MEGA MOCK CHALLENGE

gradeup

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NIELIT

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Electronics & Communication Engineering

Mega Mock Challenge
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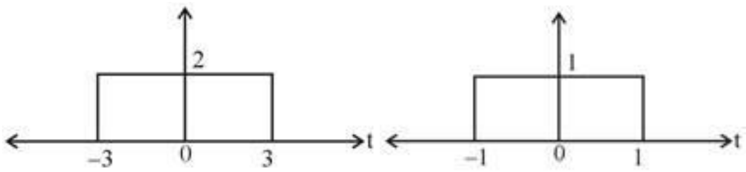
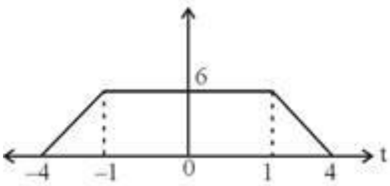
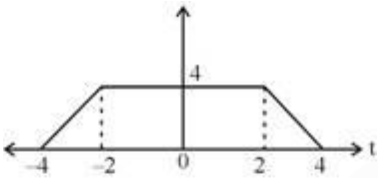
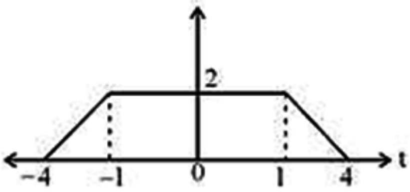
Questions & Solutions

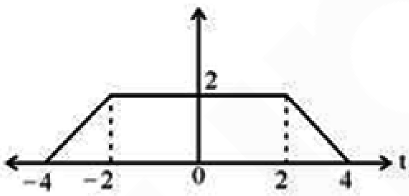
1. Perform the convolution of these two signals,



A. 

B. 

C. 

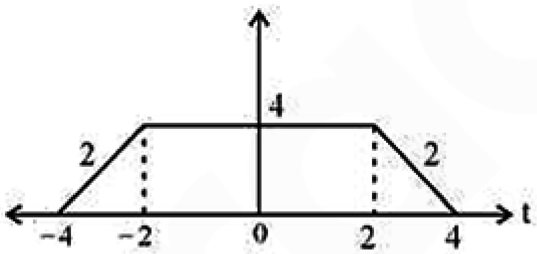
D. 

Ans. B

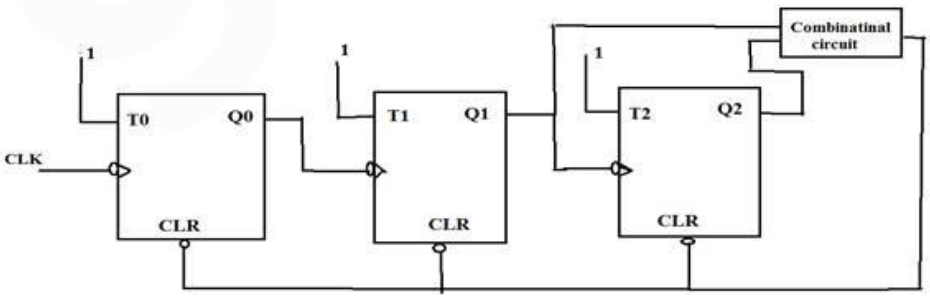
Sol. upper limit = sum of upper limits = 3 + 1 = 4

Lower limit = sum of lower limits = −3 − 1 = −4

And we will have slope of duration equal to the total width of small rectangle on both the sides in the convolution and slope will be equal to product of amplitudes. So final convolution will be.



2. A MOD-6 ripple up-counter is to be designed using three flip-flops as shown in below figure. The flip-flops can be reset to their initial condition ($Q_2Q_1Q_0$) = (000) by providing an active low external trigger to the CLR input. If the counter starts counting the sequence from ($Q_2Q_1Q_0$) = (000), then the combinational circuit can be constructed by using-



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A. An OR gate followed by a NOT gate

B. An AND gate followed by a NOT gate

C. An EX-OR gate followed by a NOT gate

D. An EX-OR gate followed by a buffer gate

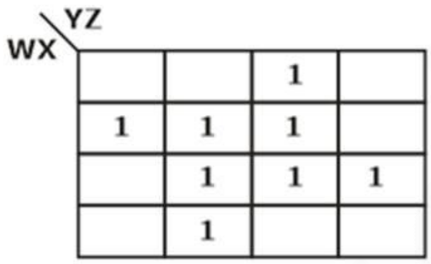
Ans. B

Sol. For A MOD 6 ripple up-counter there should be 6 pulses and output will be $(Q_2Q_1Q_0) = (110)$

So the combinational circuit is NAND GATE which is equivalent to AND GATE followed by NOT GATE.

INPUTs		OUTPUTs
A	B	A NAND B
0	0	1
0	1	1
1	0	1
1	1	0

3. The irredundant minimised logic expression corresponding to the K – map shown below is



A. XZ

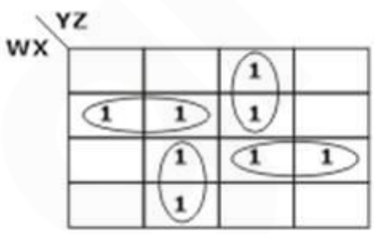
B. $\bar{w}x\bar{y} + \bar{w}yz + w\bar{y}z + wxy$

C. $\bar{w}x\bar{y} + \bar{w}yz + w\bar{y}z + wx\bar{y}$

D. $xz + \bar{w}yz + wx\bar{y} + w\bar{y}z + wxy$

Ans. B

Sol.



$Z = \bar{w}x\bar{y} + wxy + \bar{w}yz + w\bar{y}z$

4. What is the minimum number of 2-input NOR gates required to implement a 4-variable function expressed in sum of min terms form as f = Σ (1, 3, 4, 6, 9, 11, 12, 14)? Assume that all the inputs and their complements are available.

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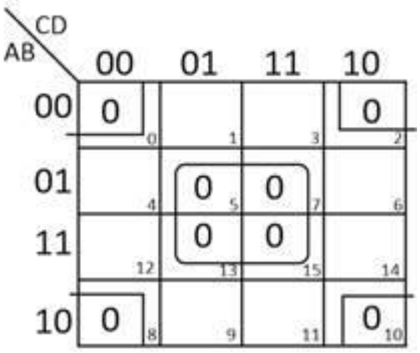
A. 1
B. 2
C. 3
D. 4

Ans. C

Sol. f = Σm (1, 3, 4, 6, 9, 11, 12, 14)

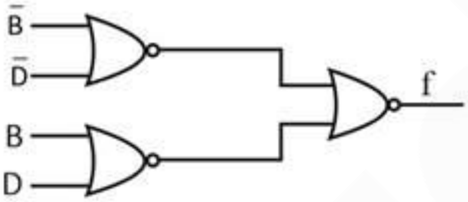
= πM (0, 2, 5, 7, 8, 10, 13, 15)

Drawing k-map, we get



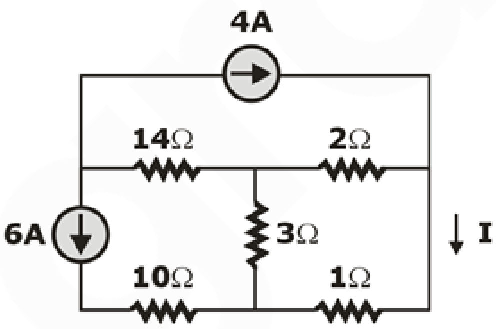
$$f = (\overline{B} + \overline{D})(B + D)$$

$$= \overline{\overline{\overline{B} + \overline{D}} + \overline{B + D}}$$



Total 3 NOR gates are required (C) option is correct.

5. In the figure, the value of I will be given by



A. $\frac{13}{3}$A
B. $-\frac{5}{3}$A
C. 5A
D. $-\frac{3}{5}$A

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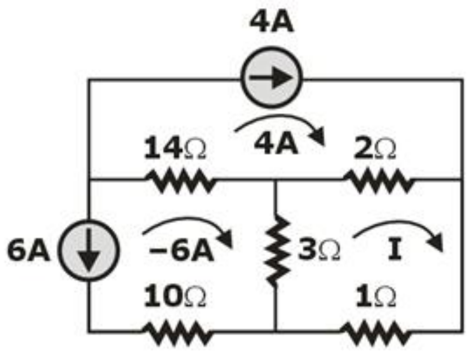
Ans. B

Sol.



