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## DFCCIL Executive

 Electronics Engineering
## Mini Mock Challenge

 (June 12th - June 13th 2021)
## Questions \& Answer Key

1. Where is the first Vedic school was established?
A. Farrukhabad
B. Mirzapur
C. Kasganj
D. Varanasi

Sol.: The first Vedic school was established at Farrukhabad in 1869. 50 students were enrolled in its first year. This success led to the founding of schools Mirzapur (1870) , Kasganj(1870) , Chhalesar (Aligarh) (1870) and Varanasi(1873).
2. What is the location of Nokrek biosphere reserves of India?
A. Part of Annupur (Madhya Pradesh)
B. Part of Garo hills (Meghalaya)
C. Part of Siang (Arunachal Pradesh)
D. Part of Kuchchh (Gujarat)

Sol.: Part of Garo hills (Meghalaya) is the location of Nokrek biosphere reserve of India. UNESCO added this National park to its list of Biosphere Reserves in May 2009. Along with Balphakram national park, Nokrek is a hotspot of biodiversity in Meghalaya.
3. Monistic theory of sovereignty stated by
A. Aristotle
B. Bodin
C. Austin
D. None of these

Sol.: In the $19^{\text {th }}$ century the theory of sovereignty as a legal concept was perfected by Austin, an English Jurist. He is regarded as a greatest exponent of Monistic Theory.
4. Production refers to
A. Destruction of utility
B. Creation of utilities
C. Exchange value
D. Use of a product

Sol.: Production refers to "Creation of utilities having value in exchange" The process of production may create six types of utilities.

1 Form utilities
2 Time utilities
3 Place utilities
4 Onership utilities
5 Service utilities
6 Knowledge utilities
Hence, option is C correct.
5. Directions: In each of the following questions, select the related word/ letters/ number/ figure from the given alternatives.
KML : NPO : : CED : ?
A. EGF
B. GHF
C. FHG
D. HGF

Sol.: The relation depicted by the above question is as follows:
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Similarly;


Hence Option C is correct
6. A boy runs 20 m towards East and turns to right, runs 10 m and turns to right, runs 9 m and again turns to right, runs 5 m and turns to left, runs 12 m and finally turns to right and runs 6 m . Now, which direction is the boy facing?
A. East
B. West
C. North
D. South

Sol.:


Thus, it is clear that the boy will face towards North.
Hence, C is correct.
7. Directions: In each of the following questions, a series is given, with one term missing. Choose the correct alternative from the given ones that will complete the series.

WORLD, XPSME, ?, ZRUOG
A. YQTNF
B. YRTNF
C. YTQNF
D. YQNTF

Sol.:

$\mathrm{O} \xrightarrow{+1} \mathrm{P} \xrightarrow{+1} \mathrm{Q} \xrightarrow{+1} \mathrm{R}$
$\mathrm{R} \xrightarrow{+1} \mathrm{~S} \xrightarrow{+1} \mathbf{T} \xrightarrow{+1} \mathrm{U}$
$\mathrm{L} \xrightarrow{+1} \mathrm{M} \xrightarrow{+1} \mathrm{~N} \xrightarrow{+1} \mathrm{O}$
$\mathrm{D} \xrightarrow{+1} \mathrm{E} \xrightarrow{+1} \mathrm{~F} \xrightarrow{+1} \mathrm{G}$
8. The sum of ages of 4 children born at intervals of 4 years each is 60 . What is the age of the youngest child?
A. 7
B. 9
C. 10
D. 12

Sol.: Let age of youngest child be $x$ years.
As, 4 children born at intervals of 4 years each.
Hence, $(x)+(x+4)+(x+8)+(x+12)=60$
$4 x+24=60$
$4 x=36$
$X=9$ years.
So, age of the youngest child is 9 years.
9. Respective ratio of curved surface area and total surface area of cylinder is $1: 4$ and total surface area of that cylinder is $1232 \mathrm{~cm}^{2}$ then what is its volume?
A. 1078
B. $1078 \sqrt{3}$
C. $592 \sqrt{3}$
D. $3000 \sqrt{3}$

