Let f(z) = $\dfrac{az+b}{cz+d}$. If $f(z_1) = f(z_2)$ for all $z_1 \neq z_2$, a = 2, b = 4 and c = 5, then d should be equal to ________
A. 150 B. 10 C. 50 D. 25
Answer ||| B
Solution ||| Correct answer is 10.

Given $f(z_1) = f(z_2)$

$$f(z) = \frac{az+b}{cz+d}$$

$$\frac{2z_1+4}{5z_1+d} = \frac{2z_2+4}{5z_2+d}$$

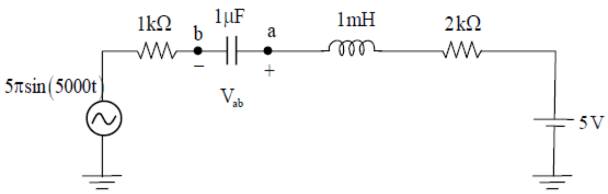
$$10z_1z_2 + 4d$$

$$= 10z_1z_2 + 4d + 20z_1 + 22_2d + 20z_2 + 2z_1d$$

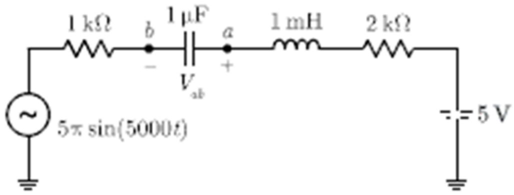
$$20(z_2 - z_1) = 2d(z_2 - z_1)$$

$$d = 10$$

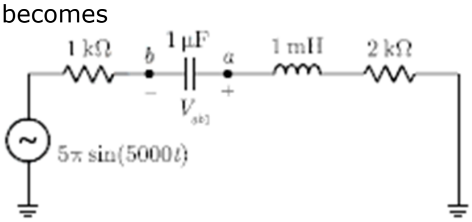
33. In the circuit shown the average value of the voltage V_{ab} (in Volts) in steady state condition is _______



A. 10V B. 25V C. 5V D. 30V
Answer ||| C
Solution ||| Correct answer is 5.
We have the circuit



Now, we have to determine the average value of voltage V_{ab}. Here, the circuit consists two voltage sources (one A.C. and other D.C.). So, we may use superposition theorem to obtain the desired average value of the voltage.
Firstly we consider ac voltage 5□ sin(500t), the circuit becomes



In steady state, the voltage across capacitor is given by

$$V_{ab1} = \frac{5\pi\angle 0^\circ}{1k + \frac{1}{j\omega(10^{-4})} + j\omega(10^{-3}) + 2k} \times \frac{1}{j\omega(10^{-6})}$$

Here, we have □ = 5000 rad/sec. Solving the above equation, we will get the voltage across capacitor in the form

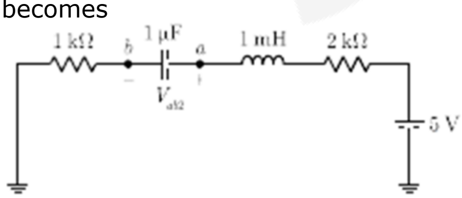
$$V_{ab1} = V_0\angle\phi$$

$$or \quad V_{ab}(t) = V_0 \sin(\omega t + \phi)$$

Since, the time average of sinusoidal signal is zero. So, we get the average value of the voltage across capacitor (due to ac voltage only) as

$$V_{ab1} = \frac{1}{T}\int_T V_{abb}(t) = \frac{1}{T}\int_T V_0 \sin(\omega t + \phi)$$

Again, we consider the dc voltage 5V. In this case, circuit becomes



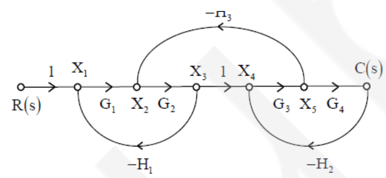
In steady state, capacitor will be fully charged and behave as open circuit. Also, the inductor will be short circuited in steady state. Hence, the dc voltage across capacitor in steady state is
$V_{ab/2}$ = 5 V

So, the average value of the voltage across capacitor (due to dc voltage only) is
$V_{ab/2}$ = $V_{ab/2}$ = 5V
Hence, applying the super position theorem, we get the net average value of voltage V_{ab} as

$$V_{av} = V_{ab/1} + V_{ab/2}$$

= 5 + 0 = 5V
Note: Average value of dc voltage is same as its instantaneous value.

34. For the signal flow graph shown in figure, the value of $\frac{C\ s}{R\ s}$ is



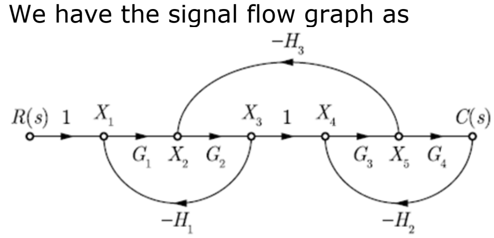
A. $\frac{G_1G_2G_3G_4}{1 - C_1G_2H_1 - G_3G_4H_2 - G_2G_3H_3 + G_1G_2G_3G_4H_1H_2}$

B. $\frac{G_1G_2G_3G_4}{1 + G_1G_2H_1 + G_3G_4H_2 + G_2G_3H_3 + G_1G_2G_3H_1H_2}$

C. $\frac{1}{1 + G_1G_2H_1 + G_3G_4H_2 + G_2G_3H_3 + G_1G_2G_3H_1H_2}$

D. $\frac{1}{1 - G_1G_2H_1 - G_3G_4H_2 - G_2G_3H_3 + G_1G_2G_3G_4H_1H_2}$

Answer ||| B
Solution ||| Correct option is B.
We have the signal flow graph as



By Mason's gain formula,

$$T(s) = \frac{\sum p_x \Delta_x}{\Delta}$$

Single loops,

$$Q_1 = -G_1G_2H_1$$

$$Q_2 = -G_2G_4H_2$$

$$Q_3 = -G_2G_3H_3$$

Non touchy loops,

$$P_{11} = G_1G_2G_3G_4H_1H_2$$

$$\Delta = 1 + G_1G_2H_1 + G_3G_4H_1 + G_2G_3H_3 + G_1G_2G_3G_4H_1H_2$$

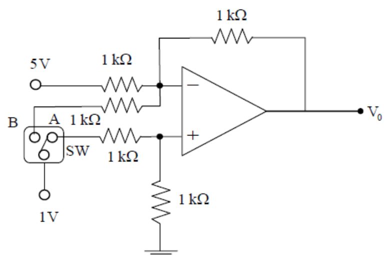
Forward path = $P_{11} = G_1G_2G_3G_4$

$$\Delta_1 = 1$$

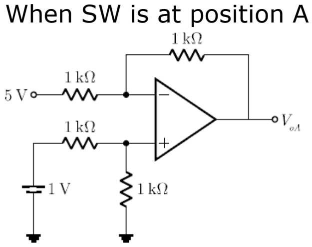
Hence,

$$T(s)=\frac{G_1G_2G_3G_4}{1+G_1G_2H_1+G_3G_4H_1+G_2G_3H_3+G_1G_2G_3G_4H_1H_2}$$

35. In the circuit shown, $V_0 = V_{0A}$ for switch SW in position A and $V_0 = V_{0B}$ for SW in position B. Assume that the opamp is ideal. The value of $\frac{V_{0B}}{V_{0A}}$ is ____________



