gradeup

GATE 2020

Electronics & Communication Engineering

Mega Mock Challenge
(02 Jan-03 Jan 2020)

Questions & Solutions

Prep Smart. Score Better. Go gradeup

www.gradeup.co

1. **Direction:** In the given question, four words are given of which two are most nearly the same or opposite in meaning. Find the two words and indicate your answer by marking the option which represents the correct combination.

A) Diligent B) Adorable
C) Meticulous D) Prominent

A. B-D B. A-C
C. A-B D. A-D

Ans. B

Sol. The meanings of the words are:
Diligent: having or showing care and conscientiousness in one's work or duties.
Adorable: inspiring great affection or delight.
Meticulous: showing great attention to detail; very careful and precise.
Prominent: important; famous.
Hence, **option B** is the correct answer.

2. **Direction:** A statement with one blank is given below. Choose the set of words from the given options which can be used to fill the given blank.
Despite almost ubiquitous scepticism, the electoral bonds have prevailed and, that too, almost solely ________ rhetorical claims of "transparency of political funding system," "clean money," and "donor's anonymity."
i. with the backing of the ruling government's
ii. based on the endorsement derived from the political party at power's
iii. backed by the political party at power's

A. Only i B. Only ii
C. Only iii D. Both i and ii

Ans. D

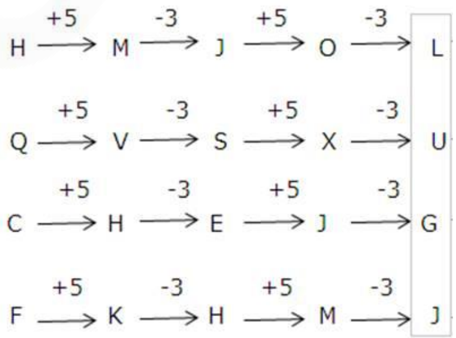
Sol. The given sentence talks about the prevailing nature of 'electoral bonds' in spite of concerns and doubts regarding the same. The sentence goes on to explain that this is occurring because of rhetorical claims by someone. From the options it is clear that the ruling part is responsible for these 'rhetorical claims'.
Option i – 'backing' means help or support and has been used in conjunction with the correct tense format of the sentence.
Option ii – 'endorsement' also means help or support and it tallies with the sentence structure.
Option iii – although 'backed' has been used it is in the incorrect tense form. This makes it incorrect.
Thus, option D is the correct answer.

3. Which letter—cluster will replace the question mark (?) in the following series?
HQCF, MVHK, JSEH, OXLM, ?

A. FTRD B. LUGJ
C. MKOP D. SWQ

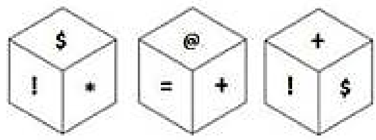
Ans. B

Sol. Pattern is-



Hence, the correct answer is option B.

4. Three different positions of the same dice are shown. Which symbol will be on the face opposite to the one having '*'?



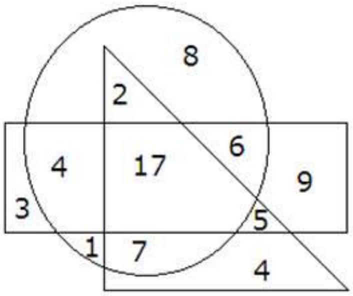
A. + B. !
C. $ D. @

Ans. A

Sol. Pick out the dices in which one symbol is common , after that arrange them in ACW or CW direction.

In II and III '+' is common
+ = @
* + ! $
Interchange the missing symbol '*' with repeated symbol '+'
Hence, option (A) is the correct answer.

5. In the following diagram, the triangle represents 'Dentists', the circle represents 'Professors' and the rectangle represents 'Doctors'. The numbers in different segments show the number of persons.

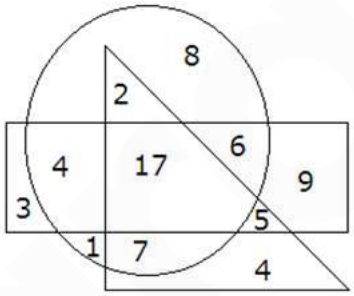


How many professors are dentists but not doctors?

A. 17 B. 9
C. 15 D. 13

Ans. B

Sol. Given diagram is-



circle represents Professors
rectangle represents Doctors
triangle represents Dentists
No. of professors who are dentists but not doctors=2+7=9
Hence, the correct answer is option B.

6. In the following question, some statements followed by some conclusions are given. Taking the given statements to be true even if they seem to be at variance from commonly known facts, read all the conclusions and then decide which of the given conclusions logically follows the given statements.

Statement:
Parents must understand that their child cannot attain excellence on his own. He needs their support. They must thus be open to help him at various steps rather than merely setting high expectations.

Conclusion:
I. Ideal students are not born ideal or perfect. They are nurtured to become ideal by their educators. The environment at home has a great impact on the way a student performs in school.
II. The life of an ideal student may seem tough from a distance. However, it is actually much more sorted as compared to those who procrastinate and do not give complete attention to their studies.

A. If only conclusion I follows
B. If only conclusion II follows
C. If both I and II conclusion follow
D. If neither I nor II conclusion follows

Ans. A

Sol. Conclusion I follows, based on the given statement a major component in the making of an Ideal student is described that it takes efforts not only from the students but also from the educators(Teachers and Parents)
Conclusion II is a correct statement that is the hard work and struggle that it takes to become an ideal student but it cannot be the conclusion of the given statement.

7. **Direction:** Each question below is followed by two statements I and II. You have to determine whether the data given in the statement is sufficient for answering the question. You should use the data and your knowledge of Mathematics to choose the best possible answer.

A man deposited Rs. 'x' in bank which gives simple interest at the rate of 8% p.a. Find the value of 'x'.

Statement I: After 3 years, amount received by him is Rs. (x + 672).

Statement II: Interest earned by him after 3 years is 24% of the amount deposited by him.

A. If the data in Statement I alone are sufficient to answer the question, while the data in Statement II alone are not sufficient to answer the question.

B. If the data in Statement II alone are sufficient to answer the question, while the data in Statement I alone are not sufficient to answer the question.

C. If the data either in Statement I or in Statement II alone are sufficient to answer the question.

D. If the data in both Statements I and II together are necessary to answer the question.

Ans. A

Sol. Statement I:

Simple interest earned by him

$= x + 672 - x = Rs. 672$

So, $672 = \frac{x \times 8 \times 3}{100}$

$x = Rs. 2800$

So, statement I alone is sufficient to answer the question.

Statement II:

We have to calculate principal(x) but we are not given interest since it is also in form of x. Hence, there are 2 unknowns.

Statement II alone is not sufficient to answer the question.

Thus, the data in Statement I alone are sufficient to answer the question, while the data in Statement II alone are not sufficient to answer the question.

So option (A) is the correct answer.

8. The given pie chart shows the breakup of total number of the employees of a company working in different offices (A, B, C, D and E).

Total no. of employees = 2400

What is the number of offices in which the number of employees of the company is between 350 and 650?

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

Ans. A

Sol. Total no. of Employees (360°) = 2400

No. of employees in office A(126°)

$= \frac{2400}{360} \times 126 = 840$

No. of employees in office B(18°)

$= \frac{2400}{360} \times 18 = 120$

No. of employees in office C(54°)

$= \frac{2400}{360} \times 54 = 360$

No. of employees in office D(90°)

$= \frac{2400}{360} \times 90 = 600$

No. of employees in office E(72°)

$= \frac{2400}{360} \times 72 = 480$

Number of offices in which the number of employees of the company is between 350 and 650 = 3

9. Find the numbers a, b, c between 2 and 18 such that

I. their sum is 25,

II. the numbers 2, a, b are consecutive terms of an A.P. and

III. The numbers b, c, 18 are consecutive terms of a G.P.

A. a=5, b=8, c=12
B. a=7, b=8, c=12
C. a=5, b=9, c=11
D. a=7, b=5, c=11

Ans. A

Sol. We have a + b + c = 25 ...(i)

2, a, b are in A.P. ⇒ 2a = 2 + b ...(ii)

b, c, 18 are in G.P. ⇒ 18b = c2 ...(iii)

Substituting for a and b in (1), using relations (2) and (3), we get

$\Rightarrow 1+\frac{b}{2}+\frac{c^2}{18}+c=25$

⇒ c^2 + 12c − 288 = 0

⇒ (c − 12) (c + 24) = 0

⇒ C= 12 or c= -24

Since the numbers lie between 2 & 18,

We take c=12

⇒ a + b = 13

⇒ a + 2a -2 = 13

⇒ b=8, a=5

10. **Statements:**

All lions are ducks.

No duck is a horse.

All horses are fruits.

Conclusions:

I. No lion is a horse.

II. Some fruits are horses.

III. Some ducks are lions.

IV. Some lions are horses.

A. Only either I or II and III & IV follow

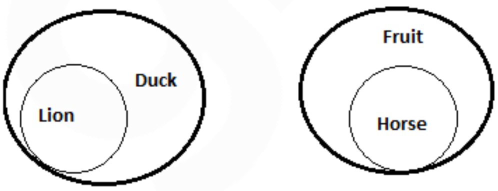
B. Only either I or IV and both II and III follow

C. Only either I or IV and II follow

D. Only Conclusion I & II and III follow

Ans. D

Sol.



We use elimination to find an exception to the generality of the question. Thus we prove they are not implied. The diagram above satisfy all the above statement but contradict with the conclusion (iv). Since we found an exception, the conclusion is not true in every case. Thus it is not implied.

We can draw many scenarios that satisfy the statements using Venn diagram & check for the validity of the conclusions.

Conclusions (i), (ii), (iii) hold good for every case so they are implied.

21. The minimal expression of function f(A,B,C,D) is

AB \ CD	00	01	11	10
00		1	×	1
01	1	1	×	×
11		×	1	×
10			×	1

A. $\overline{A}D+\overline{A}B+C$

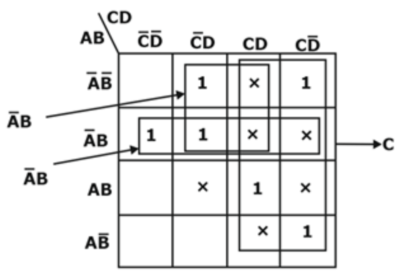
B. $\overline{A}B+AC+\overline{A}C+\overline{A}D$

C. $A+B+C+D$

D. $\overline{A}+\overline{B}+\overline{C}+\overline{D}$

Ans. A

Sol.



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

12. Consider an angle modulated signal with phase modulation as follows

$x_c(t) = 10\cos(\omega_c t + 3\sin\omega_m t)$

Assume $f_m = 1kHz$. Find the bandwidth (in kHz) when f_m is doubled.

Sol.