Sol.: According to question
$\frac{2 \pi r(r+h)}{2 \pi r h}=\frac{4}{1}$
$\frac{\mathrm{r}+\mathrm{h}}{\mathrm{h}}=\frac{4}{1}$
$r+h=4 h$
$\therefore r=3 h$
Total surface area of Cylinder -
$2 \times 22 / 7 \times 3 h(3 h+h)=1232$
$\frac{3 h \times 4 h}{7}=28$
$h^{2}=49 / 3$
$\therefore h=7 / \sqrt{ } 3$
Volume $=\pi r^{2} h=22 / 7 \times(3 h)^{2} \times h=22 / 7 \times 9 \times 49 / 3 \times 7 / \sqrt{ } 3=1078 \sqrt{ } 3$
10. $A$ and $B$ together have Rs. 6300. If $5 / 19$ of $A$ 's amount is equal to $2 / 5$ of $B$ 's amount. The amount of ' B ' is how much?
A. Rs. 2500
B. Rs. 3800
C. Rs. 2300
D. Rs. 4000

Sol.: According to the Question:
$5 / 19$ of $A$ 's amount is equal to $2 / 5$ of $B$ 's amount and $A$ and $B$ together have Rs. 6300 . Therefore,
$\frac{5}{19} A=\frac{2}{5} B$
$A+B=6300$
By using eq(2) in eq (1)
$\frac{5}{19}(6300-B)=\frac{2}{5} B$
$\rightarrow 25 \times 6300=63 \mathrm{~B}$
$\rightarrow B=$ Rs. 2500
11. An article is sold at a loss of $10 \%$. Had it been sold for Rs. 9 more, there would have been a gain of $12 \frac{1}{2} \%$ on it. The cost price of the article is
A. Rs. 40
B. Rs. 45
C. Rs. 50
D. Rs. 35

Sol.: Let the cost price of the article $=$ Rs. $x$
Selling price at $10 \%$ loss $=x \times \frac{90}{100}=$ Rs. $9 x$
Selling price at $12 \frac{1}{2} \%$ gain $=x \times \frac{100+12 \frac{1}{2}}{100}=$ Rs $\cdot \frac{225 x}{200}$
according to the question,
$9 x+9=\frac{225 x}{200}$
$\Rightarrow 180 \mathrm{x}+1800=225 \mathrm{x}$
$\Rightarrow 225 \mathrm{x}-180 \mathrm{x}=1800$
$\Rightarrow 45 \mathrm{x}=1800$
$\therefore \mathrm{x}=$ Rs. 40
12. What number must be added to the expression $16 a^{2}-12 a$ to make it a perfect square?
A. 9/4
B. $11 / 2$
C. $13 / 2$
D. 16

Sol.: Let $d$ be the number that needs to be added such that $16 a^{2}-12 a+d$ is perfect square.
let it be the square of $4 a-n$.
$(4 a-n)^{2}=16 a^{2}-8 n+n^{2}$
$8 \mathrm{n}=12 \mathrm{a}$
$\mathrm{n}=3 / 2$
$d=n^{2}=9 / 4$
13. Consider the circuit shown below :


The value of the supply voltage VCC $=10 \mathrm{~V}$ and the value of $\beta=100$. The stability factor ' S ' due to the reverse saturation current ICO is equal to
A. 43.24
B. 50.75
C. 23.23
D. 91.11

Sol.: $\therefore S=\frac{\partial \mathrm{I}_{\mathrm{C}}}{\partial \mathrm{I}_{\mathrm{C}_{0}}}=\frac{1+\beta}{1-\beta \cdot \frac{\partial \mathrm{I}_{\mathrm{B}}}{\partial \mathrm{I}_{\mathrm{C}}}}=\frac{1+\beta}{1+\frac{\beta \mathrm{R}_{\mathrm{C}}}{\mathrm{R}_{\mathrm{C}}+\mathrm{R}_{\mathrm{B}}}}$
$=\frac{101}{1+\frac{100 \times 0.5 \times 10^{3}}{0.5 \times 10^{3}+50 \times 10^{3}}}=\frac{101}{1+\frac{50}{50.5}}=\frac{101}{100.5} \times 50.5=50.751$
14. Which one of the following is the dual form of the Boolean identity given above? $A B+\bar{A} C=(A+C)(\bar{A}+B) \ldots$
A. $\mathrm{AB}+\overline{\mathrm{AC}}=\mathrm{AC}+\overline{\mathrm{A}}$
B. $(A+B)(\bar{A}+C)=(A+C)(\bar{A}+B)$
C. $(A+B)(\bar{A}+C)=A C+\bar{A} B$
D. $A B+\bar{A} C=A B+\bar{A} C+B C$