A. 1.5 B. 4 C. 10 D. 15
Answer ||| A
Solution ||| Correct answer is 1.5
When SW is at position A



$$V_+=\left(\frac{1k}{1k+1k}\right)1V=0.5\ V$$

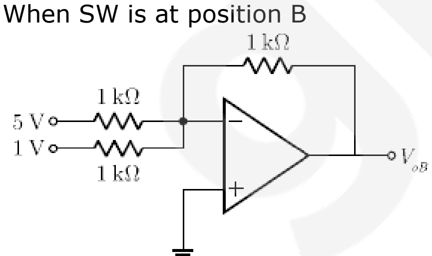
$$V_+=V_-=0.5\ V$$

$$\frac{5-0.5}{1k}=\frac{0.5-V_{0A}}{1k}$$

$$4.5=0.5-V_{0A}$$

$$V_{0A}=-4V$$

When SW is at position B



$$V_{oB}=-5\left(\frac{1k}{1k}\right)-1\left(\frac{1k}{1k}\right)$$

$$V_{0B}=-6V$$

$$Hence,\ \frac{V_{oB}}{V_{oA}}=\frac{-6}{-4}=1.5$$

36. Let X ∈ {0, 1} and Y ∈ {0, 1} be two independent binary random variables. If P (X = 0) = p and P(Y = 0) = q, then P(X + Y ≥ 1) is equal to
A. pq + (1−p) (1−q) B. pq
C. p(1−q) D. 1−pq
Answer ||| D
Solution ||| $P\{x=0\}=P \Rightarrow P\{x=1\}=1-p$

$$P\{y=0\}=q \Rightarrow P\{y=1\}=1-q$$

Let Z = X + Y

X	Y	Z
0	0	0
0	1	1
1	0	1
1	1	2

From above table,

$$P\{X+Y+Z\} \Rightarrow P<Z \geq B$$

$$P\{Z\geq 1\}=P\{X=0\ and\ Y=1\}+P\{X$$

$$=1\,and\,Y=0\}+P\{X=1\,and\,Y=1\}$$

$$=1-P\{X=0\ and\ Y=0\}$$

$$=1-pq$$

37. An LC tank circuit consists of an ideal capacitor C connected in parallel with a coil of inductance L having an internal resistance R. The resonant frequency of the tank circuit is

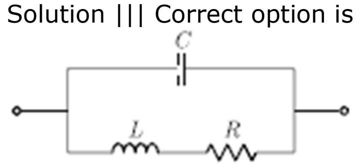
A. $\frac{1}{2\pi\sqrt{LC}}$

B. $\frac{1}{2\pi\sqrt{LC}}\sqrt{1-R^2\frac{C}{L}}$

C. $\frac{1}{2\pi\sqrt{LC}}\sqrt{1-\frac{L}{R^2C}}$

D. $\frac{1}{2\pi\sqrt{LC}}\left(1-R^2\frac{C}{L}\right)$

Answer ||| B
Solution ||| Correct option is B.



Total admittance,

$$Y = Y_C + Y_{LR}$$

$$Y = j\omega C + \frac{1}{(j\omega L + R)}$$

$$Y = j\omega C + \frac{1(R - j\omega L)}{(R + j\omega L)(R - j\omega L)}$$

$$Y = j\omega C + \frac{R - j\omega L}{R^2 + \omega^2 L^2}$$

$$Y = \frac{R}{R^2 + \omega^2 L^2} + j\left(\omega C - \frac{\omega L}{R^2 + \omega^2 L^2}\right)$$

For Resonance, Im (Y) = 0

$$\omega C = \frac{\omega L}{R^2 + \omega^2 L^2}$$

$$R^2 C + \omega^2 L^2 C = L$$

$$\omega^2 L^2 C = L - R^2 C$$

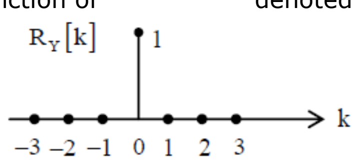
$$\omega^2 = \frac{L - R^2}{L^2 C}$$

$$\omega^2 = L\frac{\left(L - \frac{R^2 C}{L}\right)}{L^2 C}$$

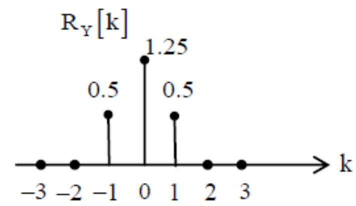
$$\omega = \frac{1}{\sqrt{LC}}\sqrt{\frac{1 - R^2 C}{L}}$$

Hence, $f = \frac{1}{2\pi\sqrt{LC}}\sqrt{1 - R^2\frac{C}{L}}$

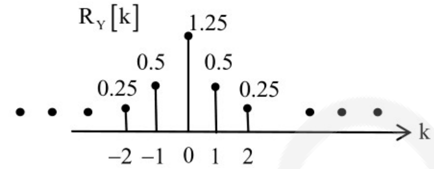
38. $\{X_n\}_{n=-\infty}^{n=\infty}$ is an independent and identically distributed (i, i, d) random process with X_n equally likely to be + 1 or −1, $\{Y_n\}_{n=-\infty}^{n=\infty}$ is another random process obtained as $Y_n = X_n + 0.5X_{n-1}$. The autocorrelation function of $\{Y_n\}_{n=-\infty}^{n=\infty}$ denoted by $R_Y[k]$ is



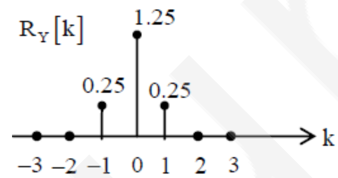
A.



B.



C.



D.

Answer ||| B

Solution ||| Correct option is B.

The autocorrelation function is defined as

$$R_Y(k) = R_y(n, n+k)$$
$$= E[Y(n).Y(n+k)]$$

Now, we have

$$Y(n) = x(n) + 0.5x(n-1)$$

So, $R_y(k) = E[(x(n) + 0.5x(n-1))$
$(x(n+k) + 0.5x(n+k-1))]$

$$= E[(x(n)\cdot x(n+k) + x(n)0.5x(n+k-1)$$
$$+0.5x(n-1)\cdot x(n+k) + 0.25x(n-1)x(n+k-1)]$$
$$= E[x(n)\cdot x(n+k)] + 0.5E[x(n)x(n+k-1)]$$
$$+0.5E[x(n-1)x(n+k))] + 0.25E[x(n-1)x(n+1-1)]$$
$$= R_x(k) + 0.5R_x(k-1) + 0.5R_x(k+1) + 0.25R_x(k)$$
$$R_y(k) = 1.25R_x(k) + 0.5\,R_x(k-1) + 0.5R_x(k+1)$$
$$R_x(k) = E[x(n)\cdot x(n+k)]$$

For k = 0, we obtain

$$R_x(0) = E[x^2(n)]$$
$$= 1^2\cdot\frac{1}{2} + (-1)^2 \times \frac{1}{2}$$
$$= 1$$

Again, for $k \neq 0$, we have

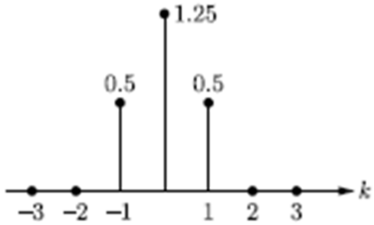
$$R_x(k) = E[x(n)]E[x(n+k)]$$
$$= 0$$

$$\{Since\ E[x(n)] = 0, E[x(n+k)] = 0\}$$

Hence, we get

$$R_y(0) = 1.25R_Z(0) + 0.5R_x(-1) + 0.5R_z(1)$$
$$= 1$$
$$R_y(1) = 1.25R_Z(1) + 0.5R_x(0) + 0.5R_z(2)$$
$$= 0.5$$
$$R_y(-1) = 1.25R_Z(-1) + 0.5R_x(-2) + 0.5R_z(0)$$
$$= 0.5$$