$x_{PM}(t) = 10\cos\left(\omega_c t + k_p m(t)\right) = 10\cos(\omega_c t + 3\sin\omega_m t)$

Thus, m(t) = $a_m \sin\omega_m t$

$x_{PM}(t) = 10\cos\left(\omega_c t + k_p a_m \sin\omega_m t\right)$

Modulation index $\beta = k_p a_m = 3$

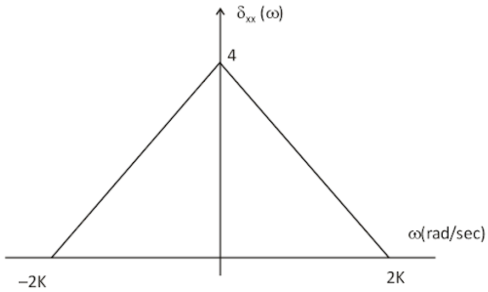
When $f_m = 1kHz,$

$f_B = 2(\beta + 1)f_m = 8kHz$

When $f_m = 2kHz, \beta = 3$ (as β is independent of f_m)

$f_B = 2(\beta + 1)2 = 16kHz$

13. If PSD of a real process x(t) is shown in figure. Calculate the maximum value of auto correlation function.



A. $\frac{6000}{\pi}$ B. $\frac{5500}{\pi}$

C. $\frac{9000}{\pi}$ D. $\frac{4000}{\pi}$

Ans. D

Sol. Maximum value $E[X^2(t)] = R_{xx}(0)$ (average power)

Average power $P_{xx} = \frac{1}{2\pi}\, area\,(\delta_{xx}(\omega))$

$$= \frac{1}{2\pi}\int_{-\infty}^{+\infty} \delta_{xx}(\omega)\, d\omega$$

$$= \frac{1}{\pi}\int_{0}^{+\infty} \delta_{xx}(\omega)\, d\omega$$

$$= \frac{1}{\pi}[\frac{1}{2}\times 2000\times 4]$$

$$= \frac{4000}{\pi}$$

14. Let x(n) $= \cos\left(2n - \frac{\pi}{3}\right)$. Even component of x(n) is acos(bn) then the value of a & b are respectively.

A. 0.5 and 2 B. -0.5 and 2

C. 0.5 and -2 D. -0.5 and -2

Ans. A

Sol. $X(n) = \cos\left(2n - \frac{\pi}{3}\right)$

$X(-n) = \cos\left(-2n - \frac{\pi}{3}\right) = \cos\left(2n + \frac{\pi}{3}\right)$

Even component of x(n) is given by

$X_e(n) = \frac{X(n) + X(n)}{2}$

$X_e(n) = \cos\left(2n - \frac{\pi}{3}\right) + \cos\left(2n + \frac{\pi}{3}\right)$

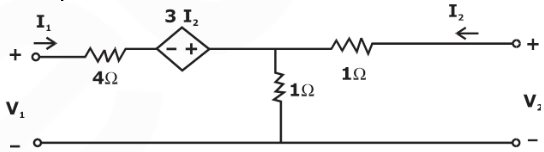
$= \frac{2.\cos(2n)\cos\left(\frac{\pi}{3}\right)}{2}$

$= \cos\left(\frac{\pi}{3}\right)\cos(2n) = 0.5\cos(2n)$

Given $X_e(n)$ = a.cos(bn)

So, a = 0.5 & b = 2

15. The sum of Z-parameters of the two port network shown below is ________?



Sol. Apply kVL to inner and outer loops

$V_1 = 4I_1 - 3I_2 + (I_1 + I_2)$

$= 5I_1 - 2I_2$

$V_2 = I_2 + (I_1 + I_2) = I_1 + 2I_2$

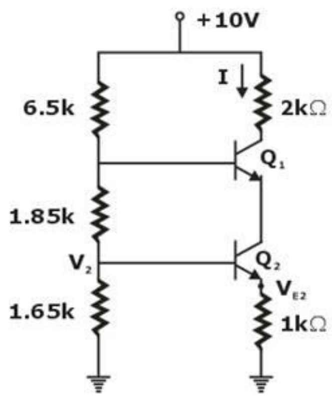
$$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} 5 & -2 \\ 1 & 2 \end{bmatrix}\begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$

The sum of the Z-parameters

$= Z_{11} + Z_{12} + Z_{21} + Z_{22}$

= 5 – 2 + 1 + 2 = 6

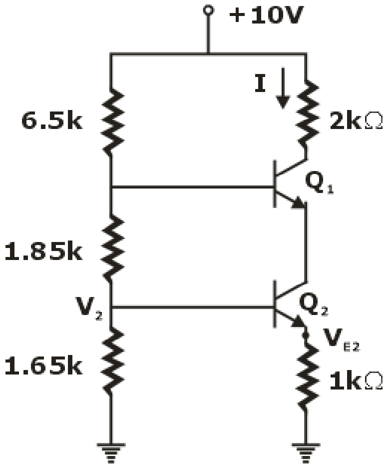
16. If the transistors in Fig. have high values of β and a V_{BE} of 0.65 Volts, the current I flowing through 2kΩ resistance is



A. 2mA   B. 6.5 mA
C. 1 mA   D. 10 mA

Ans. C

Sol.



For high values of β, current through base I_B is almost zero.

$\therefore I_B = 0A$

By using voltage division principle at the bases

$$V_2 = V_{cc} \times \frac{1.65}{1.65 + 1.85 + 6.5}$$

$$= 10 \times \frac{1.65}{10} = 1.65V$$

$V_{E2} = V_2 - 0.65V$

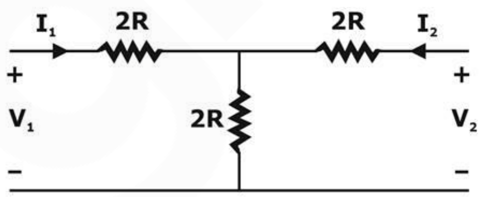
$= 1.65 - 0.65$

$V_{E2} = 1V$

$$I = \frac{V_{E2}}{1k\Omega} = \frac{1V}{1k}$$

I = 1mA

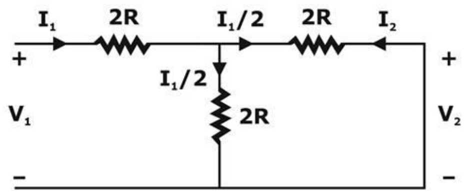
17. A two-port network is shown in figure. The parameter h_{21}, for this network can be given by



Sol. h – parameter equation to calculate h_{21}

$I_2 = h_{21} I_1 + h_{22} V_2$

$$h_{21} = \left.\frac{I_2}{I_1}\right|_{V_2=0}$$



The relevant circuit with $V_2 = 0$ is shown in above figure.

Using current division rule,

$$I_2 = \frac{-I_1}{2}$$

$$\therefore h_{21} = \frac{I_2}{I_1} = \frac{-1}{2}$$

18. If $A_{3\times3}$ is any real matrix such that |A| = 24, trace of 'A' = 9 and one of the eigen values is '2' then trace of Adj A = ______?

Sol. Let the another two eigen value of 'A' be α, β

Given that (α + β + 2) = 9

α + β = 7 ………. (1)

and 2.α.β = 24

α.β = 12 ……….(2)

By solving (1) & (2) we get α , β = 4, 3

∴ The eigen value of 'A' are 2, 3, 4

If λ is eigen value of 'A' then $\frac{|A|}{\lambda}$ is and eigen value of adj.

Hence, the eigen value of Adj A are 6, 8, 12

∴ Trace of Adj A = 6+8+12=26

19. The divergence of the vector field $\vec{V} = \left(x^2 + y\right)\hat{i} + (z - 2xy)\hat{j} + (xy)\hat{k}$ at (1,1,1) is

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

Ans. C

Sol.

$$\nabla \cdot \vec{V} = \frac{\partial}{\partial x}(x^2 + y) + \frac{\partial}{\partial y}(z - 2xy) + \frac{\partial}{\partial z}(xy)$$

$= 2x - 2y$

$= 0$ at $(1,1,1)$

20. The mean value C of Cauchy's theorem for the functions $f(x) = \frac{1}{x}$ and $g(x) = \frac{1}{x^2}$ in the interval [2, 3] is

A. 2.4 B. 2.5

C. 2.6 D. 2.8

Ans. A

Sol. The conditions of Cauchy's theorem hold good for f(x) and g(x).

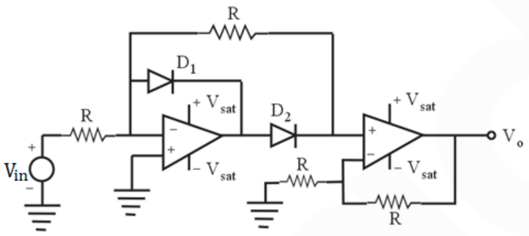
By Cauchy's theorem, there exists a value c such that

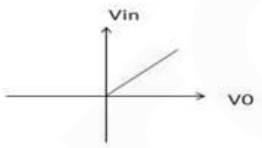
$$\frac{f'(c)}{g'(c)} = \frac{f(3)-f(2)}{g(3)-g(2)}$$

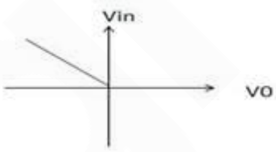
$$\Rightarrow \frac{\left(\frac{-1}{C^2}\right)}{\left(\frac{-2}{C^3}\right)} = \frac{\left(\frac{1}{3}-\frac{1}{2}\right)}{\left(\frac{1}{9}-\frac{1}{4}\right)}$$

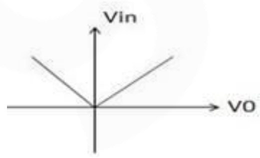
$$\Rightarrow c = 2.4$$

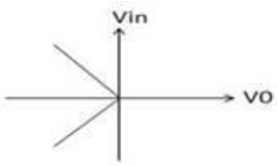
21. The transfer characteristics of the circuit shown below?



A.


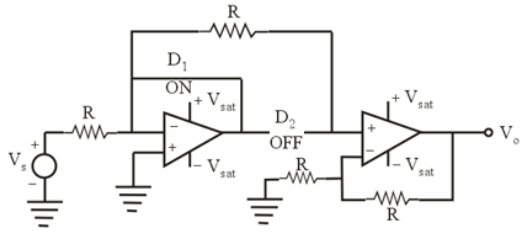
B.


C.


D.


Ans. B

Sol. Case I



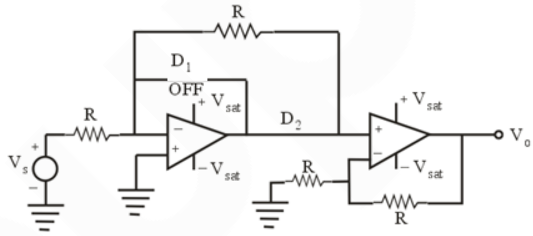
When V_{in} > 0 (inverting terminal > non inverting terminal.)

So D1=ON; D2=OFF

Current through is 0 A ,

Hence V_0=0V

Case II.



When Vin < 0, (inverting terminal < non inverting terminal.)

D1=OFF & D2=ON

V_A=[-R/R]V_{in}= -V_{in}

V_0=[1+R/R]V_A=(2)(-V_{in})

V_0= -2V_{in}

Hence V_0/V_{in}= slope= -2

So option B is correct.