Current I can be solved easily using mesh equation

In the right mesh

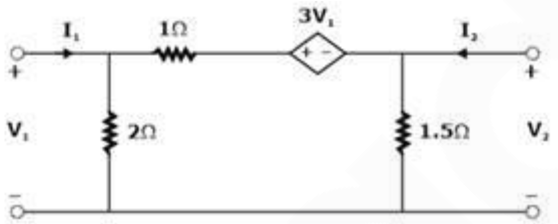
$-2\ (I - 4) - 1\ (I) - 3[I - (-6)] = 0$

$-2I + 8 - I - 3I - 18 = 0$

$-6I = 10$

$I = -\frac{5}{3}A$

6. Consider the following circuit.



They y – parameters are

A. $\begin{pmatrix} -3/2 & -1 \\ 2 & 5/3 \end{pmatrix}$

B. $\begin{pmatrix} 5/3 & -1 \\ 2 & -3/2 \end{pmatrix}$

C. $\begin{pmatrix} -1 & 5/3 \\ -3/2 & 2 \end{pmatrix}$

D. $\begin{pmatrix} 2 & 5/3 \\ -3/2 & 1 \end{pmatrix}$

Ans. A

Sol.

$$\text{Nodal} \Rightarrow -I_1 + \frac{V_1}{2} + \frac{V_1 - 3V_1 - V_2}{1} = 0$$

$$\Rightarrow I_1 = \frac{-3}{2}V_1 - V_2$$

$$-I_2 + \frac{V_2}{1.5} + \frac{V_2 + 3V_1 - V_1}{1} = 0$$

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$$I_2 = 2V_1 + \left(\frac{2}{3} + 1\right) V_2$$

$$= 2V_1 + \frac{5}{3} V_2$$

$$\Rightarrow y = \begin{pmatrix} -3/2 & -1 \\ 2 & 5/3 \end{pmatrix}$$

7. The minimum number of 2 input NAND gate required to implement the Boolean function $F = (\overline{x} + \overline{y})(z + W)$ is________

A. 6

B. 3

C. 5

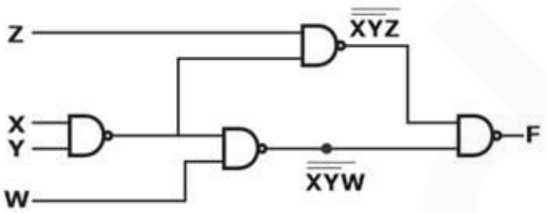
D. 4

Ans. D

Sol. $F = (\overline{x} + \overline{y})(z + W)$

$$F = \overline{xy} \cdot z + \overline{xy}\, W = \overline{\overline{\overline{xy}z}} + \overline{\overline{\overline{xy}W}}$$

$$= \overline{(\overline{\overline{xy}z})(\overline{\overline{xy}W})}$$



8. A certain 8-bit successive approximation type analog to digital converter has full scale voltage of 2.65 V, if the conversion time for V_A = 1.5 V is 75 μs, then the conversion time for V_A = 2.5 V is.

A. 75 μsec

B. 25 μsec

C. 225 μsec

D. 150 μsec

Ans. A

Sol. For successive approximation type of converter, the conversion time is independent of V_A. Here, option (A) is correct

9. Given a vector field

$$\vec{D} = (kx^2y + yz)\hat{a}_x + (xy^2 - xz^3)\hat{a}_y - (6xyz - 2x^2y^2)\hat{a}_z$$

If the vector field $\overline{D}$ is solenoidal, then the value of K will be

A. 1

B. 2

C. 4

D. −2

Ans. B

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Sol. For a solenoidal field

$$\nabla . \bar{D} = 0$$

$$\nabla.\bar{D} = \frac{\partial D_x}{\partial x} + \frac{\partial D_y}{\partial y} + \frac{\partial D_z}{\partial z} = 0$$

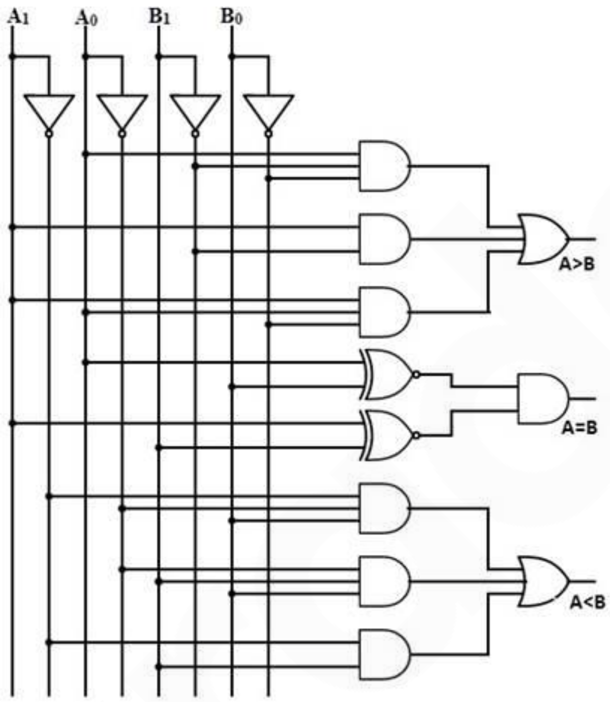
2kxy + 2xy − 6xy = 0

2kxy − 4xy = 0

2k = 4

$\boxed{K = 2}$

10. If A_1A_0 and B_1B_0 are two 2-bit numbers, then the following circuit represents which of the following function.



A. 2-bit Summer

B. 2-bit Subtractor

C. 2-bit Magnitude Comparator

D. None of these

Ans. C

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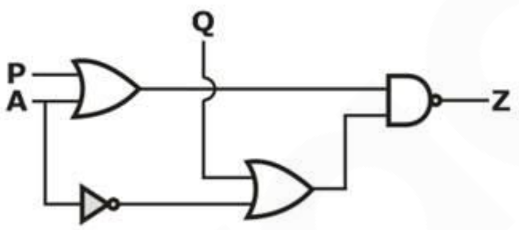
Sol. From the circuit, we can make the truth-table as follows, and conclude that the circuit behaves as 2-bit magnitude comparator.

Inputs				Outputs		
A_1	A_0	B_1	B_0	A>B	A=B	A<B
0	0	0	0	0	1	0
0	0	0	1	0	0	1
0	0	1	0	0	0	1
0	0	1	1	0	0	1
0	1	0	0	1	0	0
0	1	0	1	0	1	0
0	1	1	0	0	0	1
0	1	1	1	0	0	1
1	0	0	0	1	0	0
1	0	0	1	1	0	0
1	0	1	0	0	1	0
1	0	1	1	0	0	1
1	1	0	0	1	0	0
1	1	0	1	1	0	0
1	1	1	0	1	0	0
1	1	1	1	0	1	0

11. The circuit shown below is used to implement the function

$Z = f(A, B) = \bar{A} + B,$ the values of P and Q are



A. P = A, Q = B

B. $P = B, Q = \bar{A}$

C. $P = \bar{B}, Q = 0$

D. $P = 0, Q = \bar{B}$

Ans. D

Sol.

$$\bar{Z} = (P + A)(Q + \bar{A})$$
$$= PQ + AQ + P\bar{A}$$
$$= \bar{A} + B$$

$\bar{Z} = \overline{\bar{A} + B} = A\bar{B}$

$Q = \bar{B}, P = 0$

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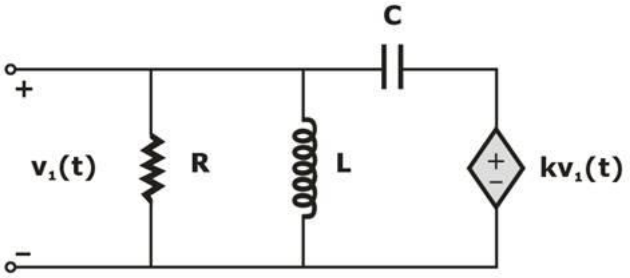
12. Consider the RLC network shown in the figure below:



The resonant frequency (ω_0) of the above network is given by

A. $\omega_0 = \frac{1}{\sqrt{LC}}$

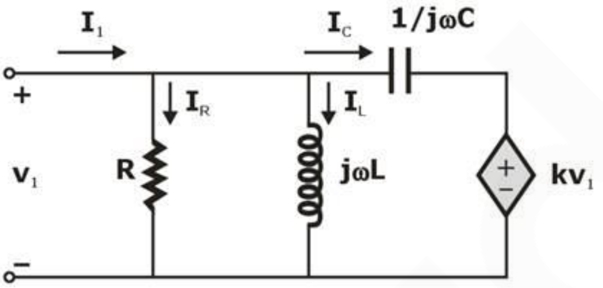
B. $\omega_0 = \frac{k}{\sqrt{LC}}$

C. $\omega_0 = \frac{1}{\sqrt{LC(2-k)}}$

D. $\omega_0 = \frac{1}{\sqrt{LC(1-k)}}$

Ans. D

Sol. Considering the circuit into phasor domain



$I_1 = I_R + I_L + I_C$

$$= \frac{V_1}{R} + \frac{V_1}{j\omega L} + \frac{V_1 - kV_1}{(1/\omega C)} = V_1\left[\frac{1}{R} + \frac{1}{j\omega L} + j\omega C(1-k)\right]$$

Input admittance,

$$y(j\omega) = \frac{I_1}{V_1} = \frac{1}{R} j\left[\omega C(1-k) - \frac{1}{\omega L}\right]$$

At resonance, imaginary part of admittance becomes zero

$$\omega_0 C(1-k) - \frac{1}{\omega_0 L} = 0$$

$$\omega_0^2 = \frac{1}{LC(1-k)}$$

$$\omega_0 = \frac{1}{\sqrt{LC(1-k)}}$$

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13. Consider the random process X(t) = A cos ($\omega_0 t + \varphi$) where A and ω_0 are constants and φ is random variable distributed on [-π, π]. Find $E\left[X^2(t)\right]$ and $R_X(\tau)$?

A. $E\left[X^2(t)\right]$ = 0 and $R_X(\tau)=\frac{A^2}{2}$

B. $E\left[X^2(t)\right]$ = $\frac{A^2}{2}$ and $R_X(\tau)=\frac{A^2}{2}$

C. $E\left[X^2(t)\right]$ =0 and $R_X(\tau)=\frac{A^2}{2}\cos\omega_0\tau$

D. $E\left[X^2(t)\right]$ = $\frac{A^2}{2}$ and $R_X(\tau)=\frac{A^2}{2}\cos\omega_0\tau$

Ans. D

Sol. Time average

$$\langle X(t)\rangle=\underset{T\to\infty}{Lt}\frac{1}{2T}\int_{-T}^{T}X(t)dt$$

$$=\underset{T\to\infty}{Lt}\frac{1}{2T}\int_{-T}^{T}A\cos(\omega_0 t+\phi)dt=0$$

$$\langle X(t)\rangle=\underset{T\to\infty}{Lt}\frac{1}{2T}\int_{-T}^{T}X^2(t)dt=\frac{A^2}{2}$$

$$\langle X(t)X(t+\tau)\rangle=\underset{T\to\infty}{Lt}\frac{1}{2T}\int_{-T}^{T}X(t)X(t+\tau)dt$$

$$=\underset{T\to\infty}{Lt}\frac{1}{2T}\int_{-T}^{T}A\cos(\omega_0 t+\phi)$$

$$A\cos(\omega_0(t+\tau)+\phi)dt$$

$$=\underset{T\to\infty}{Lt}\frac{1}{2T}\int_{-\pi}^{\pi}\cos(\omega_0 t+\phi)$$

$$\cos(\omega_0(t+\tau)+\phi)dt$$

$$=\frac{A^2}{2}\cos(\omega\tau).$$

Statistical average

$$E\left[X(t)\right]=\int_{-\pi}^{\pi}A\cos(\omega_0 t+\phi)d\phi=0$$

$$E\left[X^2(t)\right]=\int_{-\pi}^{\pi}A^2\cos^2(\omega_0 t+\phi)d\phi=\frac{A^2}{2}$$

and autocorrelation function

$$R_X(\tau)=E\{X(t_1)X(t_2)\}$$

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$$= \frac{A^2}{2} E\left[\cos\omega_0(t_1 - t_2) + \cos(\omega t_1 + \omega t_2 + 2\phi)\right]$$

$$= \frac{A^2}{2} E\left[\cos\omega_0(t_1 - t_2)\right] + 0$$

$$R_X(\tau) = \frac{A^2}{2} \cos\omega_0\tau$$

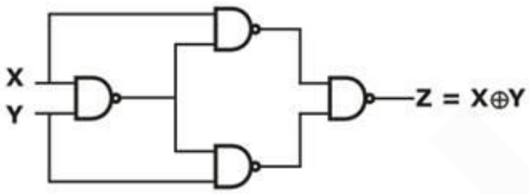
14.If X and Y logic inputs are available and their respective complements $\bar{X}$ and $\bar{Y}$ are not available, then the minimum number of two input NAND gate required to implement $X \oplus Y$ is __________

A. 7 B. 5

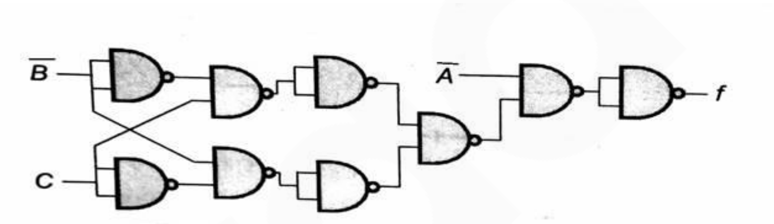
C. 4 D. 3

Ans. C

Sol.



15. Find the simplified Boolean expression for the output f?

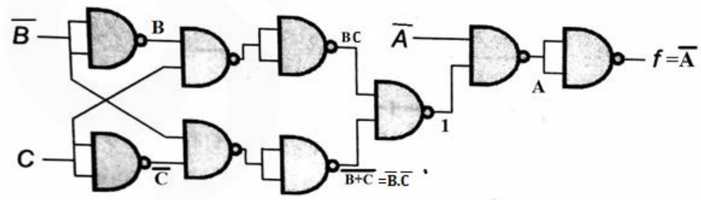


A. $\bar{A}$ B. A

C. 0 D. 1

Ans. A

Sol.



16. The numbers of 4 line to 16 line decoders with enable input required to make an 8 line to 256 line decoder is _____

A. 12 B. 17

C. 21 D. 16

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Ans. B

Sol.

$$\frac{256}{16}+\frac{16}{16}=16+1=17$$

∴ Number of 4 × 16 decoder to make 8 × 256 decode is 17.

17. 24 MHz clock frequency is applied to a cascaded counter of MOD-3, MOD-4 and MOD-5 counters. The lowest output frequency and the overall MOD value of the cascaded counter are

A. 600 KHz, 60

B. 400 KHz, 60

C. 400 KHz, 160

D. 600 KHz, 120

Ans. B

Sol. Overall MOD = 3 × 4 × 5 = 60

Lowest frequency is output frequency

$$f_{out}=\frac{24\times10^6}{60}=400\text{ KHz}$$

18. If $(211)_x = (152)_8$ then the value of x is___

A. 16

B. 2

C. 9

D. 7

Ans. D

Sol. Converting to decimal equivalent

$(211)_x = (2x^2 + x + 1)_{10}$

$(152)_8 = (64 + 40 + 2)_{10} = (106)_{10}$

$2x^2 + x + 1 = 106$

$2x^2 + x - 105 = 0$

$\boxed{x = 7}$

19. The resolution of a 10-bit analog to digital convertor is _________%.

A. 0.071

B. 0.012

C. 0.121

D. 0.097

Ans. D

Sol. % Resolution $=\frac{100}{2^n-1}=\frac{100}{2^{10}-1}=\frac{100}{1023}=0.097\%$

20. An FM signal with a deviation δ is passed through a mixer and has its frequency reduced fivefold. The deviation in the output of the mixer is

A. 5δ

B. intermediate

C. $\frac{\delta}{5}$

D. δ

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Ans. D

Sol. Given the deviation of FM signal $\Delta f = \delta$

As the mixer modifies the carrier frequency of FM signal only, so the deviation remain unchanged. Therefore, the frequency deviation at the output of mixer will be $\Delta f = \delta$.