$R_Y(k)$ for k other than 0, 1 and −1 = 0. Thus, the autocorrelation function $R_Y(k)$ is plotted as



39. In a MOS capacitor with an oxide layer thickness of 10 nm the maximum depletion layer thickness is 100 nm. The permittivities of the semiconductor and the oxide layer are ε_s and ε_{ox} respectively. Assuming $\varepsilon_s / \varepsilon_{ox} = 3$, the ratio of the maximum capacitance to the minimum capacitance of this MOS capacitor is__________

A. 4.5 B. 4.33 C. 10.25 D. 6

Answer ||| B

Solution ||| Correct answer is 4.33

The maximum capacitance per unit area is given by

$$C_{max} = \frac{\varepsilon_{ox}}{t_{ox}}$$

C_{min} occurs at maximum value of x_d (width). When both capacitance are in parallel. So, we have

$$C_{max} = \frac{\left(\frac{\varepsilon_{ox}}{t_{ox}}\right)\left(\frac{\varepsilon_s}{x_{d_{max}}}\right)}{\left(\frac{\varepsilon_{ox}}{t_{ox}}\right) + \left(\frac{\varepsilon_s}{t_{s_{max}}}\right)}$$

Hence, we obtain the ratio as

$$\frac{C_{max}}{O_{min}} = \frac{\varepsilon_{ox}}{t_{ox}} \frac{\left(\frac{\varepsilon_{ox}}{t_{ox}}\right)\left(\frac{\varepsilon_s}{x_{dmax}}\right)}{\left(\frac{\varepsilon_{ox}}{t_{ox}}\right) + \left(\frac{\varepsilon_s}{x_{dmax}}\right)}$$

$$= \frac{\varepsilon_{ox}}{t_{ox}} \frac{\varepsilon_{ox} x_{d\,max} + \varepsilon_s t_{ox}}{\varepsilon_{ox}\varepsilon_s}$$

$$= 1 + \left[\frac{x_{d\,max}}{t_{ox}} \frac{\varepsilon_{ox}}{\varepsilon_s}\right]$$

$$= \left[1 + \frac{100}{10} \times \frac{1}{3}\right] = 4.33$$

40. Let the random variable X represent the number of times a fair coin needs to be tossed till two consecutive heads appears for the first time. The expectation of X is ___

A. 1.5 B. 4 C. 0.25 D. 1.6

Answer ||| A

Solution ||| Correct answer is 1.5

Let X be random variable which denote number of tosses to get two heads.

$$P(X=2) = HH = \frac{1}{2} \times \frac{1}{2}$$

$$P(X=3) = THH = \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2}$$

$$P(X=4) = TTHH = \left(\frac{1}{2}\right)^4$$

$$So,\ E(X) = \sum XP(X)$$

$$= (2)\left(\frac{1}{2}\right)^2 + 3\left(\frac{1}{2}\right)^2 + 4\left(\frac{1}{2}\right)^2 \ldots\ldots$$

$$Again\ let\ s = (2)\left(\frac{1}{2}\right)^2 + 3\left(\frac{1}{3}\right)^3 + 4\left(\frac{1}{2}\right)^4 \ldots\ldots \quad (1)$$

$$\frac{s}{2} = (2)\left(\frac{1}{2}\right)^3 + 3\left(\frac{1}{2}\right)^4 + 4\left(\frac{1}{2}\right)^5 \ldots\ldots \quad (2)$$

Subtracting equation (2) from (1),

$$\frac{s}{2} = 2\left(\frac{1}{2}\right)^2 + \left(\frac{1}{2}\right)^3 [3-2] + \left(\frac{1}{2}\right)^4 (4-3) \ldots\ldots\ldots$$

$$\frac{s}{2} = 2\left(\frac{1}{2}\right)^2 + \left(\frac{1}{2}\right)^3 + \left(\frac{1}{2}\right)^4 + \left(\frac{1}{2}\right)^5 \ldots\ldots\ldots\ldots$$

$$\frac{s}{2} - \frac{1}{2} = \left(\frac{1}{2}\right)^3 + \left(\frac{1}{2}\right)^4 + \left(\frac{1}{2}\right)^5 \ldots\ldots\ldots$$

$$\frac{s}{2} - \frac{1}{2} = \frac{\left(\frac{1}{2}\right)^3}{1 - \frac{1}{2}} = \left(\frac{1}{2}\right)^2$$

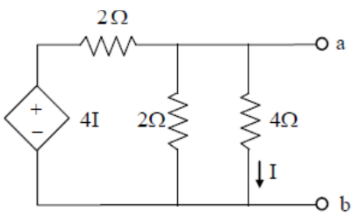
$$\frac{s}{2}=\frac{1}{2}+\frac{1}{4}$$

$$s=1+\frac{1}{2}$$

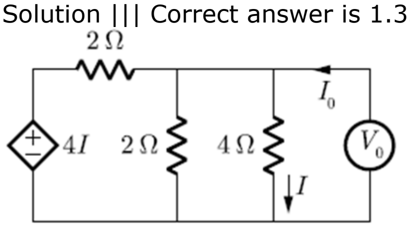
$$s=\frac{3}{2}$$

Hence, $E(X)=\frac{3}{2}=1.5$

41. In the circuit shown, the Norton equivalent resistance $(\text{in}\Omega)$ across terminals a-b is _______.



A. 2.333 B. 1.333 C. 1.255 D. 3.333
Answer ||| B
Solution ||| Correct answer is 1.333



To find Norton equivalent, an external source V_0 is applied and current through
it is I_0. So, we have

$$R_{eq}=\frac{V_0}{I_0}$$

$$I_0=\frac{V_0}{4}+\frac{V_0}{2}+\frac{V_0}{2}-2\left(\frac{V_0}{4}\right)$$

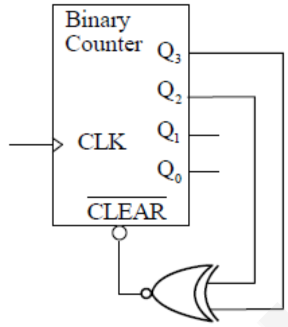
$$I_0=V_0\left(\frac{1}{2}+\frac{1}{4}\right)$$

$$I_0=V_0\left(\frac{3}{4}\right)$$

$$\frac{V_0}{I_0}=\frac{4}{3}=1.333$$

$$R_{eq}=R_{norton}=1.333$$

42. The figure shows a binary counter with synchronous clear input. With the decoding log shown, the counter works as a



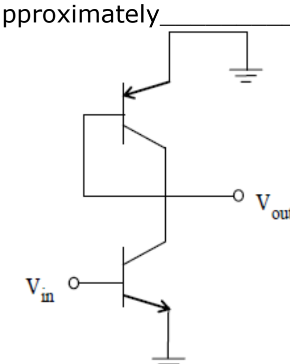
A. mod-2 counter B. mod-4 counter C. mod-5 counter D. mod-6 counter
Answer ||| C
Solution ||| Correct option is C.
From figure, it can be observed that once the Ex-NOR gate output is '0' login counter will be reset to initial stage.

Q_3	Q_2	Q_1	Q_0
0	0	0	0
0	0	0	1
0	0	1	0
0	0	1	1
0	1	0	0
0	1	0	1
0	1	1	0
0	1	1	1
1	0	0	0
1	0	0	1
1	0	1	0
1	0	1	1

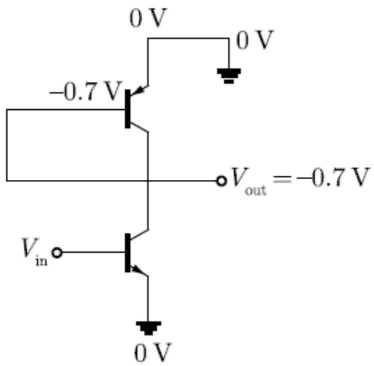
Here $Q_3=0$ $Q_2=1$ for first time at this time output of Ex NOR gate = '0' Counter will be reset. Hence it is modulo 5 counter

Hence, it is modulo 5 counter.