Sol.: $\quad A B+\bar{A} C=(A+C)(\bar{A}+B)$
Taking dual of the equation
$(A+B)(\bar{A}+C)=A C+\bar{A} B$
while taking dual AND dual is OR while literals are not changed
15. The breakaway point in the root loci plot of the unity negative feedback system with loop transfer function $G(s)=\frac{K}{s\left(s^{2}+6 s+12\right)}$ is
A. -1.5
B. -2
C. -1
D. -2.2

Sol.: Given,
$G(s)=\frac{K}{s\left(s^{2}+6 s+12\right)}$
$1+G(s)=0$
or, $s\left(s^{2}+6 s+12\right)+K=0$
or, $K=-\left(s^{3}+6 s^{2}+12 s\right)$
For break away point, $\frac{\mathrm{dK}}{\mathrm{ds}}=0$
or, $3 s^{2}+12 s+12=0$
or, $s^{2}+4 s+4=0$
or, $(s+2)^{2}=0$
or, $s=-2,-2$
For given O.L.T.F., $P=3, Z=0, P-Z=3$


Poles are at $s=0$ and $s=-3 \pm j \sqrt{3}=-3 \pm j 1.732$
Since entire -ve real axis is a part of root locus, therefore $s=-2$ is a valid breakaway point.
16. The ripple factor of the output signal of an ideal full-wave bridge rectifier with a sinusoidal signal as input is equal to
A. 0.24
B. 0.48
C. 1.21
D. 1.41

Sol.: Ripple factor $=\sqrt{\left(\frac{\mathrm{V}_{\mathrm{rms}}}{\mathrm{V}_{\mathrm{de}}}\right)^{2}-1}$
For a full-wave rectifier output,
$V_{r m s}=\frac{V_{m}}{\sqrt{2}}$
$V_{\text {de }}=\frac{2 V_{m}}{\pi}$

So, Ripple factor $=\sqrt{\left(\frac{\pi}{2 \sqrt{2}}\right)^{2}-1}=0.48$
17. The combinational circuit shown in the figure below represents

A. Priority Encoder
B. Comparator Circuit
C. Binary to Grey code converter
D. Odd sequence circuit

Sol.: This Circuit can be reduced as


Binary to Grey code converter
18. Match list I (Modulation schemes) with list II (Applications) and select correct answer using the codes given below the lists :-

## List I

A) wide band FM
B) narrow band FM
C) standard $A M$
D) VSB AM

## List II

1) Mobile communication
2) TV video transmission
3) Tv audio transmission
4) medium wave broadcasting
A. $a-3, b-1, c-4, d-2$
B. $a-3, b-4, c-1, d-2$
C. $a-4, b-3, c-2, d-L$
D. $a-1, b-2, c-3, d-4$

Sol.: Wide band FM = TV audio transmission
Narrow band FM = First generation mobile

Standard AM = Medium wave broadcasting
VSB - AM $=$ TV video transmission
19. An analog voltage of 3.41 V is converted into 8 -bit digital form by an $\mathrm{A} / \mathrm{D}$ converter with a reference voltage of 5 V . The digital output is.
A. 10011001
B. 11110001
C. 10110111
D. 10101110

Sol.: Resolution $=\frac{V_{R}}{2^{n}-1}$
Analog output $=$ Resolution * decimal equivalent (D)
$3.41=\frac{5}{2^{8}-1} * D$
$D \approx 174$
$(174)_{10}=10101110_{2}$
20. In a series RLC circuit phasor diagram at a certain frequency is shown in figure, then operating frequency is?