21. The differential entropy $H(X)$ of the uniformly distributed random variable X with probability density function $f_X(x) = \begin{cases} \frac{1}{M} & 0 \le x \le M \\ 0 & \text{otherwise} \end{cases}$

A. $\log_2 M$
B. $\log_2 1/M$
C. $M \log_2 M$
D. $1/M \log_2 M$

Ans. A

Sol.

$$H(X) = -\int_{-\infty}^{\infty} f_X(x).\log_2 f_x(x)dx$$

$$= -\int_0^M \frac{1}{M}\log_2 \frac{1}{M}dx$$

$$= \log_2 M$$

22. The message signal m(t) = $\text{sinc}^2(1000t)$ AM modulates a sinusoidal carrier signal. The minimum channel bandwidth required to transmit the modulated signal will be

A. 0.5 kHz
B. 1 kHz
C. 2 kHz
D. 4 kHz

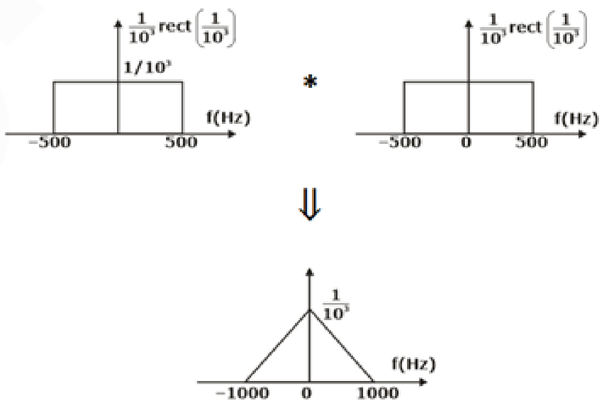
Ans. C

Sol.

$$\sin C(t) \xleftrightarrow{\text{CTFT}} \text{rect}(t)$$

$$\sin C(100t) \xleftrightarrow{\text{CTFT}} \frac{1}{10^3}\text{rect}\left(\frac{1}{10^3}\right)$$

$$\sin C^2(1000t) \xleftrightarrow{\text{CTFT}} \left[\frac{1}{10^3}\text{rect}\left(\frac{1}{10^3}\right)\right] \times \left[\frac{1}{10^3}\text{rect}\left(\frac{1}{10^3}\right)\right]$$



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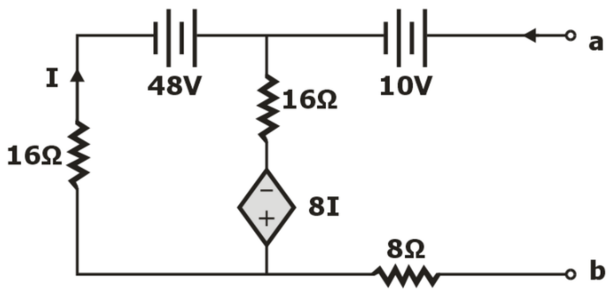
So, $f_{m(max)}$ = 100 Hz = 1 kHz

For an AM modulated signal, minimum channel BW required is,

$(BW)_{min} = 2f_{w(max)}$ = 2 kHz

23. Find the Thevenin's equivalent voltage or open-circuited voltage across the terminal a-b. [Take reference 'a' terminal at positive terminal]



A. 25 V

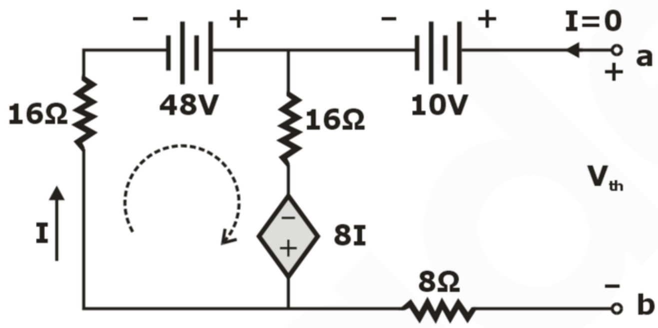
B. 26 V

C. 32 V

D. 48 V

Ans. B

Sol. For V_{th}:

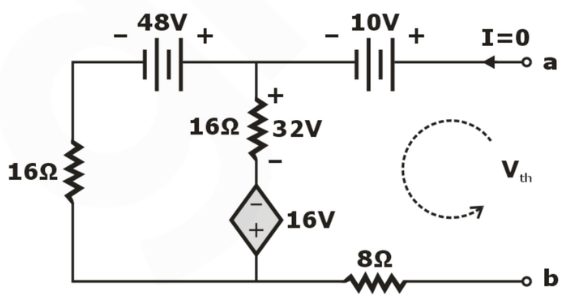


Applying KVL in the loop

48 − 16I + 8I − 16I = 0

24I = 48

I = 2A



V_{Th} − 10 − 32 + 16 = 0

V_{Th} = 42 − 16

V_{Th} = 26 volts

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24. Let X be a zero-mean unit variance Gaussian random variable. $E[|X|]$ is equal to ______

A. 0.8 B. 1.34

C. 5 D. 6

Ans. A

Sol.

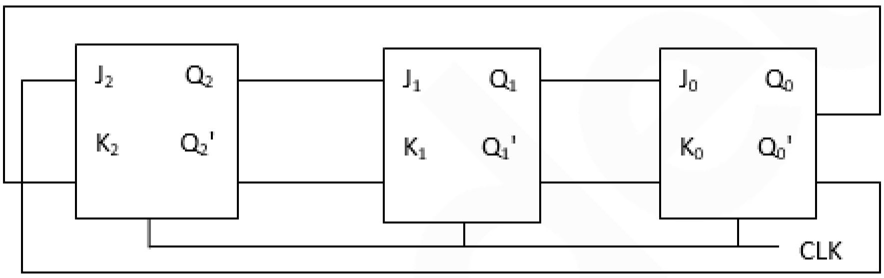
$$X \sim N(0,1) \Rightarrow f(X) = \frac{1}{\sqrt{2\pi}} e^{-x^2/2}, -\infty < X < \infty$$

$$\therefore E\{|X|\} = \int_{-\infty}^{\infty} |X| f(X)\, dx$$

$$= \frac{1}{\sqrt{2\pi}} X^2 \int_0^{\infty} X e^{-x^2/2}\, dx$$

$$= \frac{2}{\sqrt{2\pi}} \int_0^{\infty} e^{-u}\, du = \sqrt{\frac{2}{\pi}} = 0.797 \simeq 0.8$$

25. The three-stage Johnson counter is clocked at a constant frequency of f from the starting state of $Q_2Q_1Q_0$ = 101. What will be the frequency of the output $Q_2Q_1Q_0$?



A. 2f B. f

C. f/4 D. f/2

Ans. D

Sol.

$J_2 K_2$	$J_1 K_1$	$J_0 K_0$	$Q_2 Q_1 Q_0$
			1 0 1
0 1	1 0	0 1	0 1 0
1 0	0 1	1 0	1 0 1
0 1	1 0	0 1	0 1 0
1 0	0 1	1 0	1 0 1

Since the output $Q_2Q_1Q_0$ = 101 repeats every two cycles, the frequency is f/2

26. Consider an angle modulated signal x(t) = 10 cos ($\omega_c t$ + 3 sin$\omega_m t$) assume it PM signal and f_m=1KHz .Calculate modulation index and bandwidth if f_m is decreased by one -half.

A. 3,4kHz B. 1.5,16kHz

C. 3,16kHz D. 1.5,8kHz

Ans. A

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Sol. $x(t) = 10 \cos(\omega_c t + 3 \sin \omega_m t)$

and $\beta = k_p A_m$

$\beta = 3$, $f_m = 1KHz$

Modulation index = 3

Band width = $2(1 + \beta) f_m = 2(1 + 3) 1k$

If f_m is decreased by ½ $\Rightarrow f_m = ½$ KHz

$\beta = 3$ Bw = 2(1 + 3) ½ = 4

27. Five symbols are encoded into binary format using 4 different source coding schemes. From the table shown below find out most efficient coding?