43. In the ac equivalent circuit shown, the two BJTs are biased in active region and have identical parameters with β >> 1. The open circuit small signal voltage gain is approximately_____________



A. 1 B. -1 C. 0 D. 2
Answer ||| B
Solution ||| Correct answer is −1.



$$V_{BE} = 0.7\ V$$
$$V_{in} = -V_E = 0.7\ V$$
$$V_{in} = 0.7\ V$$
$$So,\ \frac{V_{out}}{V_{in}} = \frac{-0.7}{0.7} = -1$$

44. The state variable representation of a system is given as

x = $\begin{bmatrix} 0 & 1 \\ 0 & -1 \end{bmatrix}$x; x (0) = $\begin{bmatrix} 1 \\ 0 \end{bmatrix}$

y = [0, 1] x
The response y(t) is
A. sin (t) B. 1-e^t
C. 1 – cos (t) D. 0
Answer ||| D
Solution ||| Correct option is D.

$$x = \begin{bmatrix} 0 & 1 \\ 0 & -1 \end{bmatrix} x;$$
$$x(0) = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$
$$y = [0 \quad 1]x$$

Since, $X(s) = \phi(s)X(0)$

where, $\phi(s)$ is state transition matrix given by

$$\phi(s) = (sI - A)^{-1},$$
$$So,\ X(s) = (sI - A)^{-1} \times (0)$$
$$= \begin{bmatrix} s & -1 \\ 0 & s+1 \end{bmatrix}^{-1} \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$
$$= \frac{1}{s(s+1)} \begin{bmatrix} s+1 & 1 \\ 0 & s \end{bmatrix} \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$
$$= \frac{1}{s(s+1)} \begin{bmatrix} s+1 & 1 \\ 0 & s \end{bmatrix} \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$
$$= \frac{1}{s(s+1)} \begin{bmatrix} s+1 \\ 0 \end{bmatrix}$$
$$X(s) = \begin{bmatrix} \frac{1}{s} \\ 0 \end{bmatrix}$$
$$X(t) = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

Hence, $y(t) = [0 \quad 1] \begin{bmatrix} 1 \\ 0 \end{bmatrix} = 0$

45. Consider the differential equation $\frac{dx}{dt} = 10 - 0.2x$ with initial condition x (0) = 1. The response x(t) for t > 0 is

A. $2 - e^{-0.2t}$ B. $2 - e^{0.2t}$
C. $50 - 49e^{-0.2t}$ D. $50 - 49e^{0.2t}$
Answer ||| C
Solution ||| Correction option is C.

$$\frac{dx}{dt} = 10 - 0.2x$$
$$\frac{dx}{dt} + 0.2x = 10$$

For the differential equation, we have

$$I.F. = e^{\int 0.2 dt}$$

$$I.F. = e^{0.2t}$$

$$xe^{0.2t} = \int 10e^{0.2t} dt + C$$

$$xe^{0.2t} = 10\left[\frac{e^{0.2t}}{0.2}\right] + C$$

$$xe^{0.2t} = \frac{10}{2} \times 10e^{0.2t} + C$$

$$x(t) = 50 + Ce^{-0.2t}$$

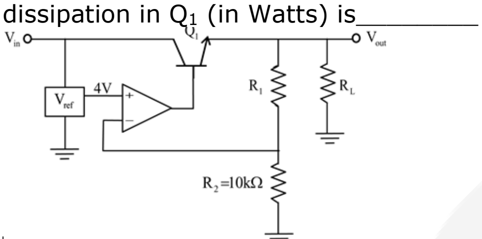
$$At\ t = 0,\ x(0) = 50 + Ce^{0} = 1$$

$$50 + C = 1$$

$$C = -49$$

$$Hence,\ x(t) = 50 - 49e^{-0.2t}$$

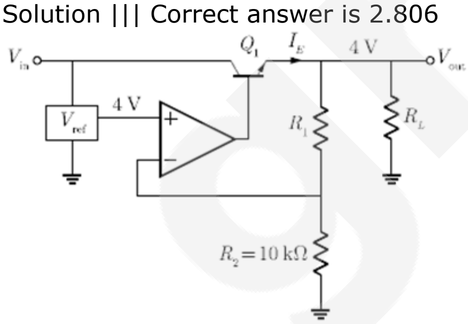
46. For the voltage regulator circuit shown, the input voltage (V_{in}) is 20V ±20% and the regulated output voltage (V_{out}) is 10V. Assume the opamp to be ideal. For a load R_L drawing 20 mA, the maximum power dissipation in Q_1 (in Watts) is__________



A. 2.205 Watts B. 3.835 Watts C. 2.8056 Watts D. 4.245 Watts

Answer ||| C

Solution ||| Correct answer is 2.806



Power dissipation in

$$Q_1 = (V_{CE} \times I_C)_{\max}$$

$$R_2 = 10k$$

$$I_E = I_C = \frac{V_{out}}{R_L} + \frac{V_A}{R_2}$$

By virtual ground property,

$$V_A = 4V$$

$$I_E = I_C = 200\,mA + \frac{4}{10k}$$

$$I_C = 200\,mA + 0.4\,mA$$

$$I_C = 200.4\,mA$$

Current through R_L is

$$I_L = \frac{V_{out}}{R_L} = 200\ mA$$

$$(V_{CE})_{\max} = V_{in} - V_0$$

$$= 24 - 10$$

$$= 14\ V$$

Hence, Power = (14 V) × (200.4 mA)
= 2.8056 watts

47. Input x(t) and output y(t) of an LTI system are related by the differential equation y″(t) - y′(t) −6y(t) = x(t). If the system is neither causal nor stable, the impulse response h(t) of the system is

A. $\frac{1}{5}e^{3t}u(-t) + \frac{1}{5}e^{-2t}u(-t)$

B. $-\frac{1}{5}e^{3t}u(-t) + \frac{1}{5}e^{-2t}u(-t)$

C. $\frac{1}{5}e^{3t}u(-t) - \frac{1}{5}e^{-2t}u(-t)$

D. $-\frac{1}{5}e^{3t}u(-t) - \frac{1}{5}e^{-2t}u(-t)$

Answer ||| B

Solution ||| Correct option is B.

$$y''(t) - y'(t) - 6y(t) = x(t)$$

Given system is neither causal nor stable. Taking the Laplace transform,

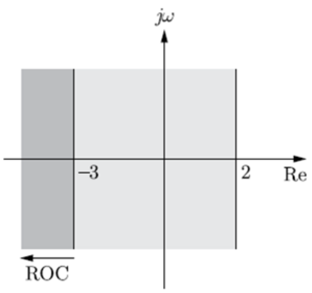
$$s^2 y(s) - sy(s) - 6y(s) = X(s)$$ (Given initial condition = 0)

$$Y(s')(s^2 - s - 6) = X(s)$$

$$\frac{Y(s)}{X(s)} H(s) = \frac{1}{s^2 - s - 6} = \frac{1}{(s-3)(s+2)}$$

$$= \frac{1}{5}\left[\frac{1}{(s-3)} - \frac{1}{(s+2)}\right]$$

Given that *h*(t) is non causal so ROC should be left side of plane. Also, h(t) is instable, so ROC should not contain j□ axis.