22. An NMOS transistor with threshold voltage V_T = 1 V, m_n c_{ox} = 0.02 A /V^2 and the terminal voltages are V_{GS} = 1.2 V and V_{DS} = 0.1 V. The drain current of the NMOS transistor is ____________ mA

Sol. V_T (Threshold voltage) = 1V

Conductance parameter, $\mu_n C_{ox}\left(\frac{W}{L}\right)$ = 0.002 A/V^2

Gate to source voltage, V_{GS} = 1.2 V

Drain to source voltage, V_{DS} = 0.1 V

Since, $V_{GS} > V_T \Rightarrow$ NMOS transistor is ON

$V_{GS} - V_T = 1.2 - 1 = 0.2$

$V_{DS} < V_{GS} - V_T$

Hence, NMOS transistor is in linear region.

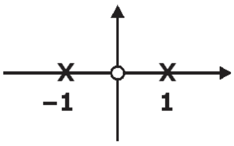
Drain current,

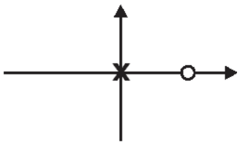
$$I_D = \mu_n C_{ox} \frac{W}{L}\left[(V_{GS} - V_T)V_{DS} - \frac{V^2_{DS}}{2}\right]$$

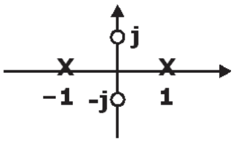
$$I_D = 0.002\left[(0.2)(0.1) - \frac{(0.1)^2}{2}\right] \text{ A}$$

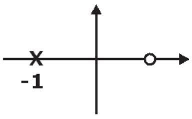
$I_D = 30\ \mu A$

23. For the given pole zero plot which one could correspond to an even function of time.

A.


B.


C.


D.


Ans. C

Sol. For a signal to be even it must be either two sided or finite duration. Therefore if X(s) has poles and the ROC must have strip in s-plane.

For Plot A

$$X(s) = \frac{As}{(s+1)(s-1)}$$

For even function

X(s) = X (-s)

But

$$X(-s) = \frac{As}{(S-1)(S+1)} = -X(s)$$

Therefore X(A) is not even (it is odd)

For Plot B:

We note that the ROC cannot be chosen to correspond to a two-sided function X(t) therefore signal is not even.

For plot C:

We get

$$X(s) = \frac{A(s-j)(s+j)}{(s+1)(s-1)} = \frac{A(s^2+1)}{s^2-1}$$

$$X(-s) = \frac{A(s^2+1)}{s^2-1} = X(s)$$

Hence, x(t) is even provided ROC is chosen to be -1 < Re (s) < 2

For Plot D:

We note that the ROC cannot be chosen to correspond to a two sided function X(t).

Hence, it is not even.

24. An EM wave at wave length 500 nm traveling with speed of 2×10^8 m/s in certain medium and enters another medium of refractive index $\frac{5}{4}$ times that of the first medium, then velocity of the second medium is ______ $\times 10^8$ m/s

Sol. $f = \frac{C}{\lambda} = \frac{2 \times 10^8}{500 \times 10^{-9}} = 4 \times 10^{14}\text{Hz}$

$$V_{P1} = \frac{3 \times 10^8}{n_2} = \frac{3 \times 10^8}{\left(\frac{15}{8}\right)} = 1.6 \times 10^8 \text{m/s}$$

$$\left(n_2 = \frac{5}{4}n_1 = \frac{5}{4}\left(\frac{3}{2}\right), n_1 = \frac{3 \times 10^8}{2 \times 10^8} = \frac{3}{2}\right)$$

25. Which of the following is correct ?

A. $(\bar{x} + y) \odot (x \oplus y) = \bar{x}y$

B. $(\bar{x} + y) \odot (x \oplus y) = x\bar{y}$

C. $(\bar{x} + y) \odot (x \oplus y) = xy$

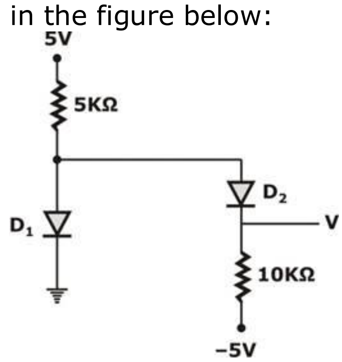
D. $(\bar{x} + y) \odot (x \oplus y) = x + y$

Ans. A

Sol.

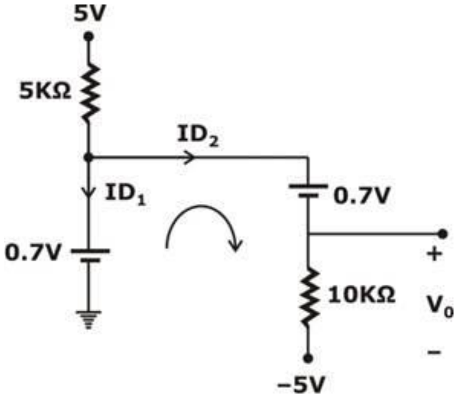
$$(\bar{x} + y) \odot (x \oplus y) = (\bar{x} + y)(\bar{x}y + x\bar{y}) + \overline{(\bar{x} + y)}(xy + \bar{x}\bar{y})$$
$$= (\bar{x}y + 0 + \bar{x}y + 0) + (0 + 0)$$
$$= \bar{x}y$$

26. Consider the two diode circuit shown in the figure below:



The diodes D_1 and D_2 can be modelled as a constant voltage source of 0.7 V, when forward biased. The value of current flowing through diode D_1 is equal to I_{D1}, then the value of current I_{D1} is equal to _______ mA

Sol. Assuming both the diodes to be ON, thus the circuit will reduce to



The current I_{D2} will be equal to

$$I_{D2} = \frac{0-(-5)}{10\ K\Omega} = \frac{5}{10} \times 10^{-3} = 0.5\ mA$$

Now, the current I from the 5V source will be equal to

$$I = \frac{5-0.7}{5\ K\Omega} = 0.86\ mA$$

Current $I_{D1} = I - I_{D1}$

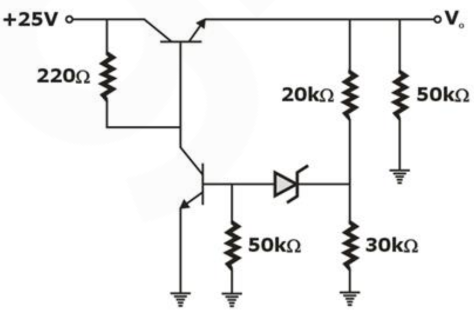
$= (0.86 - 0.5) \times 10^{-3}$ A

= 0.36 mA

∵ I_{D1} and I_{D2} both are positive, hence out assumption was correct.

I_{D1} = 0.36 mA

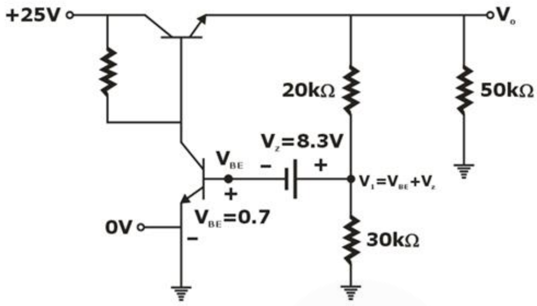
27. In the series voltage regulator circuit shown below $V_{BE} = 0.7$ V, $\beta = 50$, $V_Z = 8.3$ V. The output voltage V_0 is ______ volts.



A. 15
B. 11
C. 10
D. 12

Ans. A

Sol. In this circuit, zener diode works as a voltage regulator. So, the equivalent circuit is drawn as



From the circuit, we have

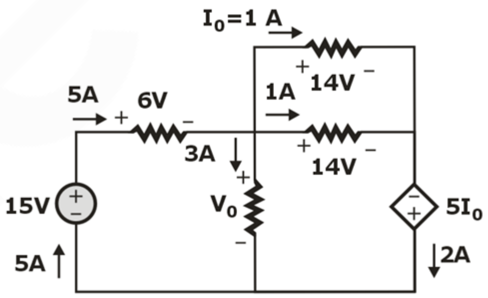
$V_1 = V_{BE} + V_z = 0.7 + 8.3 = 9$ V

Using voltage divider rule, we get

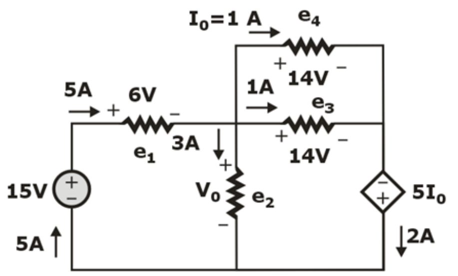
$$V_1 = \frac{30k}{20k + 30k} V_0$$

$$V_0 = \frac{5}{3} \times 9 = 15V$$

28. In the circuit shown in figure, voltage V_0 is



Sol. We solve this problem using principal of power conservation.



Using passive sign convention, we calculate power absorbed by each element

Element e_1: $P_1 = 6 \times 5 = 30$ W (absorbed)

Element e_2: $P_2 = 3V_0$ (absorbed)

Element e_3: $P_3 = 1 \times 14 = 14$ W (absorbed)

Element e_4: $P_4 = 1 \times 14 = 14$ W (absorbed)
15 V source: $P_5 = -15 \times 5 = -75$ W
or, $P_5 = 75$W (delivered)
Dependent source: $P_6 = -(5I_0) \times 2 = -10$ W
or, $P_6 = 10$ W (delivered)
Power absorbed = Power delivered
$30 + 3V_0 + 14 + 14 = 75 + 10$
$3V_0 = 27 \Rightarrow V_0 = 9$ V

29. If $(x)_r + (x^2)_{r+1} + (x^3)_{r+2} = (109)_{10}$, where *x* represents the minimum number of NOR gates required to implement a half adder, then the positive value of radix '*r*' is _______.

Sol. Given that:

$$(x)_r + (x^2)_{r+1} + (x^3)_{r+2} = (109)_{10}$$

Where x = Number of NOR Gates required to implement a half adder = 5

$$(5)_r + (5^2)_{r+1} + (5^3)_{r+2} = (109)_{10}$$

Decimal equivalent of each individual term is as follows:

$$(5)_r = (r^0 \times 5)_{10} = 5$$

$$(25)_{r+1} = \left[2\times(r+1)^1 + 5\times(r+1)^0\right]_{10} = (2r+7)_{10}$$

$$(125)_{r+2} = \left[1\times(r+2)^2 + 2\times(r+2)^1 + 5\times(r+2)^0\right]_{10} = (r^2+6r+13)_{10}$$

Substituting all decimal values in the above equation,

$$5 + 2r + 7 + r^2 + 6r + 13 = 109$$

$$r^2 + 8r + 25 = 109$$

$$r^2 + 8r - 84 = 0$$

$$r^2 - 6r + 14r - 84 = 0$$

$$(r-6)(r+14) = 0$$

$$r = 6, -14$$

Hence, the positive value of radix 'r' is 6.

30. The transfer function of a network can be written as $\frac{1+s}{1+0.5s}$. The maximum phase angle occurs at a frequency of ________ rad/sec.