Symbol (xi)	Probability P(xi)	Coding scheme 1	Coding scheme 2	Coding scheme 2	Coding scheme 3
X_0	$\frac{1}{2}$	1	1111	00	111
X_1	$\frac{1}{4}$	10	1110	01	11
X_2	$\frac{1}{4}$	110	110	10	10
X_3	$\frac{1}{8}$	1110	10	11	01
X_4	$\frac{1}{16}$	1111	1	111	00

A. coding scheme 1

B. coding scheme 2

C. coding scheme 3

D. coding scheme 4

Ans. C

Sol. $\text{coding efficiency} = \eta = \frac{H}{L}$

But in each case H is same as it only depends upon probability so efficiency will be maximum when L is minimum

(i) For coding scheme 1

$L = \Sigma P(xi) L_i$

$$= \frac{1}{2} \times 1 + \frac{1}{4} \times 2 + \frac{1}{4} \times 3 + \frac{1}{2} \times 4 + \frac{1}{16} \times 4$$

L = 2.5

(ii) For coding scheme 2

$L = \Sigma P(xi) Li$

$$= \frac{1}{2} \times 4 + \frac{1}{4} \times 4 + \frac{1}{4} \times 3 + \frac{1}{8} \times 2 + \frac{1}{16} \times 1$$

L = 4.0625

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(iii) For coding scheme 3

$L = \Sigma\, P(xi)\, Li$

$$= \frac{1}{2}\times 2 + \frac{1}{4}\times 2 + \frac{1}{4}\times 2 + \frac{1}{8}\times 2 + \frac{1}{16}\times 3$$

$L = 2.4375$

(iv) For coding scheme 4

$L = \Sigma\, P(xi)\, Li$

$$= \frac{1}{2}\times 3 + \frac{1}{4}\times 2 + \frac{1}{4}\times 2 + \frac{1}{8}\times 2 + \frac{1}{16}\times 2$$

$L = 2.875$

∴ L is minimum for coding scheme 3

28. A signal m(t) is band limited to ω_m . It is frequency translated by multiplying it by signal $\cos\omega_c t$. Find ω_c so that the bandwidth of transmitted signal is 1 percent of the carrier frequency ω_C.

A. $\omega_c = 100\ \omega_m$

B. $\omega_c = 200\ \omega_m$

C. $\omega_c = 400\ \omega_m$

D. $\omega_c = 50\ \omega_m$

Ans. B

Sol.

$\Rightarrow m(t)\cos 2\pi f_c t \Rightarrow m(t)\cos\omega_c t \Rightarrow$

↳ DSB – SC

Band width = $2\ \omega_m = 1/100\ \omega_c$

Therefore, $\omega_c = 200\ \omega_m$

29. A random variable X is uniformly distributed in the range [−1, 2]. Another random variable y is related to x as,

y = 2x + 3. The probability $P(y \le 3)$ is equal to ________.

A. 0.33

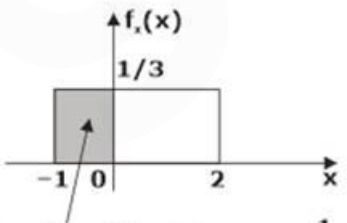
B. 0.50

C. 0.2

D. 1

Ans. A

Sol. $P(y \le 3) = P(2x + 3 \le 3) = P(2x \le 0) = P(x \le 0)$



$P(x \le 0)$ = Shaded area $= \frac{1}{3}$

$P(y \le 3) = P(x \le 0) = \frac{1}{3} = 0.33$

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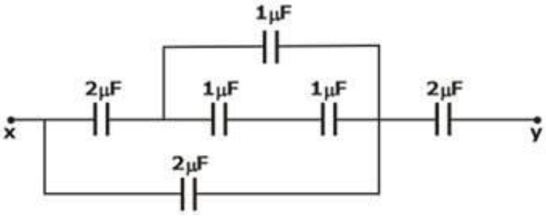
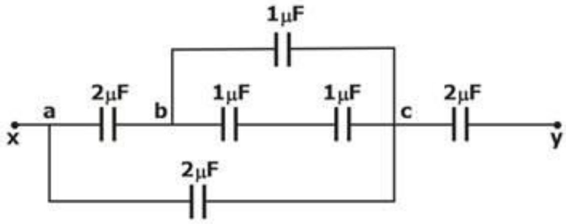
30. The equivalent capacitance seen across the terminals x and y if the circuit shown below is ___μF.



A. 1.176
B. 2.176
C. 0.766
D. 4.886

Ans. A

Sol. By redrawing the circuits



The equivalent capacitance seen across the terminals 'b' and 'c' is

$$C_{bc} = \frac{1 \times 1}{1 + 1}\mu F + 1\mu F = 1.5\mu F$$

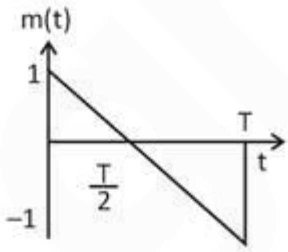
Similarly, the equivalent capacitance seen across the terminals 'a' and 'c' are

$$C_{ac} = \frac{2 \times 1.5}{1 + 1.5}\mu F + 2\mu F = 2.857\mu F$$

∴ The total capacitance between the terminals x and y is

C_{xy} = (2857||2)μF = 1.176 μF

31. A message signal periodic with T applied to an AM modulator with modulation index 0.5. The modulation efficiency will be___________(in %)



A. 5.1
B. 7.7
C. 6.1
D. 15.4

Ans. B

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Sol.

$$100 \times \frac{ka^2 P_m}{1 + k_a^2 P_m} = \eta(\%)$$

P_m= power of message signal $= \frac{v^2 m}{3}$

$$\eta = \frac{k_a^2 \left(\frac{v_m{}^2}{3}\right)}{1 + k_a^2 \left(\frac{v_m{}^2}{3}\right)} \times 100$$

$\mu = k_a v_m$

hence $v_m = 1$, $\mu = k_a$

$$\eta = \frac{\mu^2/3 \times 100}{1 + \mu^2/3} = \frac{(0.5)2/3 \times 100}{1 + (0.5)^2/3)} = 7.7\%$$

32. The greater the propagation delay, the

A. Lower the maximum frequency

B. Higher the maximum frequency

C. Maximum frequency is unaffected

D. Minimum frequency is unaffected

Ans. A

Sol. The frequency is given by

$$f = \frac{1}{t_{pd}}$$

Where t_{pd} – propagation delay.

33. In super heterodyne receiver, IF is 455kHz. If it is tuned to 1000kHz, then find the image frequency and rejection ratio if quality factor of receiver is 100.

A. 1810kHz and 42.8dB

B. 1910kHz and 138.6dB

C. 1910kHz and 42.8dB

D. 1810kHz and 43.8dB

Ans. C

Sol. given, Q=100, IF=455kHz, f_s=1000kHz

image frequency $=f_s+2IF=1000+2(455)=1910kHz$

$$\rho = \frac{f_{si}}{f_s} - \frac{f_s}{f_{si}} = \frac{1910}{1000} - \frac{1000}{1910} = 1.386$$

$$rejectionratio = \alpha = \sqrt{1 + Q^2 \rho^2}$$

$$= \sqrt{1 + 100^2 (1.386)^2} = 138.6$$

$$= 20log(\alpha)$$

$$= 42.8dB$$

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34. Which one of the following relations holds true for an irrotational field $\bar{B}$?