A. $f=0$
B. $f=f_{0}$
C. $\mathrm{f}<\mathrm{f}_{\mathrm{o}}$
D. $\mathrm{f}>\mathrm{fo}$

Sol.: As we know in resistor both voltage and current will be in phase with each other. Here $\mathrm{V}_{\mathrm{r}}$ direction is in current direction


Since current leads the voltage, the nature of the circuit is capacitive and hence the operating frequency is $f<f_{o}$

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21. In a time-of-flight mass spectrometer if $q$ is the charge and $m$ the mass of the ionized species, then the time of flight is proportional to
A. $\frac{\sqrt{\mathrm{m}}}{\sqrt{\mathrm{q}}}$
B. $\frac{\sqrt{q}}{\sqrt{m}}$
C. $\frac{m}{\sqrt{q}}$
D. $\frac{\mathrm{q}}{\sqrt{\mathrm{m}}}$

Sol.: We know that the Time of flight $t$ is given by
$\mathrm{t}=\frac{\mathrm{d}}{\sqrt{2 \mathrm{~V}}} \sqrt{\frac{\mathrm{~m}}{\mathrm{q}}}$ Hence t is directly proportional to $\sqrt{\frac{\mathrm{m}}{\mathrm{q}}}$
22. Consider the following circuit


The network ' N ' contains dependent sources and only resistances
Current $\mathrm{I}=4 \mathrm{~A}$ when $\mathrm{R}_{\mathrm{L}}=1$ ohm and
Current $\mathrm{I}=2 \mathrm{~A}$ when $\mathrm{RL}_{\mathrm{L}}=4$ ohm
The value of ' $I$ ' when $R=2$ ohm and 10 V source is replaced by 5 V source is
A. 0.5 A
B. 1.0 A
C. 1.5 A
D. 3 A

Sol.: The thevenin equivalent of the given network

$\frac{\mathrm{V}_{\mathrm{th}}}{\mathrm{R}_{\mathrm{th}}+1}=4 \rightarrow(1)$
$\frac{V_{\mathrm{th}}}{\mathrm{R}_{\mathrm{th}}+4}=2 \rightarrow(2)$
From the eq (1) and (2)
$\mathrm{V}_{\mathrm{th}}=12 \mathrm{~V}$ and $\mathrm{R}_{\mathrm{th}}=2 \mathrm{ohm}$
So, when the source is 10 V then the response $\mathrm{V}_{\mathrm{th}}=12 \mathrm{~V}$. By the principle of homogeneity principle, when the excitation is 5 V then the response $\mathrm{V}_{\mathrm{th}}=\frac{12}{2}=6 \mathrm{~V}$;


But $R_{t h}$ is independent of the magnitude of excitation
$\Rightarrow I=\frac{6}{2+2}=\frac{3}{2}=1.5 \mathrm{~A}$
23. Match the following Lists

## List-I

A. Gauss's law
B. Continuity Equation
C. Faraday's law
D. Ampere's law

## List-I

1. $\nabla \times \overline{\mathrm{E}}=\frac{-\partial \overline{\mathrm{B}}}{\partial \mathrm{t}}$
2. $\nabla \times \overline{\mathrm{H}}=\mathrm{J}_{\mathrm{c}}+\frac{\partial \overline{\mathrm{D}}}{\partial \mathrm{t}}$
3. $\nabla \cdot \vec{j}=\frac{-\partial \rho \mathrm{v}}{\partial \mathrm{t}}$
4. $\nabla \cdot \overline{\mathrm{D}}=\rho_{\mathrm{r}}$
A. A-4 B-3 C-2 D-1
B. A-4 B-2 C-3 D-1
C. A-3 B-4 C-2 D-1
D. A-4 B-3 C-1 D-2

Sol.: A. Gauss's law is $\nabla \cdot \vec{D}=\rho_{\mathrm{v}}$
B. Continuity Equation is $\nabla \cdot \overline{\mathrm{J}}=\frac{-\partial \rho_{v}}{\partial \mathrm{t}}$
C. Faraday's law is $\int \overline{\mathrm{E}} \cdot \mathrm{d} \bar{\ell}=\int_{\mathrm{s}} \frac{-\partial \overline{\mathrm{B}}}{\partial \mathrm{t}} \cdot \mathrm{d} \overline{\mathrm{S}}$
$\Rightarrow \nabla \times \overline{\mathrm{E}}=\frac{\partial \overline{\mathrm{B}}}{\partial \mathrm{t}}$
D. Ampere's law is $\int \overline{\mathrm{H}} \cdot \mathrm{d} \ell=\int_{\mathrm{c}} \overrightarrow{\mathrm{j}} \cdot \mathrm{ds}$
$\Rightarrow \nabla \times \overline{\mathrm{H}}=\overline{\mathrm{J}}$
24. A single bus structure is primarily found in
A. Main frames
B. Mini and micro computers
C. super computers
D. High performance machines