A. 2
B. 5
C. 8
D. 16

Ans. A

Sol. Comparing with standard transfer function

$$\frac{1+s\tau}{1+\alpha s\tau}$$

Here, $\tau = 1$

and $a\tau = 0.5$

or $a = 0.5$

$\because \alpha < 1$

$\therefore$ Lead network

Maximum phase occurs at a frequency of

$$\omega_m = \frac{1}{\alpha\sqrt{\tau}} = \frac{1}{\alpha} = 2 rad/\sec$$

31. An 8 bit unipolar successive approximation register type ADC is used to convert 6.1 volts to digital equivalent output. The reference voltage is + 15V. The output of ADC at the end of 4th clock pulse after the start of the conversion, is

A. 01010000
B. 01110000
C. 01100000
D. 01001000

Ans. C

Sol. V_R = 15V size of ADC = 8 bit (D_0 to D_7)

$V_{D7} = 7.5$ V, $V_{D6} = 3.75$ V, $V_{D5} = 1.875$ V, $V_{D4} = 0.9375$ V

C/k	D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0	V_R	V_a	
1	1	0	0	0	0	0	0	0	7.5	6.1	Reset
2	0	1	0	0	0	0	0	0	3.75	6.1	Set
3	0	1	1	0	0	0	0	0	5.625	6.1	Set
4	0	1	1	1	0	0	0	0	6.56	6.1	Reset
	0	1	1	0	0	0	0	0			

∴ Find output at the end of 4th clock is 01100000
The output at the starting of 5th clock is 01101000

32. The input impedance of short-circuited transmission line of length $\frac{\lambda}{2}$

A. jz_o B. ∞

C. Zero D. $-jz_o$

Ans. C

Sol. For short circuited line

$Z_{in} = jZ_o \tan\beta l$

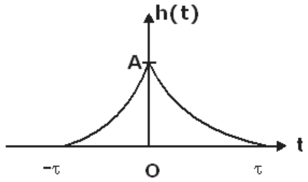
$= jZ_o \tan\frac{2\pi}{\lambda}\cdot\frac{\lambda}{2}$

$= 0$

33. A pulse $X(t) = A\,\text{rect}\left(\frac{t}{2\tau}\right)\left[1-\left(\frac{t}{\tau}\right)^2\right]$

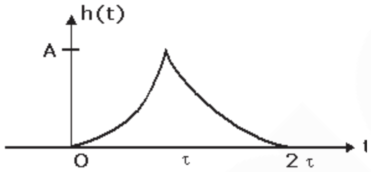
Where A> 0, τ > 0 are constants, is added to white noise. The impulse response matched to X(t) and output signal to noise ratio (SNR) respectively are.

A.



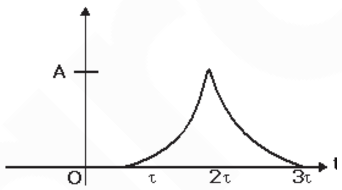
$(SNR)_0 = \frac{8A^2\tau}{3N_0}$

B.



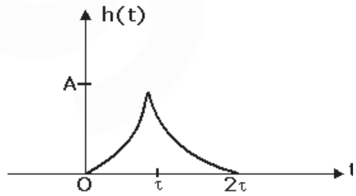
$(SNR)_0 = \frac{8A^2\tau}{3N_0}$

C.



$(SNR)_0 = \frac{52A^2\tau}{15N_0}$

D.



$(SNR)_0 = \frac{52A^2\tau}{15N_0}$

Ans. D

Sol. Maximum signal to Noise ratio of matched filter is $(SNR)_0 = \frac{2E}{N_0}$

E = Energy of the signal

$X(t) = A\,rect\left[\frac{t}{2\tau}\right]\left[1-\left(\frac{t}{2\tau}\right)^2\right]$

Energy of X(t) is

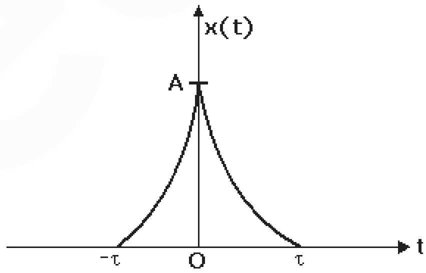
$E = 2\int_0^{\tau}\left[A\left[1-\left(\frac{t}{\tau}\right)^2\right]\right]^2 dt$

$E = 2A^2\int_0^{\tau}\left[1-\frac{t^4}{\tau^4}-\frac{2t^2}{\tau^2}\right]dt = 2A^2\left[\tau+\frac{\tau}{5}-\frac{2\tau}{3}\right]$

$E = 2A^2\left[\frac{15\tau+3\tau-5\tau}{15}\right]$

$E = \frac{2A^2\times13\tau}{15} = \frac{26A^2\tau}{15}$

$(SNR)_0 = \frac{2E}{N_0} = \frac{52A^2\tau}{15N_0}$



34. X and Y are two continuous random variable with joint distribution:

$$f(x,y) = \begin{cases} cx+1, & y \geq 0 \ \&\ x+y<1 \\ 0, & otherwise \end{cases}$$

The value of the constant c is:

Sol. For a joint probability distribution, we must have:

$$\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} f(x,y)\,dx\,dy = 1$$

$$\int_0^1\int_0^{1-x} (cx+1)\,dx\,dy = 1$$

$$\int_0^1 (cx+1)(1-x)\,dx = 1$$

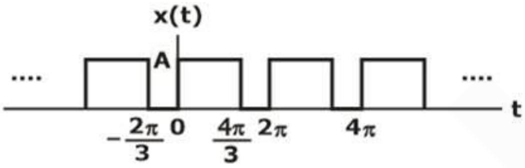
$$giving\ \frac{1}{2}+\frac{c}{6} = 1$$

Thus: $c = 3$

35. A bipolar transistor has I_{CBO} = 0.5 mA, common base current gain a = 0.98 and emitter current I_E = 2mA . Then the trans conductance of the transistor is ________ m℧.
(Assume V_T = 26 mV and η= 1)

Sol. I_E = 2mA
Common base current gain,
a = 0.98
I_{CBO} = 0.5 mA
Collector current, $I_C = aI_E + I_{CBO}$
$= 0.98\ (2 \times 10^{-3}) + 0.5 \times 10^{-3}$
= 2.46 mA
Transconductance of the transistor,
$$q_m = \frac{I_C}{V_T} = \frac{2.46 \times 10^{-3}}{26 \times 10^{-3}}$$
= 94. 62 m℧

36. The Fourier series coefficient for the periodic signal below is



A. $\frac{A}{2\pi n}\left(e^{-j\left(\frac{4\pi n}{3}\right)} - 1\right)$

B. $j\frac{A}{2\pi n}\left(e^{-j\left(\frac{4\pi n}{3}\right)} - 1\right)$

C. $-j\frac{A}{2\pi n}\left(e^{-j\left(\frac{4\pi n}{3}\right)} - 1\right)$

D. $\frac{-A}{2\pi n}\left(e^{-j\left(\frac{4\pi n}{3}\right)} - 1\right)$

Ans. B

Sol. We have T = 2π and $\omega_0 = \frac{2\pi}{2\pi} = 1,$

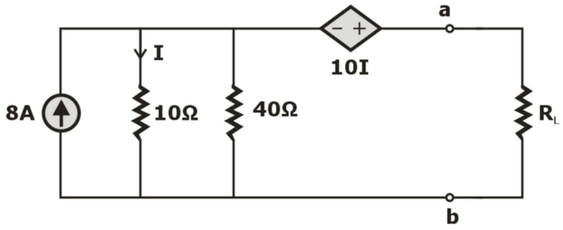
$$x(t) = \begin{cases} A, & 0 < t < \frac{4\pi}{3} \\ 0, & \frac{4\pi}{3} < t < 2\pi \end{cases}$$

$$c_n = \frac{1}{T}\int_0^T x(t)e^{-j\omega_0 nt}dt$$

$$= \frac{1}{2\pi}\int_0^{2\pi} x(t)e^{-jnt}dt$$

$$= \frac{1}{2\pi}\int_0^{4\pi/3} Ae^{-jnt}dt = \frac{jA}{2\pi n}\left[e^{-j\left(\frac{4\pi n}{3}\right)} - 1\right]$$

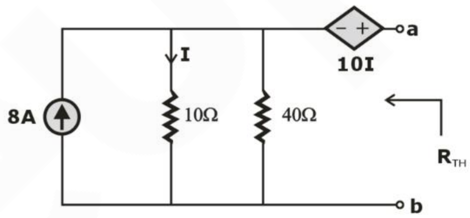
37. In the circuit shown in figure below, what is the value of R_L such that maximum power is transferred to the load?



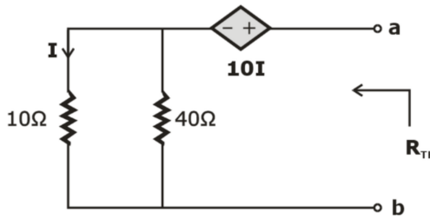
A. 20 Ω
B. 18 Ω
C. 25 Ω
D. 16 Ω

Ans. D

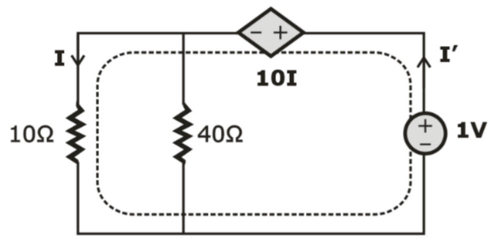
Sol. For maximum power to be transferred to the load,
$R_L = R_{Th}$



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



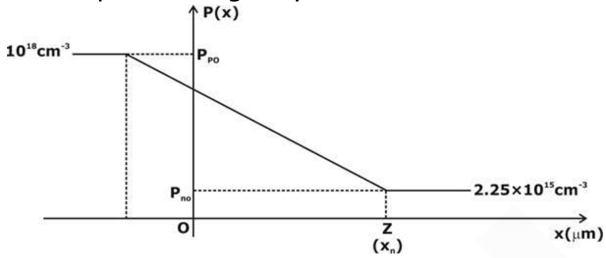
Connect the 1 V source across the a-b terminals,



$R_{Th} = V/I' = 1/I'$
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 Ω
R_{Th} = 16 Ω

38. In a silicon p–n junction, the variation of the hole concentration in the space charge region is shown in the figure below, where the hole concentration changes from P_{PO} to P_{no} aver the space charge layer width



The hole diffusion constant in the space charge region is 6.5 cm^2/sec. Then the hole diffusion current density J_P is ________ kA/cm^2.