A. $\nabla \times \bar{B} \neq 0$

B. $\nabla \times \bar{B} = 0$

C. $\oint_s (\nabla \times \bar{B}).\overline{ds} = 0$

D. $\int_L \bar{B}.\overline{dl} = 0$

Ans. B

Sol. For an irrotational field

$\nabla \times \bar{B} = 0$

35. Consider a random process x(t) and its derivative $x'(t) = \frac{d}{dt}x(t)$. Assume that the derivatives are well defined. The cross correlation function $R_{xx}(t_1, t_2)$ is

A. $\frac{\partial}{\partial t_1} R_x(t_1, t_2)$

B. $\frac{\partial}{\partial t_2} R_x(t_1, t_2)$

C. $\frac{\partial}{\partial t_2}\left[\frac{\partial}{\partial t_1} R_x(t_1, t_2)\right]$

D. $\frac{\partial}{\partial t_1}\left[\frac{\partial}{\partial t_2} R_x(t_1, t_2)\right]$

Ans. B

Sol.

$$x'(t) = \frac{d}{dt}x(t)$$

Cross correlation is given by

$$R_{xx}(t_1, t_2) = E[x(t_1)\times(t_2)]$$

$$= E\left[x(t_1)\frac{d}{dt}\times(t_2)\right]$$

$$= E\left[\frac{\partial}{\partial t_2}\times(t_1)\times(t_2)\right]$$

$$= \frac{\partial}{\partial t_2}E[x(t_1)\times(t_2)]$$

$$R_{xx}(t_1, t_2) = \frac{\partial}{\partial t_2} R_x(t_1, t_2)$$

36. Energy of signal n u[n] is

A. $\frac{1}{2}n(n+1)$

B. $\frac{1}{6}n(n+1)(2n+1)$

C. $\left(\frac{1}{2}n(n+1)\right)^2$

D. ∞

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Ans. D

Sol. $E = \sum_{-\infty}^{\infty} |nu[n]|^2 = \sum_{0}^{\infty} n^2 = \infty$

37. A spectrum of (1000 – 1650) kHz is assigned for DSB – SC AM transmission. The spectrum is shared for different users using frequency division multiplexing and quadrature carrier multiplexing and quadrature carrier multiplexing. If each user has a message BW of 5 kHz, then the maximum number of users that can simultaneously use the spectrum will be

A. 65
B. 130
C. 260
D. 650

Ans. B

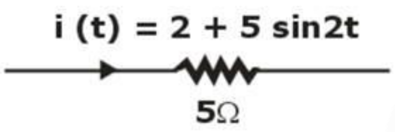
Sol. BW required for each user = 2 × 5 = 10 kHz

Number of 10 kHz bands possible $= \frac{1650 - 1000}{10} = 65$

We can send two different signals through a single channel of 10 kHz using quadrature carrier multiplexing. So, maximum number of simultaneous users possible = 65 × 2 = 130

38. Consider in fig. below, determine the power dissipate in 5 Ω resistor.

i(t) = 2 + 5 sin2t



A. 145Watt
B. 82.5 Watt
C. 72.5 Watt
D. 50 Watt

Ans. B

Sol.

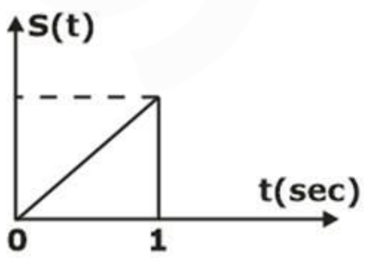
$$I_{rms} = \sqrt{2^2 + \frac{5^2}{2}}$$

= 4.06 Amp

$P = I^2_{rms}R$

= 82.5 Watt

39. Consider the signal S(t) shown in the figure below.



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This signal is applied to its matched filter after contaminated with an AWGN noise. If the two sided PSD of the noise is $\frac{N_0}{2}$, then the maximum signal to noise ratio possible at the output of the filter will be?

A. $\frac{3}{N_0}$

B. $\frac{6}{N_0}$

C. $\frac{9}{N_0}$

D. $\frac{12}{N_0}$

Ans. B

Sol. Maximum SNR possible at the output of a matched filter is

$$(SNR)_{max} = \frac{2E_S}{N_0}$$

E_S = Energy of the signal S(t)

$$F_S = \int_{-\infty}^{\infty} |S(t)|^2 \, dt = \int_0^1 (3t)^2 dt = \left[\frac{9t^3}{3}\right]_0^1 = 3$$

So, $(SNR)_{max} = \frac{6}{N_0}$

40. A two-port network has parameters *ABCD*. If all the impedances in the network are doubled, then

A. *A* and *D* remain unchanged *B* is doubled and *C* is halved

B. *A, B, C* and *D* are all doubled

C. *A* and *D* are doubled, *C* and *B* remain unchanged

D. *A* and *D* remain unchanged, *C* is doubled and *B* is halved

Ans. A

Sol. $V_1 = AV_2 - BI_2$

$I_1 = CV_2 - DI_2$

Impedances are $B = \frac{V_1}{I_2}$

and *C* = admittance $= \frac{V_1}{I_2}$

So, when impedance is doubled, B is doubled and *C* gets halved and all other parameters remain same.

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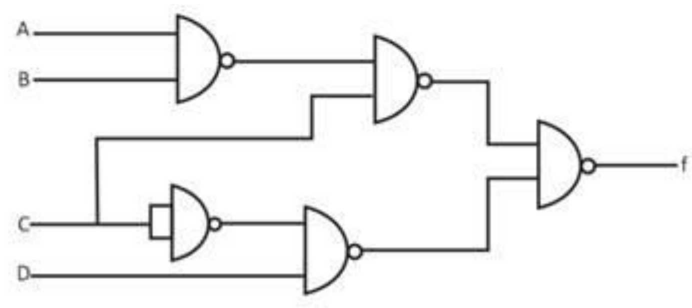
41. Consider the circuit shown in the figure below:



The output 'f' of the logic circuit represents as

A. $f=\overline{\overline{\overline{A}\,\overline{B}\,\overline{C}}+\overline{D}\,\overline{C}}$

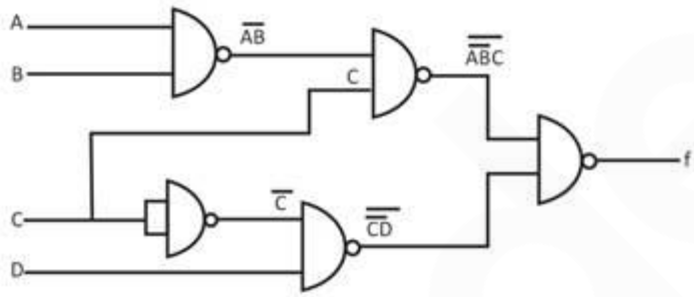
B. $f=(\overline{A}+\overline{B})\cdot C+\overline{C}D$

C. $f=\overline{(A+\overline{B})+\overline{C}}+C\overline{D}$

D. $f=(A+\overline{B})+\overline{C}+C\overline{D}$

Ans. B

Sol. The output logic function of the given circuit is minimised as



$$f=\overline{\left(\overline{\overline{AB}\cdot C}\right)\cdot\left(\overline{\overline{C}D}\right)}$$

$$f=(\overline{AB}\cdot C)+\overline{C}D$$

$$f=(\overline{A}+\overline{B})\cdot C+\overline{C}D$$

42. The instantaneous frequency of the signal S(t) = cos(200πt + πt^2) can be expressed as

A. $\left(200+\frac{t^2}{2}\right)$Hz

B. $\left(100+\frac{t^2}{2}\right)$Hz

C. $\left(100+\frac{t}{2}\right)$Hz

D. $(100+t)$Hz

Ans. D

Sol. S(t) = cos(200πt + πt^2)

θ(t) = 200πt + πt^2

instantaneous frequency,

$$f_i=\frac{1}{2\pi}\frac{d\theta(t)}{dt}=\frac{1}{2\pi}[200\pi+2\pi t]$$

= (100 + t) Hz

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43. The no of chips required to make up 128 K – bytes memory, if the available memory chip size is
2048 × 16
A. 16
B. 32
C. 4
D. 8

Ans. B

Sol. The no. of chips required = $\frac{\text{required chip size}}{\text{Available chip size}}$

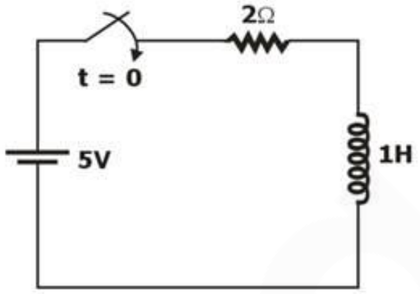
$= \frac{128 \times 1024 \times 8}{2048 \times 16} = 32$

44. The superposition theorem applies to
A. Current/voltage calculations
B. Power calculations
C. Current and power calculations
D. Voltage and power calculations

Ans. A

Sol. Since superposition theorem is based on linearity, it is not applicable to the effect on power $(= I^2R)$ due to each source. Note that power is a nonlinear mathematical operation. Therefore, it is applicable to current/voltage calculations.