Sol.: A single bus structure is primarily found in Mini and micro computers.
25. The average successful search time for sequential search ' $n$ ' items is
A. $\frac{(\mathrm{n}+1)}{2}$
B. $\frac{\mathrm{n}}{2}$
C. $(\mathrm{n}-1)$
D. $\log (n)+1$

Sol.:

| 1 | 2 | 3 | 4 | $\cdots \cdots$ | $n-1$ | $n$ |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- |

Search $1 \rightarrow 1$ comparison
Search $2 \rightarrow 2$ comparison
Search $n \rightarrow n$ comparison
Total comparison $=1+2+\ldots .+n=\frac{n(n+1)}{2}$
Average successful comparisons $=\frac{n(n+1)}{n 2}=\frac{(n+1)}{2}$
26. A parallel plate guide is partially filled with two lossless dielectrics as shown below. At a certain frequency the TM mode propagates through the guide without suffering any reflective loss at the dielectric interface.

A. 8.6 GHz
B. 12.8 GHz
C. 4.3 GHz
D. 7.5 GHz

Sol.: The ray angle is such that wave is interface at Brewster angle
$\phi_{\mathrm{B}}=\tan ^{-1} \sqrt{\frac{2.1}{4}}=35.9^{\circ}$
The ray angle $=90-35.9=54.1^{\circ}=\theta$
$\mathrm{f}_{\mathrm{c}_{1}}=\frac{\mathrm{c}}{2 \lambda \sqrt{\epsilon_{\mathrm{r}_{1}}}}=\frac{3 \times 10^{10}}{4}=7.5 \mathrm{GHz}$
$f=\frac{f_{c 1}}{\cos \theta}=\frac{7.5}{\cos 54.1^{\circ}}=12.8 G H z$
27. The impedance (in ohm) looking into nodes 1 and 2 in the given circuit is :

A. 99.90
B. 89.80
C. 113.60
D. 130.90

Sol.: The given circuit can be redrawn is


To find the impedance between node 1 and node 2 , connect a 1 V voltage source across the nodes which supplies current $I_{T}$ to the circuit

So impedance $=Z=\frac{1}{\mathrm{I}_{T}}$
Now

$I=-\frac{1}{8}=-0.125 m A$
$I^{\prime}=\frac{1}{80}=0.0125 \mathrm{~mA}$
KCL at node,

$$
\begin{aligned}
& \mathrm{I}^{\prime}=\mathrm{I}+60 \mathrm{I}+\mathrm{I}_{\mathrm{T}} \\
& \Rightarrow \mathrm{I}_{\mathrm{T}}=\mathrm{I}^{\prime}-61 \mathrm{I} \Rightarrow(0.0125+7.625) \mathrm{mA} \\
& \Rightarrow \mathrm{I}_{\mathrm{T}}=7.6375 \mathrm{~mA} \\
& \mathrm{Z}=\frac{1}{\mathrm{I}_{\mathrm{T}}}=\frac{1}{7.6375 \times 10^{-3}} \Omega=130.93 \Omega
\end{aligned}
$$

28. A dual trace CRO has $\qquad$ vertical and $\qquad$ horizontal amplifier.
A. 2,1
B. 1, 2
C. 2, 2
D. 1,1

Sol.: A dual trace CRO has 1 vertical and 1 horizontal amplifier.
29. Which of the following are included in the architecture of computer?
1). Addressing modes, design of CPU
2). Instruction set, data formats
3). Secondary memory, operating system

Which of the statements given above are correct?
A. 1 and 2 only
B. 2 and 3 only
C. 1 and 3 only
D. 1, 2 and 3

Sol.: Addressing modes, designed of CPU, instructions set and data are particular to specific CPU.

Secondary memory and operating system cab work with different computer with different architecture hence, there are not part of computer architecture.
30. The equivalent circuit of a practical op-amp can be given as
A.


B.


C.


D.