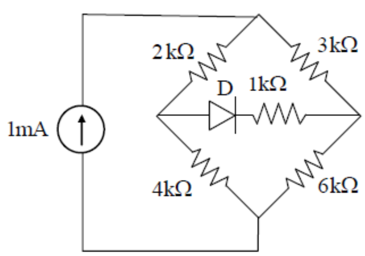


Hence, $H(s)=\frac{1}{5}\left[\frac{1}{(s-3)}-\frac{1}{(s+2)}\right]$

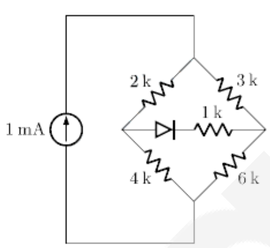
and $h(t)=\frac{1}{5}\left[-e^{-3t}u(t)+e^{-2t}u(-t)\right]$

$$=\frac{-1}{5}e^{-3t}u(-t)+\frac{1}{5}e^{=2t}u(-t)$$

48. The diode in the circuit given below has V_{ON} = 0.7 V but is ideal otherwise. The current (in mA) in the 4kΩ resistor is_______



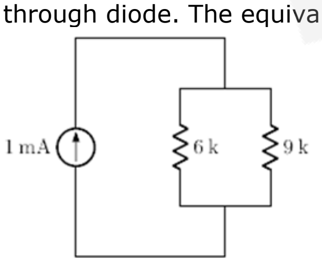
A. 0.6 mA B. 1.6 mA C. 1.5 mA D. 4 mA
Answer ||| A
Solution ||| Correct answer is 0.6
Given circuit is



Here, we have

$$\frac{2k}{4k}=\frac{3k}{6k}$$

So bridge is balanced, and hence, no current will flow through diode. The equivalent circuit is shown below.



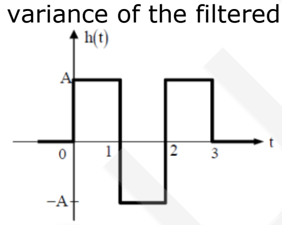
Current through 4kΩ resistor is

$$=\left(\frac{9k}{6k+9k}\right)1mA$$

$$=\frac{9k}{15k}\times 1mA=\frac{3}{5}mA$$

$$=0.6mA$$

49. A zero mean white Gaussian noise having power spectral density $\frac{N_0}{2}$ is passed through an LTI filter whose impulse response h(t) is shown in the figure. The variance of the filtered noise at t = 4 is



A. $\frac{3}{2}A^2N_0$ B. $\frac{3}{4}A^2N_0$

C. A^2N_0 D. $\frac{1}{2}A^2N_0$

Answer ||| A
Solution ||| Correct option is A.
Let N(t) be the noise at the output of filter.

Variation of $N(t)=E\left[N^2(t)\right]-\left\{E\left[N(t)\right]\right\}^2$

Since the input nose is zero mean.
Output nose mean is also zero.

$E\ N(t)=\quad \int$

E[W(t)] = 0
W(t) is white nose, so

$$\mathrm{var}(N(t))=E(N^2(t))]$$

$$=R_N(0)$$

$$\textit{Since,}\quad R_N(\tau)=h(\tau)*h(-\tau)*R_\omega(\tau)$$

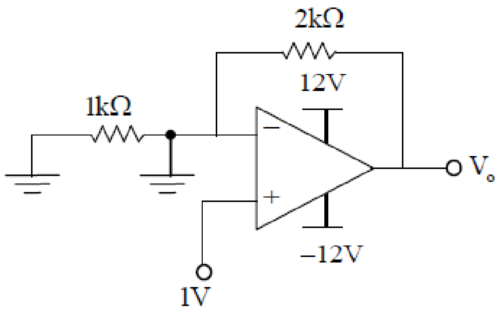
$$\textit{and}\quad R_N(\tau)=\frac{N_0}{2}\cdot\delta(\tau)$$

$$R_N(\tau)=[h(\tau)*h(-\tau)]\cdot\frac{N_0}{2}$$

$$R_N(\tau)=\frac{N_0}{2}\int_{-\infty}^{\infty}h(k)\cdot h(\tau+k)dk$$

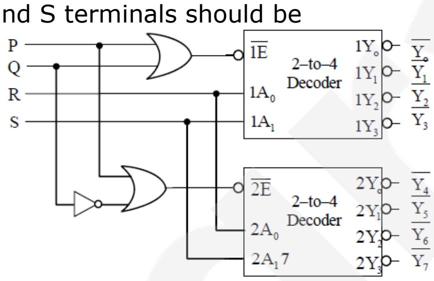
$$R_N(0) = \frac{N_0}{2}\int_{-\infty} h^2(k)dk = \frac{N_0}{2}(3A^2)$$
$$= \frac{3}{2}A^2 N_0$$

50. Assuming that the opamp in the circuit shown below is ideal, the output voltage V_0 (in volts) is_______

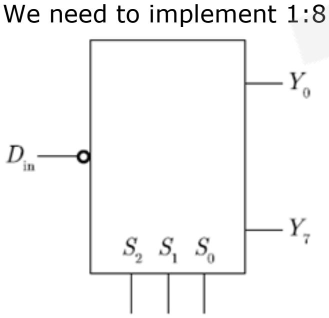


A. 10 Volts B. 12.5 Volts C. 12 Volts D. 15 Volts
Answer ||| C
Solution ||| Correct answer is 12.
For the given op-amp,
$V_+ > V_-$
So, $V_{out} = V_{saturation} = 12$ Volts

51. A 1–to–8 demultiplexer with data input D_{in}, address inputs S_0, S_1, S_2 (with S_0 as the LSB) and $\overline{Y}_0$ to $\overline{Y}_7$ as the eight demultiplexed output, is to be designed using two 2–to–4 decoders (with enable input $\overline{E}$ and address input A_0 and A_1) as shown in the figure D_{in}, S_0, S_1 and S_2 are to be connected to P, Q, R and S, but not necessarily in this order. The respective input connections to P, Q, R and S terminals should be



A. S_2, D_{in}, S_0, S_1 B. S_1, D_{in}, S_0, S_2
C. D_{in}, S_0, S_1, S_2 D. D_{in}, S_2, S_0, S_1
Answer ||| D
Solution ||| Correct option is D.
We need to implement 1:8 DEMUX



As input to both the decoder should be same. So from figure only line P is acting same to both 2 × 4 decoder. Hence, P is mapped with D_{in} . Again, we have

$$\begin{array}{ccc} S_2 & S_1 & S_0 \end{array}$$
$$\left\{\begin{array}{ccc} 0 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \\ 0 & 1 & 1 \end{array}\right.$$
$$\left\{\begin{array}{ccc} 1 & 0 & 0 \\ 1 & 0 & 1 \\ 1 & 1 & 0 \\ 1 & 1 & 1 \end{array}\right.$$

Here, we observe that S_2 is '0' in 4 cases then '1' logic. From figure, it can be seen only line Q is connected to NOT gate to OR gate. So Q is mapped to S_2 and remaining two line should be mapped in same order because select lines of 1:8 DEMUX should be mapped with address line of decoder. Hence, the mapping is

$P \rightarrow D_{in}$

$R \rightarrow S_0$

$Q \rightarrow S_2$

$S \rightarrow S_1$

52. The value of the integral $\int_{-\infty}^{\infty} 12\cos(2\pi t)\frac{\sin(4\pi t)}{4\pi t}$ dt is__________
A. 2 B. 3 C. 4 D. 5
Answer ||| B
Solution ||| Correct answer is 3.
We solve the given integral as

$$I = \int_{-\infty}^{\infty} 12\cos 2\pi t\frac{\sin 4\pi t}{4\pi t}dt$$
$$= \frac{12}{4\pi}\int_{-\infty}^{\infty}\frac{2\cos 2\pi t\sin 4\pi t}{t}dt$$
$$= \frac{3}{\pi}\left[\int_0^{\infty}\frac{\sin 6\pi t\,dt}{t} + \int_0^{\infty}\frac{\sin 2\pi t\,dt}{t}\right]$$