45. Find $i(0^+)$ and $i(\infty)$ in the given circuit.



A. Zero, Zero
B. Zero, 2.5 Amp
C. 1 A, 1.66 Amp
D. Zero, 5 Amp

Ans. B

Sol. The given circuit is the series connection of R and L.
At $t= 0^-$, the switch is open so no current will flow through L.
$i(0^-)= i(0^+)=0$ amp
Inductor behave as short circuit at $t= \infty$

$$i(\infty) = \frac{V}{R} = \frac{5}{2} = 2.5\ Amp$$

46. For a bit rate of 8 kbps best possible values of the transmitted frequencies in a coherent binary FSK system are
A. 16 kHz and 20 kHz
B. 20 kHz and 32 kHz
C. 20 kHz and 40 kHz
D. 32 kHz and 40 kHz

Ans. D

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Sol. $R_b = 8$ kbps

$\frac{1}{T_b} = 8$

$\therefore$ f_1 & f_2 should be multiple of 8

bcz in FSK, $f_1 = n_1 \frac{1}{T_b}$

$f_2 = n_2 \frac{1}{T_b}$

n_1 & n_2 are integers.

47. The capacity of a Binary Symmetric Channel (BSC) with cross-over probability 0.5 is ________

A. 1
B. 0
C. 1.5
D. 2

Ans. B

Sol. Channel capacity of BSC is as

$C = P\log_2 P+(1-P)\log_2(1-P)+1 = 0.5\log_2 0.5+0.5 \log_2 0.5+1 = 0$

(since $\log_2 0.5 = 1$)

It is the case of channel with independent input and output.

Hence Capacity = 0

Hence option B is correct

48. Express switching function f(ABC)= B'+C' in terms of min term.

A. $f=\sum(1,0,3,4,5,6)$
B. $f=\sum(0,1,2,4,7,6)$
C. $f=\sum(0,1,2,4,5,6)$
D. $f=\sum(2,4,3,5,6,7)$

Ans. C

Sol. f(ABC)= B'+C'

Write the missing terms

=(A+A') (C+C') B'+(A'+A) (B+B') C'

=(AC+AC'+A'C+A'C') B'+(A'B+A'B'+AB+AB') C'

=ACB'+AC'B'+A'CB'+A'C'B'+A'BC'+A'B'C'+ABC'+AB'C'

= ACB'+AC'B'+A'CB'+A'C'B'+A'BC'+A'B'C'+ABC'

$f=\sum(0,1,2,4,5,6)$

49. A data with a rate of 500 KbPS is to be transmitted using BPSK modulation. If the baseband modelling of the data is done by a raised cosine filter with a roll-off factor of 0.50, then the minimum channel bandwidth required to transmit the BPSK modulated signal will be _____ kHz.

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A. 650 kHz
B. 650 kHz
C. 750 kHz
D. 700 kHz

Ans. C

Sol. BW of the baseband modelled data will be

$$(BW)_{Baseband} = \frac{R_b}{2}(1 + \alpha)$$

BW of the BPSK signal will be

$(BW)_{BPSK} = 2(BW)_{Baseband} = R_b(1 + \alpha)$

Given that, R_b = 500 KbPS and α = 0.50

$(BW)_{BPSK} = 500(1 + 0.50) = 750$ kHz

50. A linear phase FIR system with real impulse has a real zero at $z_o = \frac{1}{2}e^{j\pi/4}$. what are other possible zeros of FIR filter.

A. $\frac{1}{2}e^{\frac{-j\pi}{4}}, 2e^{\frac{-j\pi}{4}}, 2e^{\frac{j\pi}{4}}$
B. $\frac{1}{2}, \frac{1}{2}e^{\frac{-j\pi}{4}}, 2$
C. $\frac{1}{2}, \frac{-1}{2}, \frac{1}{2}$
D. $e^{j\pi/4}, e^{-j\pi/4}, \frac{1}{2}$

Ans. A

Sol. $|Z_o| = \frac{1}{2}$, $Z_o = \frac{e^{j\pi/4}}{2}$, $Z_o^* = \frac{1}{2}e^{-j\pi/4}$

$$Z_o^{-1} = \frac{2}{e^{j\pi/4}} = 2e^{-j\pi/4},$$

$$(Z_o^*)^{-1} = 2e^{j\pi/4}$$

51. Which of the following theorem is applicable for both linear and non-linear circuits?

A. Superposition theorem
B. Thevenin's theorem
C. Norton's theorem
D. None of these

Ans. D

Sol. Tellegen's theorem is valid for any linear or non linear circuit as it is on the basis of principles of conservation of energy and till basic laws i.e. KCL and KVL are valid

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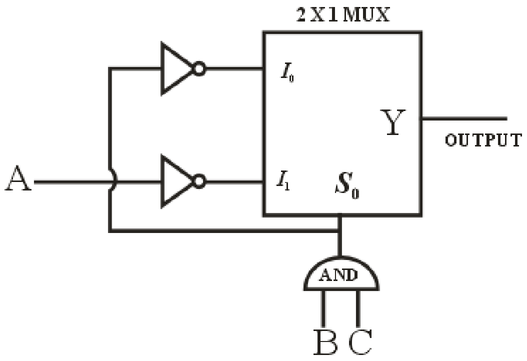
52. The combinational circuit given below implements which of the following



A. NOR gate

B. XOR gate

C. NAND gate

D. None of these

Ans. C

Sol. $Y = \overline{S_0}.I_0 + S_0 I_1$

$= \overline{BC}\ \overline{BC} + \overline{A}\ B\ C$

$= (\overline{B}+\overline{C}) + \overline{A}\ B\ C$

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

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

$= \overline{ABC} \equiv$ NAND gate

53. A lossy material has $\mu = 5\mu_o, \varepsilon = 2\varepsilon_o$.The phase constant is 10 rad/m at 5Mhz

The loss tangent is

A. 2913

B. 1823

C. 2468

D. 1374

Ans. B

Sol. Loss tangent $= \frac{\sigma}{\omega\varepsilon} = x$

Phase constant $\beta = 10 = \omega\sqrt{\frac{\mu\varepsilon}{2}\sqrt{1+\left(\frac{\sigma}{\omega\varepsilon}\right)^2}+1}$

$10 = \frac{2\pi\times5\times10^6}{3\times10^8}\sqrt{\frac{5\times2}{2}\sqrt{1+x^2}+1}$

$x = \frac{\sigma}{\omega\varepsilon} = 1823$

54. Four voice signals, Each limited to 4 KHz and sampled at Nyquist Rate are converted into binary PCM signal using 256 quantized levels. The bit transmission Rate for the time-division multiplexed signal will be

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A. 8 Kbps
B. 64 Kbps
C. 256 Kbps
D. 512 Kbps

Ans. C

Sol. Nyquist Rate = 2 f_{max}

= 2 × 4K = 8 KHz

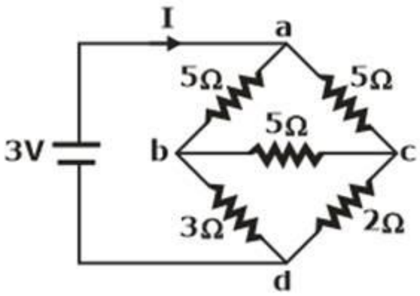
Total samples = 4 × 8 = 32 K sample/sec.