Sol. Depletion width in the p–side, x_p = 1 μm
Depletion width in the n–side, x_n = 2 μm
Total depletion width, W = $x_n + x_p$ = 3μm
The diffusion constant of holes, D_p = 6.5 cm^2/sec
The diffusion current density of holes is $J_p = -q D_P \frac{dp}{dx}$
The concentration gradient across the space charge region is $\frac{dp}{dx}$

$$\frac{dp}{dx} = -\left[\frac{P_{po} - P_{no}}{W}\right] = -\left[\frac{10^{18} - 2.25\times10^{15}}{3\times10^{-4}}\right]$$

$$\frac{dp}{dx} = -3.33\times10^{21}\ \text{cm}^{-4}$$

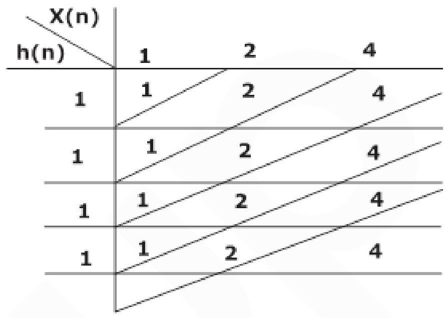
The diffusion current density of holes J_P is

$$J_P = -q D_P \frac{dp}{dx}$$

$= -1.6\times10^{-19}\times6.5\times(-3.33\times10^{21})$
J_P = 3.46 kA/cm^2

39. Considered two signals, X(n) = {1, 2, 4}, h(n) = {1, 1, 1, 1} also Y(n) = X(n) * h(n).
Then the value of $\sum_{K=1}^{3} Y(k)$?

Sol.



$X(n) = \{\underset{\uparrow}{1}, 2, 4\}$

$h(n) = \{1, \underset{\uparrow}{1}, 1, 1\}$

$Y(n) = X(n)*h(n) = \{1, \underset{\uparrow}{3}, 7, 7, 6, 4\}$

$$\sum_{K=1}^{3} Y(K) = 7 + 7 + 6 = 20$$

40. An analog signal of bandwidth 20kHz is sampled at a rate of 40kHz, and quantized into 16 levels. The resultant digital signal is transmitted using M-ary PSK with raised cosine pulse(with α = 0.3). A channel with a 110 kHz bandwidth is available to transmit the data. Then find the smallest acceptable value of number of phase angles.
A. 3
B. 4
C. 2
D. none of the above

Ans. B

Sol. 16 levels = 2^4 levels
Therefore, n = 4 bits/sample
Bit rate

$$= 40000\ \frac{samples}{sec}\ X\ \frac{4bits}{sample} = 160kbps$$

For M-ary PSK signalling the pulse rate would be

$$\frac{R\ bits/sec}{log_2 M\ bits/symbol} = \frac{R}{log_2 M}\ symbols/sec$$

$$2f_B = \frac{(1+\alpha).R}{log_2 M} \leq 110kHz$$

$$log_2 M \geq \frac{1.3X160}{110} = 1.89$$

∴ The smallest acceptable value of M is 4

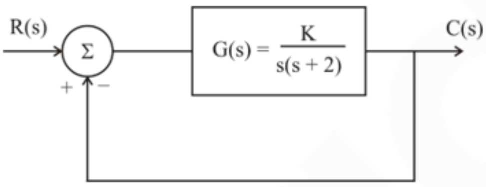
41. A unity-feedback servo-driven instrument has an open loop transfer function given as $\frac{K}{s(s+2)}$. It is given that the peak overshoot of the system on step input is 35.1 %. Find the steady state error to an input (1 + 4t)u(t).

A. 0.70 B. 0.60

C. 0.80 D. 0.50

Ans. C

Sol. Consider, $G(s) = \frac{K}{s(s+2)}$



Closed loop transfer function is given by,

$$\frac{C(s)}{R(s)} = \frac{G(s)}{1+G(s)} = \frac{K}{s^2+2s+K}$$

Comparing it this with the general second order transfer function

$$T(s) = \frac{\omega_n^2}{s^2+2\zeta\omega_n s+\omega_n^2}$$

We get, $\omega_n = \sqrt{K}$ and

$$2\zeta\omega_n = 2 \Rightarrow \zeta = \frac{1}{\sqrt{K}}$$

Peak overshoot is given by,

$$M_p = e^{\frac{-\pi\zeta}{\sqrt{1-\zeta^2}}} = 0.351$$

$$\Rightarrow -\pi\sqrt{\frac{1}{K-1}} = \ln 0.351$$

$$\Rightarrow K = 1 + \left(\frac{\pi}{\ln 0.351}\right)^2 \cong 10$$

Since, its an LTI system thus error due to sum of input is equal to sum of errors due to single inputs.

Error due to u(t) is:

$$K_p = \lim_{s\to 0} G(s) = \infty \Rightarrow e_{ss} = \frac{1}{1+K_p} = 0$$

Error due to 4tu(t) is:

$$K_v = \lim_{s\to 0} sG(s) = \lim_{s\to 0}\frac{10}{s+2} = 5 \Rightarrow e_{ss} = \frac{4}{K_v} = \frac{4}{5} = 0.8$$

Total steady state error is $E_{ss} = 0.8$

42. Find the Laplace transform of the function f(t) given as

$$f(t) = (t-2)^2$$

A. $\frac{4}{s} - \frac{4}{s^2} + \frac{2}{s^3}$, s>0

B. $\frac{4}{s} - \frac{4}{s^2} + \frac{4}{s^3}$, s>0

C. $\frac{4}{s} - \frac{2}{s^2} + \frac{2}{s^3}$, s>0

D. $\frac{2}{s} - \frac{4}{s^2} + \frac{2}{s^3}$, s>0

Ans. A

Sol. Given L $[(t-2)^2]$

$$= \lim_{T\to\infty} \int_0^T (t-2)^2 e^{-st}\,dt$$

Using integration by parts with u' $= e^{-st}$ and V = $(t-2)^2$ we will find,

$$\int_0^T (t-2)^2 e^{-st}\,dt = -[\frac{(t-2)^2 e^{-st}}{s}]_0^T + \frac{2}{s}\int_0^T (t-2)e^{-st}\,dt$$

$$= \frac{4}{s} - \frac{(T-2)^2 e^{-sT}}{s} + \frac{2}{s}\int_0^T (t-2)e^{-st}\,dt$$

thus,

$$\lim_{T\to\infty}\int_0^T (t-2)^2 e^{-st}\,dt = \frac{4}{s} + \frac{2}{s}\lim_{T\to\infty}\int_0^T (t-2)e^{-st}\,dt$$

Using by parts with u' = e^{-st} and v =t-2 we find

$$\int_0^T (t-2)e^{-st}\,dt = [-\frac{(t-2)e^{-st}}{s} - \frac{1}{s^2}e^{-st}]_0^T$$

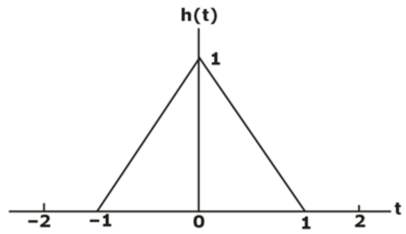
Let T $\rightarrow \infty$ in the above expression we will get

$\lim_{T\to\infty}\int_0^T (t-2)e^{-st}dt = -\frac{2}{s}+\frac{1}{s^2}, s>0$

Hence,

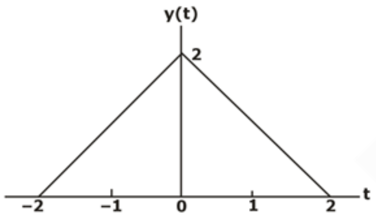
F(s) = $\frac{4}{s}+\frac{2}{s}\left(-\frac{2}{s}+\frac{1}{s^2}\right) = \frac{4}{s}-\frac{4}{s^2}+\frac{2}{s^3}$, s>0

43. An LTI system has the impulse response shown below.

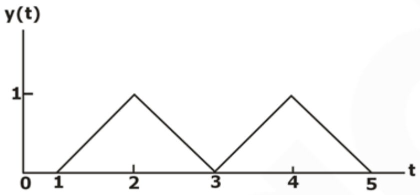


If the system is excited by an input x(t) = δ (t − 1) + δ (t − 3), then output y(t) will be

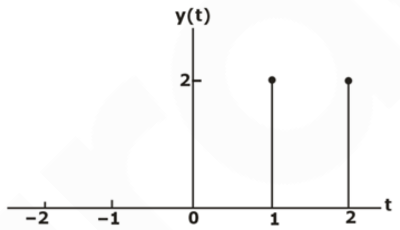
A.



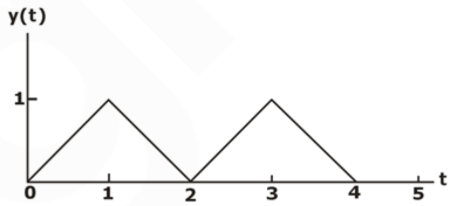
B.



C.



D.



Ans. D

Sol. Output of the system is

Y(t) = h (t) * x(t)

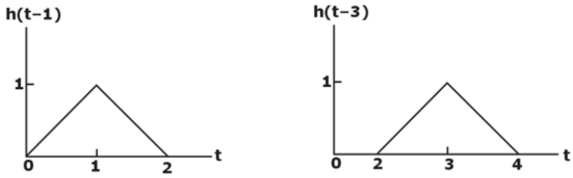
= h(t) * [δ (t − 1) + δ (t − 3)]

= h(t) * δ (t − 1) + h (t) * δ (t − 3)

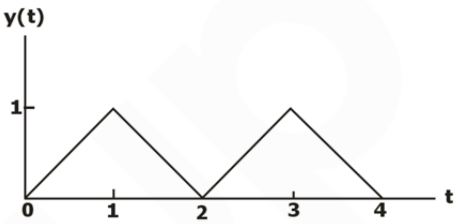
= h(t − 1) + h (t − 3)

As we know that, x(t) * δ (t − t_0) = x (t − t_0)

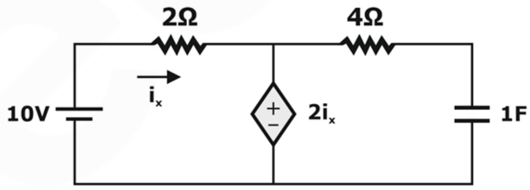
Signal h(t − 1) and h(t − 3) are obtained by shifting h(t) to the right by 1 unit and 3 unit respectively as shown below



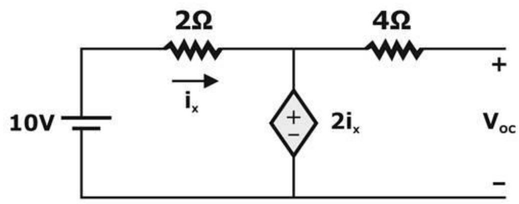
Now, adding above two we get the output



44. Calculate the time constant, τ (in sec) of the circuit shown below?



Sol. Calculation of open circuit voltage across capacitor,

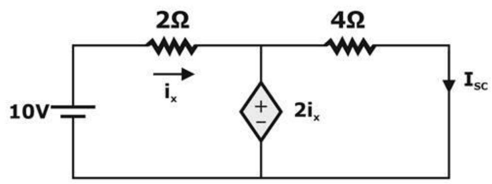


$$V_{OC} = 2i_x = 2\left(\frac{10 - V_{OC}}{2}\right)$$

$2V_{OC}$ = 10

V_{OC} = 5 V

Calculation of I_{SC}:



$$I_{SC} = \frac{2i_x}{4} = \frac{i_x}{2} \quad ...(1)$$

writing KVL in outer loop,

10 − $2i_x$ − $4I_{SC}$ = 0

By putting the value of i_x from equation (1)