Since, sin A – cos B = sin (A + B) + sin (A – B), so we can rewrite the integral as

$$I = \frac{3}{\pi}\left[\int_0^{\infty} e^{\theta t}\frac{6\sin 6\pi t}{t}dt + \int_0^{\infty} e^{\theta t}\frac{\sin 2\pi t}{t}dt\right]$$

The integral can be considered as the Laplace transform with s = 0, i.e.

$$I = \frac{3}{\pi}\left[L\left\{\frac{\sin 6\pi t}{t}\right\} + L\left\{\frac{\sin 2\pi t}{t}\right\}\right]$$

$$or\ I = \frac{3}{\pi}\left[\int_s^{\infty}\frac{6\pi}{s^2+36\pi^2}ds + \int_s^{\infty}\frac{2\pi}{s^2+4\pi^2}ds\right] \quad with\ s = 0$$

$$= \frac{3}{\pi}\left[6\pi \cdot \frac{1}{6\pi}\tan^{-1}\left(\frac{s}{6\pi}\right) + 2\pi \cdot \frac{1}{2\pi}\tan^{-1}\left(\frac{s}{2\pi}\right)\Bigg|_s^{\infty}\right] \quad with\ s = 0$$

$$= \frac{3}{\pi}\left[\tan^{-1}\infty \tan^{-1}\left(\frac{s}{6\pi}\right) + \tan^{-1}(\infty) - \tan^{-1}\left(\frac{s}{2\pi}\right)\right]$$

$$= \frac{3}{\pi}\left[\frac{\pi}{2} - \tan^{-1}0 + \frac{\pi}{2} - \tan^{-1}0\right]$$

$$= \frac{3}{\pi}\left[\frac{\pi}{2} - 0 + \frac{\pi}{2} - 0\right] = \frac{3}{\pi} \times \pi = 3$$

53. A function of Boolean variables X, Y and Z is expressed in terms of the min-terms as F(X, Y, Z) = Σ(1, 2, 5, 6, 7)

Which one of the product of sums given below is equal to the function F(X, Y, Z)?

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

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

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

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

Answer ||| B

Solution ||| Correct option is B.

Given minterm is $F(X,Y,Z) = \sum(1,2,5,6,7)$

Maxterm of POS is complement of SOP. So, in POS form, we obtain

$$F(X,Y,Z) = \pi(0,3,4)$$

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

54. The transfer function of a mass-spring damper system is given by

$$G(s) = \frac{1}{Ms^2 + Bs + K}$$

The frequency response data for the system are given in the following table.

ω in rad/s	|G(jω)|in dB	are (G(jω)) in deg
0.01	-18.5	-0.2
0.1	-18.5	-1.3
0.2	-18.4	-2.6
1	-16	-16.9
2	-11.4	-89.4
3	-21.5	-151
5	-32.8	-167
10	-45.3	-174.5

The unit response of the system approaches a steady state value of ___________

A. 1.25 B. 0.12 C. 0.13 D. 4

Answer ||| B

Solution ||| Correct answer is 0.12

$$G(s) = \frac{1}{Ms^2 + Bs + K}$$

$$X(s) \longrightarrow \boxed{G(s)} \longrightarrow Y(s)$$

Now, we have to obtain unit step response. So,

$$input = \frac{1}{s}$$

$$Y(s) = G(s)X(s)$$

Therefore, $= \left(\frac{1}{Ms^2 + Bs + K}\right)\frac{1}{s}$

At steady state value,

$$Y(\omega) = \lim_{t\to\infty} y(t) = \lim_{s\to 0} sY(s)$$

$$= \lim_{s\to 0}\frac{1}{Ms^2 + Bs + K}$$

$$Y(\omega) = \frac{1}{K}$$

Now, from given table

$$At\ \omega = 0.01 \quad |G(j\omega)|_{dB} = -18.5$$

$$So, \quad 20\log|G(j\omega)| = -18.5$$

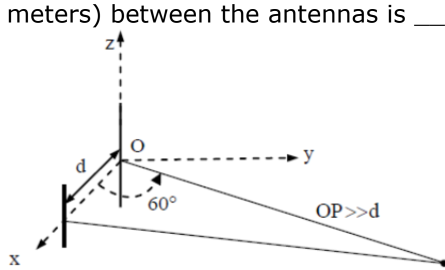
$$20\log\left|\frac{1}{K}\right| = -18.5$$

$$\log\left|\frac{1}{K}\right| = \frac{-18.5}{20}$$

$$\left|\frac{1}{K}\right| = 10^{\frac{-18.5}{20}}$$

Hence, $y(\omega) = \frac{1}{K} = 10^{\frac{-18.5}{20}} = 0.1188$

55. Two half-wave dipole antennas placed as shown in the figure are excited with sinusoidally varying currents of frequency 3 MHz and phase shift of π/2 between them (the element at the origin leads in phase). If the maximum radiated E-field at the point P in the x-y plane occurs at an azimuthal angle of 60° the distance d (in meters) between the antennas is _____________.



A. 25 B. 30 C. 50 D. 100

Answer ||| C

Solution ||| Correct answer is 50.

For maximum electric field, we have

$$\psi = \beta d\cos\theta + \alpha = 0$$

Where

$$\beta = \frac{2\pi}{\lambda} = \frac{2\pi f}{3\times10^8 ms}$$

$$= \frac{2\pi\times(3\times10^6)}{3\times10^8} = \frac{2\pi}{100}$$

□ = Azimuthal angle = 60º

□ = Phase shift $= -\frac{\pi}{2}$

Substituting these values in equation (1), we get

$$\frac{(2\pi)}{100} d\cos(60^o) + \left(-\frac{\pi}{2}\right) = 0$$

$$d = \frac{\pi\times100}{2\pi}$$

$$= 50\ m$$

56. An air-filled rectangular waveguide of internal dimensions a cm × b cm(a > b) has a cutoff frequency of 6 GHz for the dominant TE_{10} mode. For the same waveguide, if the cutoff frequency of the TM_{11} mode is 15 GHz, the cutoff frequency of the TE_{10} mode in GHz is ___________.

A. 27 B. 12.5 C. 15 D. 13.74

Answer ||| D

Solution ||| Correct answer is 13.74

We have rectangular waveguide with a cm × b cm (a > b)

For TE_{10}, f_C = 6 GHz

For TM_{11}, f_C = 15 GHz

Since, we have

$$f_C = \frac{C}{2}\sqrt{\left(\frac{m}{a}\right)^2 + \left(\frac{n}{b}\right)^2}$$

$$so,\ \ 15\times10^9 = \frac{3\times10^8}{2}\sqrt{\frac{1}{a^2}+\frac{1}{b^2}}$$

$$\sqrt{\frac{1}{a^2}+\frac{1}{b^2}} = \frac{15\times10^9\times2}{3\times10^8}$$

$$\frac{1}{a^2}+\frac{1}{b^2} = (100)^2$$

$$and\ \ 6GHz = \frac{3\times10^8}{2}\sqrt{\left(\frac{1}{a}\right)^2}$$

$$6\times10^9 = \frac{3\times10^8}{2}\times\frac{1}{a}$$

$$100 = \sqrt{\left(\frac{1}{a}\right)^2 + \left(\frac{1}{b}\right)^2}$$

$$a = \frac{3\times10^8}{2\times6\times10^9}$$

$$Therefore,\ a = \frac{1}{40}m$$

$$Again,\ (100)^2 = (40)^2 + \left(\frac{1}{b}\right)^2$$

$$(100)^2 + (40)^2 = \left(\frac{1}{b}\right)^2$$

$$(140)(60) = \left(\frac{1}{b}\right)^2$$

$$b = 91.65$$

$$For\ TE_{01},\ \ f_C = \frac{3\times10^8}{2}\times\sqrt{\left(\frac{1}{b}\right)^2}$$

$$= \frac{3\times10^8}{2}\times\frac{1}{b}$$

$$= \frac{3\times10^8}{2}\times91.65$$

$$= 13.74\ GHz$$

57. Consider two real sequences with time-origin marked by the hold value

$x_1[n]$ = {1, 2, 3, 0}, x_2 [n] = {1, 3, 2, 1}

Let X_1 (k) and X_2 (k) be 4 –point DFTs of x_1 [n] and x_2 [n], respectively

Another sequence x_3 [n] is derived by taking 4-point inverse DFT of x_3(k) = x_1 (k) x_2 (k).