Sol.: The circuit which represents op-amp parameters in terms of physical components, for the analysis purpose is called equivalent circuit of an op-amp.


The circuit shows the op-amp parameters like input resistance, output resistance, the open loop voltage gain in terms of circuit components like Rin R0 etc.
31. The message signal $\mathrm{m}(\mathrm{t})=4 \cos (800 \mathrm{t})+6 \sin \left(600 \mathrm{t}+\frac{\pi}{6}\right)$ DSB-SC modulates the carrier signal $c(t)=20 \cos (1600 t$ ). Find average power (in watts) of the modulated signal.
A. 2400
B. 5200
C. 7200
D. 1200

Sol.: $s(t)=m(t) c(t)=m(t) A_{c}\left(\cos \omega_{c} t\right)=m(t) \frac{A_{c}}{2}\left(e^{j \omega_{c} t}+e^{-j \omega_{c} t}\right)$
$s(t)=\frac{A_{c}}{2} m(t) e^{j \omega_{c} t}+\frac{A_{c}}{2} m(t) e^{-j \omega_{c} t}$
Power content, $P_{t}=P_{1}+P_{2}$
$P_{1}=\int_{-\infty}^{\infty}\left|\frac{A_{c}}{2} e^{-j \omega_{c} t} m(t)\right|^{2} d t=\frac{A_{c}^{2}}{4} \int_{-\infty}^{\infty}|m(t)|^{2} d t$
$P_{1}=\frac{A_{c}^{2}}{4} \cdot P_{m}$
Similarly $P_{2}=\frac{A_{c}^{2}}{4} P_{m}$
$P_{t}=P_{1}+P_{2}=\frac{A_{c}^{2}}{2} P_{m}$
$P_{m}=\left(\frac{4}{\sqrt{2}}\right)^{2}+\left(\frac{6}{\sqrt{2}}\right)^{2}=\frac{16}{2}+\frac{36}{2}=8+18=26 W$
$\mathrm{Ac}_{\mathrm{c}}=20 \mathrm{~V}$
$P_{t}=\frac{(20)^{2}}{2} \times 26=5200 \mathrm{~W}$
32. Consider the current repeater circuit shown below.


Assume all the transistors are matched with $\beta=100$ and negligible $I_{\text {co }}$ and $I_{\text {reff }}=21 \mathrm{~mA}$, then the value of current Ic flow through the transistors is equal to
A. 20.19 mA
B. 18.11 mA
C. 14.27 mA
D. 16.83 mA

Sol.:
$I_{C}=\frac{I_{\text {reff }}}{\left(1+\frac{N}{\beta}\right)} ;$ Here $N=4$
$=\frac{21 \times 10^{-3}}{1+\left(\frac{4}{100}\right)}=\frac{25}{26} \times 21 \mathrm{~mA}=20.19 \mathrm{~mA}$
33. Match the following parameters given in column $A$ to their respective formulae given in column $B$ for $a$ dual input balanced output differential amplifier.

## Column A

1) Differential voltage Gain
2) Output Resistance
3) CMRR

## Column B

a. $A_{d} / A_{c}$
b. $\mathrm{Rc} / \mathrm{r}_{\mathrm{E}}$
c. Rc
A. 1-a, 2-b, 3-c
B. 1-c, 2-b, 3-a
C. 1-b, 2-c, 3-a
D. 1-a, 2-c, 3-b

Sol.:

1. Output voltage, $\mathrm{V}_{\mathrm{o}}=\left(\mathrm{Rc}_{\mathrm{c}} / \mathrm{r}_{\mathrm{E}}\right)\left(\mathrm{V}_{\text {in1 }}-\mathrm{V}_{\text {in2 }}\right)$

Thus, the differential gain, $A_{d}=R_{c} / r_{E}$
This proves a differential amplifier amplifies the difference between two input signals.
2. The ability of a differential amplifier to reject common mode signal is called Common Mode Rejection Ratio (CMRR).
CMRR = |differential gain/common mode gain|
$C M R R=\left|A_{d} / A_{c}\right|$
3. The output is measured across the collector. Hence output resistance $R_{o}=R c$.
34. Determine the instantaneous frequency in Hz for signal at $\mathrm{t}=0$
$f(t)=\cos 400 \pi t \cos (10 \sin 4 \pi t)+\sin 400 \pi t \sin (10 \sin 4 \pi t)$
A. 95
B. 100
C. 180
D. 200