$10 - 2 \times 2I_{SC} - 4I_{SC} = 0$

$$I_{SC} = \frac{10}{8} = 1.25$$

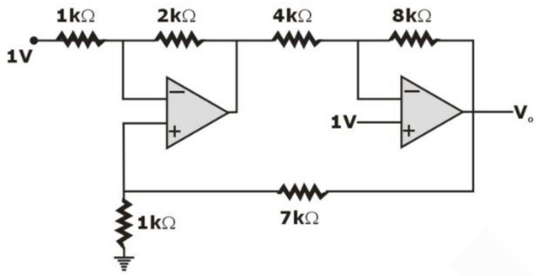
Resistance seen by capacitance is

$$R_{Th} = \frac{V_{oc}}{I_{sc}} = \frac{5}{1.25} = 4\,\Omega$$

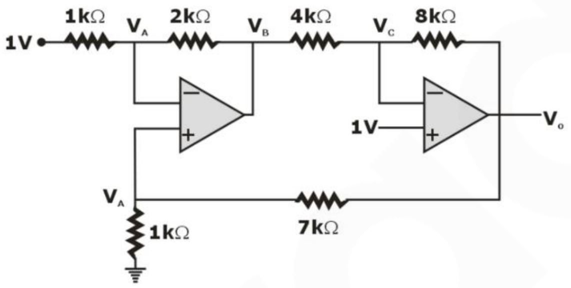
Time constant, $\tau = R_{Th} \times C = 4 \times 1$

= 4 sec

45. Find the output voltage of the following circuit assume the ideal op-amp behavior _______ V.



Sol.



By virtual short circuit $V_c = 1V$

$$V_A = V_o \times \frac{1}{1+7} = \frac{V_o}{8} \qquad (1)$$

Applying KCL at node A

$$\frac{V_A - 1}{1k\Omega} + \frac{V_A - V_B}{2k\Omega} = 0$$

$V_B = 3V_A - 2$

From eq (1)

$$V_B = \frac{3V_o}{8} - 2 \qquad (2)$$

Applying KCL at node C

$$\frac{V_C - V_B}{4} + \frac{V_C - V_o}{8} = 0$$

$3V_C - 2V_B - V_0 = 0$

$V_C = 1V$

$$V_B = \frac{3V_o}{8} - 2 \qquad \text{(From eq (2))}$$

$$3 \times 1 - 2\left[\frac{3V_o}{8} - 2\right] - V_o = 0$$

$$V_o = 4V$$

46. The value of integral $I = \frac{i}{\pi_f}\oint \frac{\cos \pi z}{z^2 - 1}$, where C is the square with vertices at ±i, 2 ±i is …………………

A. -1 B. -2

C. -3 D. -4

Ans. A

Sol. $\frac{1}{2\pi_f}\oint \frac{\cos \pi z}{(z-1)(z+1)}dz$ = sum of Residue

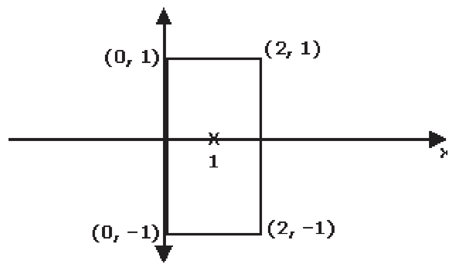
$$\frac{1}{\pi_f}\oint \frac{\cos \pi z}{(z+1)} \times \frac{1}{(z-1)} dz = 2 \times sum\ of\ \text{Residue}$$

At Z = 1, Residue of

$$f(z) = \lim_{z \to 1} \frac{\cos \pi z}{z+1} = \frac{\cos \pi}{2} = -0.5$$

$$I = 2 \times \text{Residue} = 2 \times (0.5)$$

= -1



47. An enhancement type NMOS transistor has threshold voltage of 0.8 V, process transconductance parameter $\mu_n C_{ox} = 20\,\mu A / V^2$ and channel length modulation parameter λ= O, V_G = 2.8 V, drain Voltage (V_D) = 5 V, Source Voltage V_S = 1V and drain current I_D = 0.24 m. Then the ratio (W/L) is

A. 10 B. 14

C. 24 D. 34

Ans. C

Sol. Given, threshold voltage,

$V_T = 0.8$ V

Process trans conductance parameter,

$\mu_n C_{ox} = 20\ \ \mu A/V^2$

Gate Voltage, V_G = 2.8 V

Drain voltage, V_D = 5 V

Source voltage, V_S = 1V

Drain current, I_D = 0.24 mA

$V_{GS} = V_G - V_S = 2.8 - 1 = 1.8$ V

$V_{DS} = V_D - V_S = 5 - 1 = 4$V

$V_{GS} - V_T = 1.8 - 0.8 = 1$ V

Clearly, $V_{DS} > V_{GS} - V_T$

Hence, the MOSFET in saturation mode

$$I_D = \frac{1}{2}\mu_n C_{ox}\frac{W}{L}(V_{GS} - V_T)^2$$

$$0.24 \times 10^{-3} = \frac{1}{2} \times 20 \times 10^{-6} \times \frac{W}{L}(1)^2$$

$$\frac{W}{L} = 24$$

48. The magnetic field intensity in a region is $\vec{H} = 2x\hat{a}_x - 3y\hat{a}_y + 5z\hat{a}_z$, the current density in A/m² at a point (1, 2, 3) is

Sol. Given that:

$$\vec{H} = 2x\hat{a}_x - 3y\hat{a}_y + 5z\hat{a}_z$$

From Maxwell's equation,

$$\nabla \times \vec{H} = \vec{J}$$

$$\vec{J} = \begin{vmatrix} a_x & a_y & a_z \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ 2x & -3y & 5z \end{vmatrix} = a_x\left[\frac{\partial}{\partial y}(5z) - \frac{\partial}{\partial z}(-3y)\right] - a_y\left[\frac{\partial}{\partial x}(5z) - \frac{\partial}{\partial z}(2x)\right] + a_z\left[\frac{\partial}{\partial y}(-3y) - \frac{\partial}{\partial z}(2x)\right]$$

$$= a_x(0-0) - a_y(0-0) + a_z(0-0) = 0$$

49. The loop transfer function of the system $G(s)H(s) = \frac{k}{s(s+18)(s^2+18s+81)}$.

The root locus plot of the system has

A. Three real breakaway points

B. No breakaway point

C. One real and one complex breakaway point

D. Only one breakaway point

Ans. A

Sol. 1+G(s)H(s)=0

$$\Rightarrow 1 + \frac{k}{s(s+18)(s^2+18s+81)} = 0$$

$$\Rightarrow s(s+18)(s^2+18s+81) + k = 0$$

$$\Rightarrow k = -s(s+18)(s^2+18s+81)$$

For breakaway points, $\frac{dk}{ds} = 0$

=>

$$s(s+18)(2s+18) + s(s^2+18s+81) + (s+18)(s^2+18s+81) = 0$$

=>

$$(2s+18)(s^2+18s) + (s^2+18s+81)(s+s+18) = 0$$

=>

$$(2s+18)(s^2+18s) + (s^2+18s+81)(2s+18) = 0$$

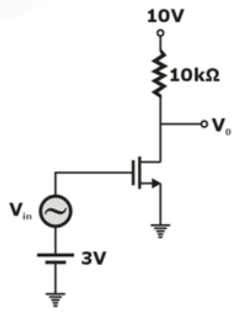
=> $(2s+18)(2s^2+36s+81) = 0$

Therefore, by solving we get,

S=-9, -2.64, -15.37

So, there are three real breakaway points.

50. Consider the NMOS transistor as shown in figure. The MOSFET has parameters $\frac{\mu_n C_{ox} W}{2L} = 0.5mA/V^2$, V_T = 2V and λ = 0. The transistor is used to amplify the small signal V_{in} as shown in the figure. If the value of signal V_{in} = 3sin(wt) mV, then the value of output signal $V_0(t)$ is equal to :-



A. −30 sin(ωt) V

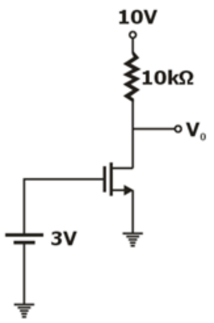
B. −15 cos(ωt) V

C. −15 cos(ωt) mV

D. −30sin (ωt) mV

Ans. D

Sol. First applying the D.C. analysis, we have



Now, assuming MOS to be in saturation region

$$I_D = \frac{\mu_n C_{ox} W}{2L}(V_{GS} - V_T)^2 = 0.5 \times 10^{-3}(3-2)^2$$

$I_D = 0.5 \times 10^{-3}$ mA

$V_{DS} = 10 - 10 \times 10^{+3} \times 0.5 \times 10^{-3} = 10 - 5 = 5V$

$V_{DS} > V_{GS} - V_T$

$5 > 3 - 2$

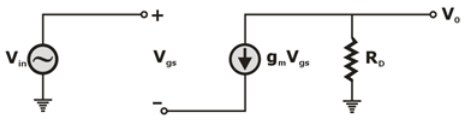
Hence, our assumption was true.

$$Now,\ g_m = 2\sqrt{\frac{\mu_n C_{ox} W}{2L} . I_D}$$

$$= 2\sqrt{0.5 \times 0.5 \times 10^{-6}}$$

$g_m = 1$ mA/V

Now, drawing the small signal equivalent circuit, we get



$V_0 = -g_m V_{gs} R_D$

$V_0 = -(g_m R_D)V_{in} = -[1 \times 10^{-3} \times 10 \times 10^3] \times 3 \sin \omega t \times 10^{-3}$

$V_0 = -30 \sin\omega t$ mV

51. The given integral

$$\int_0^{\frac{\pi}{k}} \int_x^{\frac{\pi}{k}} \frac{\sin y}{y} dy\, dx \text{ evaluates to } \frac{1}{2}$$

for some $k \geq 1$. Then the value of k is:

Sol. Changing the order of integration we get:

$$\int_0^{\frac{\pi}{k}} \int_0^{y} \frac{\sin y}{y} dx\, dy$$

$$= \int_0^{\frac{\pi}{k}} \frac{\sin y}{y} X\, [x]_0^y\ dy$$

$$= \int_0^{\frac{\pi}{k}} \sin y\ dy$$

$$= [-\cos y]_0^{\frac{\pi}{k}} = -\cos\frac{\pi}{k} + 1$$

$$-\cos\frac{\pi}{k} + 1 = \frac{1}{2}$$

$$giving \frac{\pi}{k} = \cos^{-1} 0.5$$

$$\frac{\pi}{k} = \frac{\pi}{3}$$

$$thus, k = 3$$

52. A binary PAM communication system employs rectangular pulse of duration T_b and amplitudes $\pm$A to transmit digital transmission information at a rate $R_b = 10^5$ bps. If power-spectral density of AWGN is $N_o/2$ where $N_o = 10^{-2}$ W/Hz, determine the value of A that is required to achieve a probability of error $P_e = 10^{-6}$