The value of x_3 [2] is______

A. 35 B. 12 C. 11 D. 14

Answer ||| C

Solution ||| Correct answer is 11.

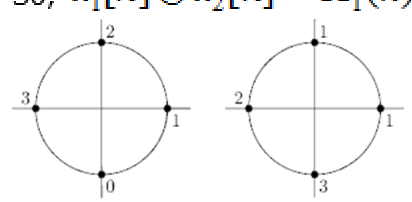
Given $x_1[n] = \{1, 2, 3, 0\}, x_2[n] = \{1, 3, 2, 1\}$

and $X_3(k) = X_1(k)X_2(k)$

By convolution circular property of DFT

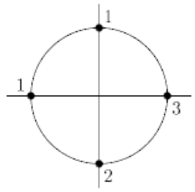
Circular convolution in time domain = Multiplication in fourier domain

So, $x_1[n]\otimes x_2[n] = X_1(k)X_2(k) = x_3[n]$

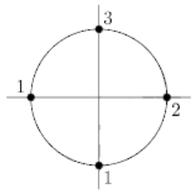


$x_3[0]$ = 2 + 6 + 1 = 0

Now rotate for second term



So, $x_3[1] = 6$



Again, $x_3[2]$ = 2 + 6 + 3 = 11

58. Let x (t) = a s (t) + s (−t) with s (t) = βe^{-4t} u (t), where u (t) is unit step function. If the bilateral Laplace transform of x (t) is

$$X(s) = \frac{16}{s^2 - 16} \quad -4 < \text{Re}\{s\} < 4$$

Then the value of β is __________
A. 2 B. -2 C. 1 D. -1
Answer ||| B
Solution ||| Correct answer is −2.
Given $x(t)$ = □s(t) + s(−t)

$$s(t) = \beta e^{-4t} u(t)$$

$$So, \quad x(t) = \alpha\beta e^{-4t} u(t) + \beta e^{+4t} u(-t)$$

Now, we have ROC $-4 < \text{Re}\{s\} < +4.$ Taking Laplace for given ROC, we have

$$X(s) = \frac{\alpha\beta}{s+4} - \frac{\beta}{s-4}$$

$$\beta\left[\frac{\alpha(s-4)-(s+4)}{s^2-16}\right] = \frac{16}{s^2-16}$$

$$\beta\left[\frac{\alpha s - 4\alpha - s - 4}{s^2-16}\right] = \frac{16}{s^2-16}$$

$$\frac{s(\alpha-1)\beta - (4+4\beta)}{s^2-16} = \frac{16}{s^2-16}$$

Coefficient of s is zero. From above equation, we conclude the result as

$$(\alpha-1)\beta = 0$$

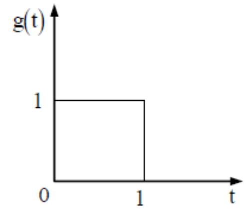
$$\alpha = 1$$

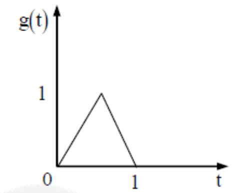
$$and \ -(4+4\alpha)\beta = 16$$

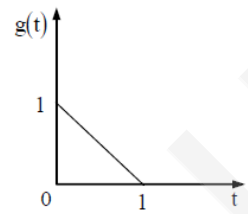
$$\beta = \frac{-16}{8}$$

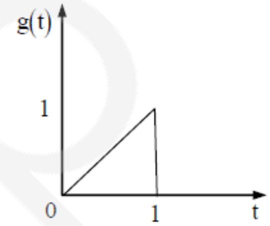
$$\beta = -2$$

59. Consider a binary, digital communication system which used pulse g(t) and −g(t) for transmitting bits over an AWGN channel. If the receiver uses a matched filter, which one of the following pulses will give the minimum probability of bit error?

A. 

B. 

C. 

D. 

Answer ||| A
Solution ||| Correct option is A.
Probability of error of matched filter receiver is given by

$$= Q\left(\sqrt{\frac{2E}{N_0}}\right)$$

Where E = Energy of signal
So, probability of error will be minimum for which energy is maximum. By finding energy of signals given in option, we conclude that energy is minimum for option A.

60. The electric field of a plan wave propagating in a lossless non-magnetic medium is given by the following expression
E (z, t) = a_x 5cos (2π × 10^9 t + βz) +

$$a_y 3\cos\left(2\pi \times 10^9 t + \beta z - \frac{\pi}{2}\right)$$

The type of the polarization is
A. Right Hand Circular B. Left Hand Elliptical
C. Right Hand Elliptical D. Linear
Answer ||| B
Solution ||| Correct option is B.

$$\vec{E}(z,t) = a_x 5\cos(2\pi \times 10^9 t + \beta z)$$

$$+ a_y 3\cos\left(2\pi \times 10^9 t + \beta z - \frac{\pi}{2}\right)$$

So, $E_x = 5\cos(2\pi \times 10^9 + \beta z)$

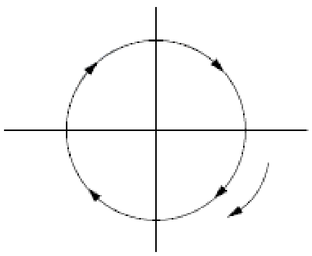
$$E_y = 3\cos\left(2\pi \times 10^9 + \beta z - \frac{\pi}{2}\right)$$

Since phase difference between E_x and E_y is □/2, and magnitudes are not equal. So, this is elliptical polarization. Now, we have to determine direction.

At $E_x = 5\cos(2\pi \times 10^9 t)$

$$E_y = 3\cos\left(2\pi \times 10^9 t - \frac{\pi}{2}\right)$$

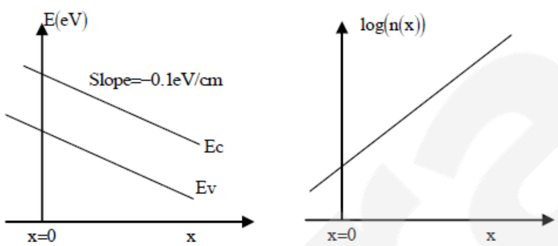
For t = 1, t = 2, …. we have the circulation as shown below :



Time advancing in lefthand direction

Hence, the polarization is left hand elliptical.