256 = 2^8, so 8 bit are required

Bit rate = nf_s

=32 K × 8 = 256 Kbps

55. Consider the circuit shown in the figure below:



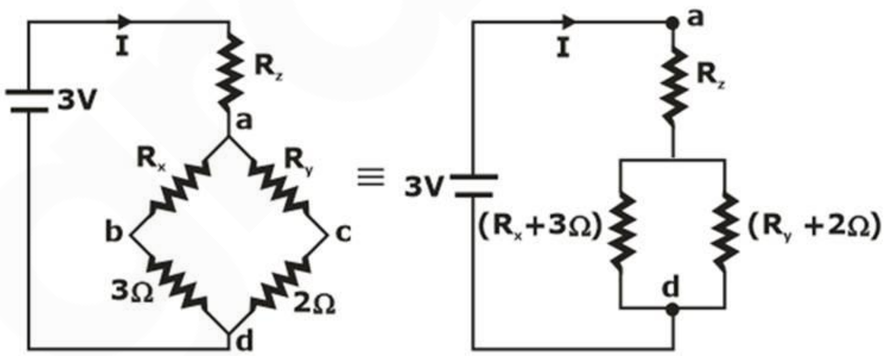
The value of the source current I is _________

A. 0 A
B. 0.54 A
C. 0.80 A
D. 1.6 A

Ans. C

Sol. Let us convert Δ abc to Y xyz

Where, R_x, R_y, R_z are the component resistors



R_{ad} = [(R_x + 3) || (R_y + 2Ω)] + R_z

where,

$$R_x = R_y = R_z = \frac{5}{3} = 1.667\Omega$$

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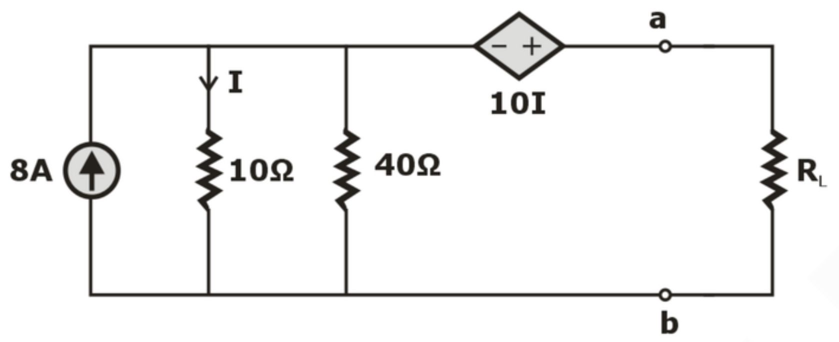
$R_{ad} = [(1.667+3)\,||\,(1.667+2)] + 1.667 = 3.721\Omega$

Source current,

$$I = \frac{3}{3.721} = 0.808\ A$$

56. In the circuit shown in figure below, what is the value of R_L such that maximum power is transferred to the load?



A. 20 Ω

B. 18 Ω

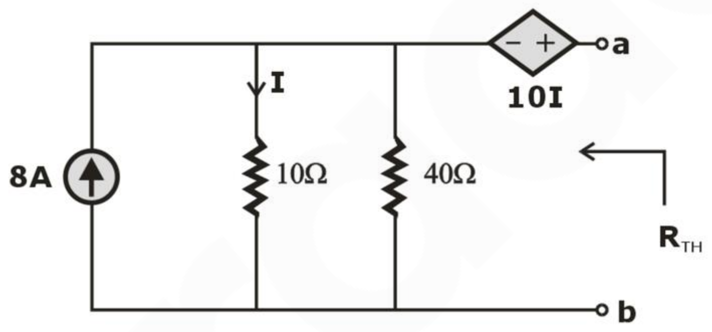
C. 25 Ω

D. 16 Ω

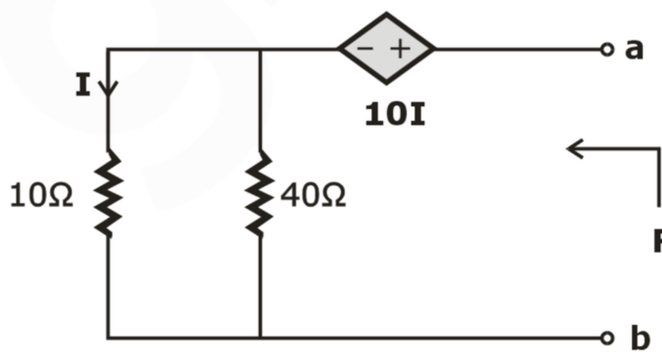
Ans. D

Sol. For maximum power to be transferred to the load,

$R_L = R_{Th}$



For calculating R_{Th}, independent sources are replaced by their internal resistance. Therefore, the circuit reduces to



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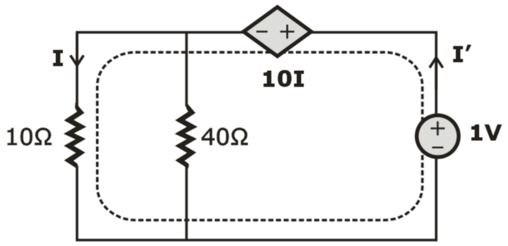
Connect the 1 V source across the a-b terminals,



$R_{Th} = V/I' = 1/I'$

Applying KVL in the loop.

1 – 10I – 10I = 0

1 – 20I = 0

I = 1/20 = 0.05 A

Voltage across 10 Ω resistor = 10I = 0.5 V.

Current through 40 Ω resistor = 0.5/40 = 0.0125 Amp.

I′ = current through 10 Ω resistor + current through 40 Ω resistor

I′ = 0.05 + 0.0125

I′ = 0.0625 Amp

$R_{Th} = 1/0.0625 = 16\ \Omega$

$R_{Th} = 16\ \Omega$

57. The physical length of a transmission line is λ/4, then what is its electrical length?

A. π/2 B. π

C. 3π/2 D. 2π

Ans. A

Sol. If 'l' is the physical length, then 'βl' is the electrical length.

We know that β = 2π/λ → βl = π/2.

58. For a message signal m(t) with modulation index 60% and frequency 100 kHz, the maximum envelope time will be.

A. 10.3ms B. 13.3ms

C. 33.3ms D. 10ms

Ans. B

Sol. $$envelopetime = \frac{\sqrt{1-\mu^2}}{\mu\omega_m}$$

given μ = 0.6

$\omega_m = 100$

$$t = \frac{\sqrt{1-(0.6)^2}}{(0.6)(100)}$$

t = 13.3 ms

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59. 111100,11100,1100 are represented in corresponding signed 2's complement then find its decimal equivalent.

A. -3,-3,-3 B. -35,-23.-12

C. -4,-4,-4 D. -12,-12,-12

Ans. C

Sol. 1100 2's complement number is 0011 +1 =0100 = -4

11100 2's complement number is 00011 +1 =00100 = -4

111100 2's complement number is 000011 +1 =000100 = -4

60. An analog signal having 4kHz bandwidth is sampled at 1.25 times the Nyquist rate and each sample is quantized into 256 equally likely levels. Find the minimum bandwidth required for error free transmission if S/N is 20 dB.

A. 10kHz B. 12kHz

C. 14kHz D. 8kHz

Ans. B

Sol. $f_m = 4 \times 10^3$, S/N = 20dB = 10^2

Nyquist rate = 2fm = 8×10^3 samples/s

r = $8 \times 10^3 \times 1.25 = 10^4$ samples/s

H(x) = $\log_2 256$ = 8bits/samples

R = information rate = rH(x) = $10^4 \times 8$ bits/s.

$$C = B\ log_2(1+100) \geq 8 \times 10^4$$

$$B \geq \frac{8 \times 10^4}{log_2^{101}} = 1.2 \times 10^4 = 12KHz$$

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Upcoming Mini Mock Challenge in June Month

NIELIT Scientist 'B'/Technical Assistant 'A'

Electronics & Communication Engineering

Exam	Live Date	Syllabus	No. of Questions	Time
NIELIT Scientist 'B'/ Technical Assistant 'A'	06 June 2020	Full Syllabus (Tech. (30 Q's) & Non-Tech. (15 Q's))	50	60
NIELIT Scientist 'B'/ Technical Assistant 'A'	13 June 2020	Full Syllabus (Tech. (30 Q's) & Non-Tech. (15 Q's))	50	60
NIELIT Scientist 'B'/ Technical Assistant 'A'	20 June 2020	Full Syllabus (Tech. (30 Q's) & Non-Tech. (15 Q's))	50	60
NIELIT Scientist 'B'/ Technical Assistant 'A'	27 June 2020	Full Syllabus (Tech. (30 Q's) & Non-Tech. (15 Q's))	50	60

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