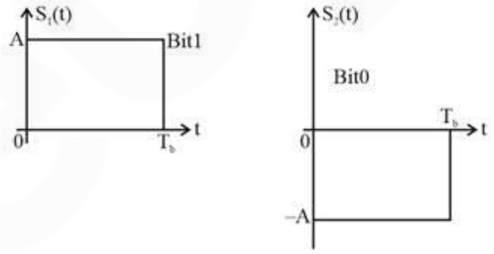
Assume $Q(4.5) \approx 10^{-6}$

A. 100.62 V
B. 200.62V
C. 300.62 V
D. 400.62 V

Ans. A

Sol. $R_b = 10^5$ bps, $N_o = 10^{-2}$ (W/Hz) Pe = 10^{-6}

$$Pe = Q\left(\sqrt{\frac{Ed}{2N_o}}\right)$$



$S_1(t) - S_2(t) = 2A,\ 0 < t < Tb$

$$E_d = \int_0^{Tb} 4A^2 dt = 4A^2 T_b = \frac{4A^2}{R_b}$$

$$P_e = Q\left(\sqrt{\frac{4A^2}{10^5 \times 2 \times 10^{-2}}}\right) = 10^{-6}$$

$$Q\left(\sqrt{\frac{A^2}{500}}\right) = 10^{-6}$$

Using given data $\sqrt{\frac{A^2}{500}} = 4.5$

$\Rightarrow$ A = 100.62 V

53. The cut off wavelength of wave guide is given as 80 mm. find the length (in km) of waveguide to ensure signal of 5 GHz emerging out of waveguide is delayed by 10μ sec with respect to the signal that is propogating in free space outside the waveguide is __________ km.

Sol. $fc = \frac{C}{\lambda} = \frac{3\times10^{10}}{80\times10^{-1}} = 3.75\times10^{+9}\ Hz$

= 3.75 GHz

$$\boxed{T_{delay} = \frac{l}{Vg} - \frac{l}{C} = l\left(\frac{1}{Vg} - \frac{1}{C}\right)}$$

Where 'l' is the length of the waveguide and Vg is the group velocity of signal through the waveguide, C is velocity of wave outside the waveguide.

$$Vg = c\sqrt{1-\left(\frac{fc}{f}\right)^2} = 3\times10^8\sqrt{1-\left(\frac{3.75}{5}\right)^2}$$

V_g = 1.98 × 10^8 m/s

$\therefore T_{delay} = l\left[\frac{1}{1.98\times10^8} - \frac{1}{3\times10^8}\right]$

10 × 10^{-6} = l [1.717 × 10^{-9}]

$$\boxed{l = 5.823\ km}$$

54. A memory is mapped to 8085 microprocessor. The memory map is B00F to FCDE H. The number of bytes stored in memory are (_________)$_{10}$.

Sol. Starting address = B00F H
Ending address = FCDE H
Total number of bytes = Total number address
=(FCDE – B00F + 1)$_H$
=4CCF+ 1 =4CD0 H = $(19664)_{10}$

55. The normalized radiation intensity of an antenna in spherical coordinates is given by
$U = \sin\theta \sin\varphi$, $0 \le \theta \le \pi$, $0 \le \varphi \le \pi$
The directivity of antenna is given by ________.

Sol. $U = \sin\theta = \sin\phi,$

$$|U|_{max} = 1\ for\ \theta = \phi = \frac{\pi}{2}$$

$$P_{rad} = \int_{\theta}\int_{\phi} U \sin\theta\, d\theta\, d\phi$$

$$= \int_{\theta=0}^{\pi}\int_{\phi=0}^{\pi} \sin^2\theta \sin\phi\, d\theta\, d\phi$$

$$= \int_{\theta=0}^{\pi} \sin^2\theta d\theta \int_{\phi=0}^{\pi} \sin\phi\, d\phi = \left(\frac{\pi}{2}\right)2 = \pi$$

$$D = \frac{4\pi U_{max}}{P_{rad}} = \frac{4\pi.1}{\pi} = 4$$

56. In a lightly depend p–type semiconductor, the corresponding accepter doing concentration to get minimum conducting is _____ × 10^{10} cm^{-3}.
(Assume intrinsic carries concentration is
n_i = 2.5 $10^{10}/cm^3$ & m_p = 0.4 m_n)

Sol. $n_i = 2.5 \times 10^{10}\ /cm^3$

$\mu_p = 0.4\ \mu_n$

$\frac{\mu_p}{\mu_n} = 0.4$

We know that electrical neutrality condition $N_D + P = N_A + n$
for lightly doped p–type semiconductor
$N_D = O$
$N_A = P - n$

$$N_A = P - \frac{n_i^2}{P}$$

$$N_A = n_i\sqrt{\frac{\mu_n}{\mu_p}} - \frac{n_i^2}{n_i\sqrt{\frac{\mu_n}{\mu_p}}}$$

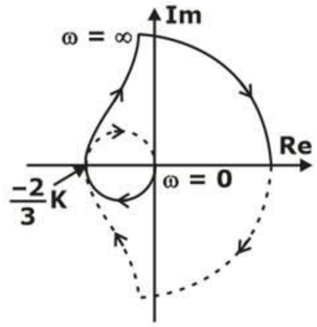
$$\left[\because \text{For minimum conductivity, } p = n_i\sqrt{\frac{\mu_n}{\mu_p}}\right]$$

$$N_A = n_i\left[\sqrt{\frac{\mu_n}{\mu_p}} - \sqrt{\frac{\mu_p}{\mu_n}}\right]$$

$$= 2.5\times10^{10}\left[\sqrt{2.5} - \sqrt{\frac{1}{2.5}}\right]$$

= 2.372 × 10^{10} /cm^3

57. The Nyquist plot for a stable open loop system is shown below:



For $K > \frac{3}{2}$, how many closed loop poles of a unity feedback system are in the right half of s-plane

Sol. Given that open loop system is stable, so we have no pole of open loop in right half of s-plane, i.e. P = 0

The intersection point of Nyquist plot with negative real axis

is $\left(-\frac{2}{3}K, 0\right)$ and $K > \frac{3}{2}$

Now, for the given range,

$K > \frac{3}{2}$

Or $\frac{2}{3}K > 1$

Or $-\frac{2}{3}K > -1$

The intersection point will be in left of the critical point, so (−1 + j0) point will lie in the small loop in Nyquist plot. Therefore, the Nyquist plot encircles the critical point (−1 + j0) two times in clockwise direction, i.e. N = −2

So, we obtain the number of closed loop poles in right half plane as

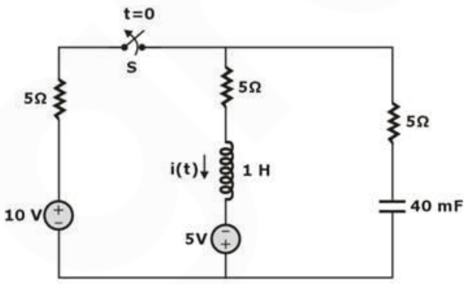
N = P − Z

Or −2 = 0 − Z

Or Z = 2

Hence, the closed loop system has two poles in the right half of s-plane.

58. The switch S in the circuit of figure has been closed for a long time and is opened at t = 0. The current i(t) for t > 0 is



A. $i(t)=(15 + 1.5t)e^{-5t}$ A

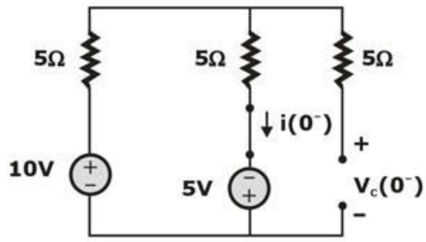
B. $i(t)=1.5e^{-5t}$ A

C. $i(t)=7.5e^{-10t}$ A

D. $i(t)=(7.5 + 1.5t)e^{-5t}$ A

Ans. B

Sol. For t < 0:

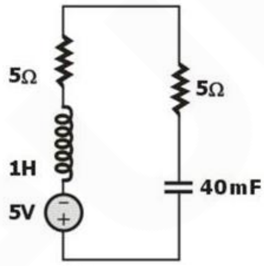


$i(0^-) = \frac{10+5}{5+5} = \frac{15}{10} = 1.5\,A$

$-5 + 5i(0^-) - V_C(0^-) = 0$ (KVL in the right sided mesh)

$V_C(0^-) = -5 + 5(1.5) = 2.5V$

For t > 0, the circuit becomes as an RLC series network.



Characteristic equation,

$s^2 + \frac{R}{L}s + \frac{1}{LC} = 0$

$s^2 + \frac{10}{1}s + \frac{1}{1 \times 40 \times 10^{-3}} = 0 \quad (R = 5 + 5 = 10\Omega)$

$s^2 + 10s + 25 = 0$

Roots, $(s + 5)^2 = 0 \Rightarrow s_1 = = -5$, $s_2 = -5$

$\alpha = \frac{10}{2} = 5, \omega_0 = 5$

$\alpha = \omega_0$ (Critically damped)

So, $i(t) = (A + Bt)\,e^{-at}$

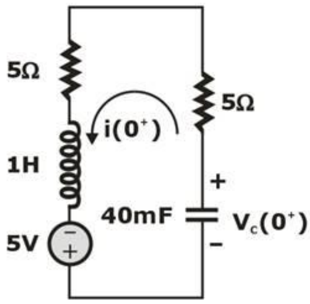
$i(t) = (A + Bt)\,e^{-5t}$

Now, we obtain A and B using initial conditions

$I(0^-) = i(0^+) = 1.5 = (A + 0)\,e^0 = A$

A = 1.5

At $t = 0^+$,



Writing KVL at t = 0^+

$$-5+L\frac{di(0^+)}{dt}+5i(0^+)-V_C(0^+)=0$$

$$-5+L\frac{di(0^+)}{dt}+10\times1.5-2.5=0$$

$$L\frac{di(0^+)}{dt}=-7.5$$

Differentiating equation (1)

$$\frac{di(t)}{dt}=(A+Bt)(-5e^{-5t})+Be^{-5t}$$

$$\frac{di(0^+)}{dt}A(-5)+B=-7.5$$

B = −7.5 + 5(A) = −7.5 + 5(1.5) = 0

So $i(t) = 1.5e^{-5t}$A

59. The solution curve of the differential equation $x\frac{dy}{dx}=y+2x^3$ passes through the point (1,0). Then among the points given below, the curve also passes through:

A. (-1, 0) B. (0, -1)

C. (2, 10) D. (-2, 6)

Ans. A

Sol. The differential equation can be written as:

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

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

$$which\ is\ a\ linear\ equation\ in\ 'y'$$

$$IF=e^{-\int\frac{1}{x}dx}=e^{-\log x}=-\frac{1}{x}$$

Thus, the solution of the equation will be:

$$y\,x\,IF=\int 2x^2 x\,IF\,dx$$

$$-\frac{y}{x}=-\int 2\,x\,dx$$

$$\frac{y}{x}=x^2+C$$

Putting (1,0) we get $C=-1$

Thus,

$$\frac{y}{x}=x^2-1$$

Clearly only (-1,0) satisfies the above equation.