61. The energy band diagram and electron density profile n(x) in a semiconductor are shown in the figure. Assume that n (x) = $10^{15} e^{\left(\frac{q\alpha x}{kT}\right)} cm^{-3}$; with α = 0.1 V/ cm and x expressed in cm. Given $\frac{kT}{q}$ = 0.026V, D_n = 36 $cm^2\ s^{-1}$, and $\frac{D}{\mu} = \frac{kT}{q}$. The electron current density (in A/cm^2) at x = 0 is



A. -4.4×10^{-2} B. -2.2×10^{-2}

C. 0 D. 2.2×10^{-2}

Answer ||| C

Solution ||| $$J_n(diff) = qD_n\frac{dn(x)}{dx}$$

Given $n(x) = 10^{15} e^{\frac{eq\alpha x}{kT}}$

$$\left.\frac{dn(x)}{dx}\right|_{x=0} = 3.846\times10^{15}\ |\ cm^4$$

Jn(diff) = 2.2 × 10−2 A/cm2

$$\left.J_{n(drift)}\right|_{x=0} = n(0).q\mu_n E_n$$

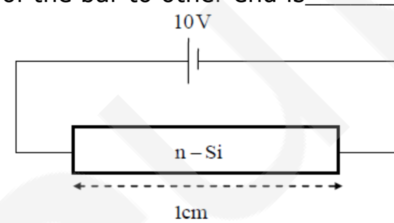
$$= 10^{15}\times1.6\times10^{-19}\times1384.5\times E_x$$

$$E_x = \frac{-kT}{q}\cdot\frac{1}{n(x)}\cdot\frac{dn(x)}{dx} = -\alpha = -0.1\ V/cm$$

$$J_n(drift) = -2.2\times10^{-12}\ A/cm^2$$

$$J = J_n(drift) + J_n(drift) = 0\ A/cm^2$$

62. A dc voltage of 10 V is applied across an n-type silicon bar having a rectangular cross-section and a length of 1 cm as shown in figure. The donor doping concentration N_D and the mobility of electrons μ_n are 10^{16} cm^{-3} and 1000 $cm^2V^{-1}s^{-1}$, respectively. The average time (in μs) taken by the electrons to move from one end of the bar to other end is__________



A. 100 μsec B. 200 μsec

C. 300 μsec D. 400 μsec

Answer ||| A

Solution ||| Correct answer is 100.

$$\vec{E} = \frac{\vec{V}}{d} = \frac{10V}{1cm} = 10V/cm$$

Given,

$$V_{applied} = 10V$$

$$d = 1cm(length)$$

$$V_d = drift\ velocity = \mu\vec{E}$$

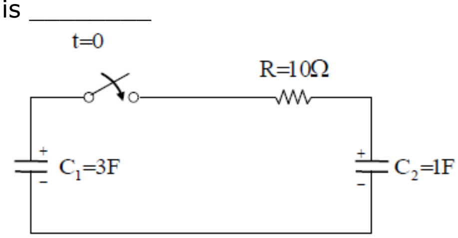
$$= 1000cm^2V^{-1}S^{-1}\times10V/cm$$

= 10^4 cm/s

$$time = \frac{length}{V_d} = \frac{1cm}{10^4 cm/s} = 10^{-4}\ \sec$$

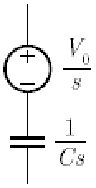
$$= 100\ \mu\sec$$

63. In the circuit shown, the initial voltages across the capacitors C_1 and C_2 are 1V and 3V, respectively. The switch is closed at time t = 0. The total energy dissipated (in Joules) in the resistor R until steady state is reached is __________

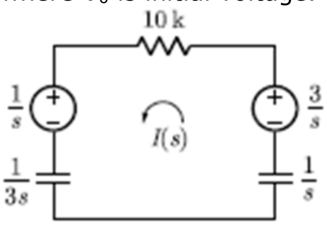


A. 5 B. 1.5 C. 2 D. 2.5

Answer ||| B
Solution ||| Correct answer is 1.5
The capacitor can be represented in Laplace domain as



where V_0 is initial voltage. So, the given circuit result in



From the circuit,

$$I(s)=\frac{(3/s-1/s)}{10+(1/3s+1/s)}$$

$$=\frac{2/s}{10+(4/3s)}$$

$$=\frac{2/s}{(30s+4)/3s}$$

$$=\frac{3s}{30s+4}\left(\frac{2}{s}\right)$$

$$=\frac{6}{30s+4}=\frac{3}{15s+2}$$

$$=\frac{3}{15s+2}$$

$$=\frac{3}{15}\left(\frac{1}{s+\frac{2}{15}}\right)$$

$$=\frac{1}{5}\left(\frac{1}{s+\frac{2}{15}}\right)$$

Therefore, $i(t)=\frac{1}{5}e^{-\frac{2}{n}t}u(t)$

Hence, energy dissipated

$$=\int_{-\infty}^{0}t^2(t)R\,dt$$

$$=\frac{1}{25}\int_0^{\infty}e^{-(4/15)t}(10)dt$$

$$=\frac{10}{25}\int_0^{\infty}e^{-(4/15)t}\,dt$$

$$=\frac{10}{25}\times\frac{15}{4}=1.5\ Joule$$

64. The output of standard second – order system for a unit step input is given as

$$y(t)=1-\frac{2}{\sqrt{3}}e^{-t}\cos\left(\sqrt{3}t-\frac{\pi}{6}\right).$$

The transfer function of the system is

A. $\frac{2}{(s+2)(s+\sqrt{3})}$ B. $\frac{1}{S^2+2s+1}$

C. $\frac{3}{S^2+2s+3}$ D. $\frac{4}{S^2+2s+4}$

Answer ||| D
Solution ||| Correct option is D.

Given
$$y(t)=1-\frac{2}{\sqrt{3}}e^{-t}\cos\left(\sqrt{3}t-\frac{\pi}{6}\right)$$

In standard form, we define

$$y(t)=1-Ae^{-t/\tau}\cos(\omega dt-\phi)$$

For standard equation,

$$\tau=\xi\omega_n$$

$$\omega_d=\omega_n\sqrt{1-\xi^2}=\sqrt{3}$$

$$or\quad \frac{1}{\xi}=\frac{\sqrt{3}}{\sqrt{1-\xi^2}}\quad(\xi\omega_n=1,\ or\ \omega_n=1/\xi)$$

$$or\quad \frac{1}{\xi^2}=\frac{3}{1-\xi^2}$$

$$or\quad 1-\xi^2=3\xi^2$$

$$or \quad 1 = 4\xi^2$$

$$or \quad \xi^2 = \frac{1}{4}$$

$$So, \quad \xi = 0.5$$

$$Again, \quad \omega_n - \frac{1}{\xi} = \frac{1}{\frac{1}{2}}$$

$$= 2$$

So, the characteristic equation is

$$= s^2 + 2\xi\omega_n s + \omega_n^2$$

$$= s^2 \times 2 \times \frac{1}{2} \times 2s + 4$$

$$= s^2 + 2s + 4$$

This denominator term is present only in option D.

65. If C denotes the counterclockwise unit circle, the value of the contour integral $\frac{1}{2\pi j}\oint_C \mathrm{Re}\{z\}dz$ is ________

$\frac{1}{2\pi j}\oint_C \mathrm{Re}\{z\}dz$ where |z|= 1

A. 0. 5 B. 1.5 C. 2 D. 3.5

Answer ||| A

Solution ||| Correct answer is 0.5

$$\frac{1}{2\pi j}\phi_C \mathrm{Re}(z)dz$$

$$z = e^{j\theta}$$

Let $dz = je^{j\theta} j\theta$

Taking limit from 0 to 2□

$$= \frac{1}{2\pi j}\int_0^{2\pi} \mathrm{Re}(e^{j\theta}) je^{j\theta} d\theta$$

$$= \frac{1}{2\pi j}\int_0^{2\pi} (\cos^2\theta + j\sin\theta\cos\theta)d\theta$$

$$= \frac{1}{2\pi}\left[\int_0^{2\pi} \cos^2 d\theta + \int_0^{2\pi} \sin\theta\cos\theta d\theta\right]$$

$$= \frac{1}{2\pi}[n - 0]$$

$$= \frac{1}{2} = 0.5$$

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