60. Consider the channel

$$P(Y/X)=\begin{bmatrix}0.6 & 0.2 & 0.2\\0.2 & 0.6 & 0.2\\0.2 & 0.2 & 0.6\end{bmatrix}$$

$P(X_1)$ =1/8 $P(X_2)$ =1/8 $P(X_3)$ =6/8

Calculate information carried by the channel.

Sol. We have

$$P(X,Y)=\begin{bmatrix}0.6/8 & 0.2/8 & 0.2/8\\0.2/8 & 0.6/8 & 0.2/8\\0.2\times6/8 & 0.2\times6/8 & 0.6\times6/8\end{bmatrix}$$

Now $H=\sum_{k=1}^{N}P_k\log_2\left(\frac{1}{P_k}\right)$ bits/message

$$H(Y)=\frac{1}{4}\log_2 4+\frac{1}{4}\log_2 4+\frac{1}{2}\log_2 2$$

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

$$H(X,Y)=4\left(\frac{0.2}{8}\log_2\frac{8}{0.2}\right)+2\left(\frac{0.6}{8}\log_2\frac{8}{0.6}\right)+2\left(\frac{0.2\times6}{8}\log_2\frac{8}{1.2}\right)+\frac{0.6\times6}{8}\log_2\frac{8}{3.6}$$

=2.432

$$H(X)=\frac{1}{8}\log_2 8+\frac{1}{8}\log_2 8+\frac{6}{8}\log_2\frac{8}{6}$$

=1.0613

Now mutual information is given by

$$I(X,Y)=H(X)+H(Y)-H(X,Y)$$

= 1.0613+1.5- 2.432

= 0.1293

61. The characteristic equation of the system is

C.E = $s^5-2s^4-2s^3+4s^2+s-2$ = 0

The number of symmetric poles located in right half of s-plane is

A. 3 B. 1

C. 4 D. 2

Ans. D

Sol. C.E = $s^5 - 2s^4 - 2s^3 + 4s^2 + s - 2$ = 0

s^5	1	−2	1
s^4	−2	4	−2
s^3	0(−1)	0(1)	0
s^2	+2	−2	0
s^1	0(4)	0	0
s^0	−2		

$AE_1 = -2s^4 + 4s^2 - 2 = 0$

$\frac{d}{ds}AE_1 = -8s^3 + 8s \Rightarrow$ take 8 common $\Rightarrow -1, 1$

$AE_2 = 2s^2 - 2 = 0$

$\frac{d}{ds}AE_2 = 4s$

3 signs changes in the first columns

$\Rightarrow AE_1 = -2s^4 + 4s^2 - 2 = 0$

Or, $s^4 - 2s^2 + 1 = 0$

Or, $(s^2 - 1)^2 = 0$

$\therefore \Rightarrow$ There are two symmetric poles are located in RHP.

$\Rightarrow$ 1 non symmetric pole in RHP.

Total 3 poles in RHP.

62. All queens and kings are removed from a deck of playing cards. Ace will be considered as 1 and jack will be considered as 0. You took out 4 cards. The probability that all cards will be in order (order is – 1234,0123,2345,6789….) from the same deck is M. What is (M x 10^5)?

A. 0.982 B. 0.700

C. 0.643 D. 0.500

Ans. A

Sol. Total cards = 52 – 4 – 4 = 44 (cards)

→ You took out 4 cards

∴ (1) Let order be 0, 1, 2, 3

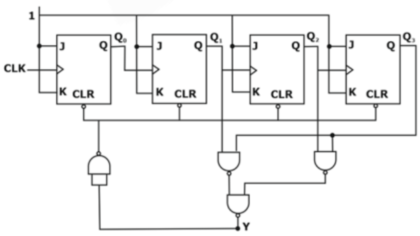
So, $P(\text{order} - 0, 1, 2, 3) = \frac{4}{44} \times \frac{1}{43} \times \frac{1}{42} \times \frac{1}{41} = x$

∴ Lost possible set – (7, 8, 9, 10) – 8 such sets are possible

∴ P (Total) = 8 × P(order – 0, 1, 2, 3) = 8x

⇒ 8x × 10^5 = 0.982

63. Consider the counter circuit shown in figure below:



Then the modulus of the given counter is __________.(Assume Q_3 be MSB & Q_0 be LSB)

Sol. Let the initial contents of the flip-flops ($Q_3Q_2Q_1Q_0$) be 0000

To reset the counter, output Y must be equal to 1.

The expression for the output Y is given as

$$Y = \overline{\overline{Q_1Q_3} \cdot \overline{Q_2Q_3}}$$
$$= \overline{\overline{Q_1Q_3}} + \overline{\overline{Q_2Q_3}} = Q_1Q_3 + Q_2Q_3$$
$$= Q_3(Q_1 + Q_2)$$

So, from the table below,

S.No.	Q_3	Q_2	Q_1	Q_0	Y
0	0	0	0	0	0
1	0	0	0	1	0
2	0	0	1	0	0
3	0	0	1	1	0
4	0	1	0	0	0
5	0	1	0	1	0
6	0	1	1	0	0
7	0	1	1	1	0
8	1	0	0	0	0
9	1	0	0	1	0
10	**1**	**0**	**1**	**0**	**1**

Now, the output Y becomes 1, hence the combination ($Q_3Q_2Q_1Q_0$) becomes 1010.

The decimal equivalent of 1010 is 10. Hence the modulus of the given counter is 10.

64. A uniform plane wave with E= $a_x E_x$ propagates in a lossless medium $(\varepsilon_r = 4, \mu_r = 1, \sigma = 0)$ in the +z direction. Consider E_x is sinusoidal with a frequency 100(MHz) and has a maximum value of $+10^{-4}$ (V/m) at t=0 and z=1/8 m. Instantaneous expression for H is _____.

A.

H(z,t)= $a_x \frac{10^{-4}}{60\pi}\cos(2\pi 10^8 t + \frac{4\pi}{3}(z - \frac{1}{8}))$ A/m

B.

H(z,t)= $a_y \frac{10^{-4}}{60\pi}\cos(2\pi 10^8 t - \frac{4\pi}{3}(z - \frac{1}{8}))$ A/m

C.

H(z,t)= $a_z \frac{10^{-4}}{60\pi}\cos(2\pi 10^8 t - \frac{4\pi}{3}(z - \frac{1}{8}))$ A/m

D.

H(z,t)= $a_x \frac{10^{-4}}{60\pi}\cos(2\pi 10^8 t - \frac{4\pi}{3}(z + \frac{1}{8}))$ A/m

Ans. B

Sol. AS we know , standard equation of Plane wave is :

E(z,t) =E $\cos(\omega t - \beta z + \varphi)$

So , here we need to calculate β, *wave number*.

$$\beta = \omega\sqrt{\varepsilon\mu} = \frac{\omega}{c}\sqrt{\mu_r\varepsilon_r}$$

f = 100MHz =10^8Hz

$$\beta = \frac{4\pi}{3}$$

Therefore, E(z,t)= $a_x E_x$ =

$a_x 10^{-4}\cos(2\pi 10^8 t - \beta z + \varphi)$

$= a_x 10^{-4}\cos(2\pi 10^8 t - \frac{4\pi}{3} z + \varphi)$

Since E_x equals + 10^{-4} when the argument of the cosine function equals zero, i.e.

$2\pi 10^8 t - \frac{4\pi}{3} z + \varphi$=0 when t=0, z=1/8

$$\varphi = \frac{\pi}{6}\ rad$$

So

E(z,t)= $a_x 10^{-4}\cos(2\pi 10^8 t - \frac{4\pi}{3} z + \frac{\pi}{6})$

Now, instantaneous expression for H is , H= $a_y H_y$=$a_y\frac{E_x}{\eta}$

Where, $\eta = \sqrt{\frac{\mu}{\varepsilon}} = \frac{\eta_0}{\sqrt{\varepsilon_r}}$ = 60π (Ω)

Hence,

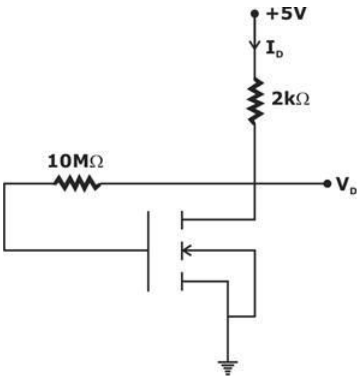
H(z,t)= $a_y\frac{10^{-4}}{60\pi}\cos(2\pi 10^8 t - \frac{4\pi}{3} z + \frac{\pi}{6})$ A/m

H(z,t)= $a_y\frac{10^{-4}}{60\pi}\cos(2\pi 10^8 t - \frac{4\pi}{3}(z - \frac{1}{8}))$ A/m

65. For on n–channel E – MOSFFT used in the circuit shown below, the threshold voltage, V_T = 1V, the channel length modulation parameter

I = 0 and $\mu_n C_{ox}\frac{W}{L}$ = 0.3 mA/V².

Then the output voltage V_o is



A. –3.35 V B. 3.35 V

C. –4.68 V D. 4.68 V

Ans. B

Sol. Given,

Threshold voltage, V_T = 1V

$\mu_n C_{ox}\frac{W}{L}$ = 0.3 mA/v²

As drain and gate are connected together MOSFET is in saturation region.

Drain current,

$$I_D = \frac{5 - V_0}{2k\Omega} \quad \text{———— (i)}$$

But,

$$I_D = \frac{1}{2}(0.3\times 10^{-3})(V_{GS} - 1)^2 \quad \text{—— (ii)}$$

Equating equation (i) & (ii)

$$\frac{5 - V_0}{2k\Omega} = \frac{1}{2}(0.3\times 10^{-3})(V_{GS}-1)^2$$

Since, V_{GS} = 0

$$\frac{5 - V_0}{2k\Omega} = \frac{1}{2}(0.3\times 10^{-3})(V_o-1)^2$$

$5 - V_0 = 0.3\ (V_0 - 1)^2$

$5 - V_0 = 0.3\ (V_0^2 - 2V_0 + 1)$

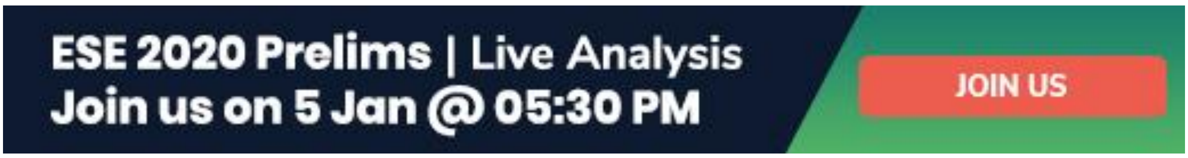
$5 - V_0 = 0.3\ V_0^2 - 0.6V_0 + 0.3$

$$V_0 = \frac{-4 \pm \sqrt{16 + 4(3)(47)}}{6}\ V$$

Since, V_0 can be only +Ve

$$V_0 = \frac{-4 + \sqrt{580}}{6} = 3.35\ V$$

****



VIEW PACKAGE
BUY NOW
TEST SERIES