Sol.: $f(t)=\cos 400 \pi t \cos (10 \sin 4 \pi t)+\sin 400 \pi t \sin (10 \sin 4 \pi t)=\cos (400 \pi t-10 \sin 4 \pi t)$
$\Theta(t)=400 \pi t-10 \sin 4 \pi t$
$\omega_{\mathrm{i}}=\frac{\mathrm{d} \theta(\mathrm{t})}{\mathrm{dt}}=400 \pi-40 \pi \cos 4 \pi \mathrm{t}$
At $t=0, \omega_{i}=400 \pi-40 п$
$f i=\frac{400 \pi}{2 \pi}-\frac{40 \pi}{2 \pi}$
fi $=200-20=180 \mathrm{~Hz}$
35. Consider the Schmitt trigger circuit shown below:


If the op-amp is ideal, then the value of lower threshold voltage $V_{T L}$ is equal to
A. -2 V
B. 2 V
C. -4 V
D. 4 V

Sol.: At $\mathrm{V}_{\mathrm{n}}$ the output must be
$-\mathrm{V}_{\text {sat }}=-10 \mathrm{~V}$,
Thus, the value of voltage
$V_{A}=-10 \times \frac{5}{25}=-2 \mathrm{~V}$
Thus, the input voltage for which the transition occurs will be when $\mathrm{V}_{\mathrm{A}}=\mathrm{V}_{\mathrm{B}}=-2 \mathrm{~V}$
Thus applying KCL at node ' A ', we get
$\frac{\mathrm{V}_{\mathrm{B}}-\mathrm{V}_{\mathrm{i}}}{10 \mathrm{k} \Omega}+\frac{\mathrm{V}_{\mathrm{B}}-2}{20 \mathrm{k} \Omega}>0$
Thus, $\frac{-2-\mathrm{V}_{\mathrm{TL}}}{10 \mathrm{~K} \Omega}+\frac{-2-2}{20 \mathrm{k} \Omega}=0$
$V_{A}=-4 V$

36. Which of the following statement is correct with respect to receivers in analog communication?
A. TRF receiver has good selectivity but poor sensitivity.
B. Superheterodyne receivers has good gain hence good sensitivity, selectivity as well as fidelity
C. FM receivers show good fidelity over AM receivers
D. All the above statements are correct.

Sol.: FM receiver have good fidelity over AM receivers.
37. Which of fall is state diagram for Mealy machine shown:

A.

B.

C.

D.


Sol.: $D=\bar{X}, Y=X \cdot Q$

| X | Q | D | $\mathrm{Q}^{+}$ | Y |
| :---: | :---: | :---: | :---: | :---: |
| 0 | 0 | 1 | 1 | 0 |
| 0 | 1 | 1 | 1 | 0 |
| 1 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 0 | 1 |

(a) option is matching
38. The $\qquad$ layer is the layer closest to the transmission medium.
A. Network
B. Transport
C. Physical
D. Data link

Sol.: Physical layer is lower most layer and is closest to the transmission media

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39. Find the transmitted code if $(n, k)=(6,3)$ code. Parity check matrix, $H=\left[\begin{array}{llllll}1 & 0 & 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 & 1 & 0 \\ 0 & 1 & 1 & 0 & 0 & 1\end{array}\right]$ and data $d=\left[\begin{array}{lll}1 & 0 & 1\end{array}\right]$.
A. $\left[\begin{array}{llllll}1 & 1 & 1 & 0 & 0 & 0\end{array}\right]$
B. $\left[\begin{array}{llllll}1 & 0 & 1 & 0 & 1 & 0\end{array}\right]$
C. $\left[\begin{array}{llllll}1 & 0 & 1 & 0 & 1 & 1\end{array}\right]$
D. $\left[\begin{array}{llllll}0 & 0 & 0 & 1 & 1 & 1\end{array}\right]$

Sol.: $P=\left[\begin{array}{lll}1 & 0 & 1 \\ 1 & 1 & 0 \\ 0 & 1 & 1\end{array}\right], P^{t}=\left[\begin{array}{lll}1 & 1 & 0 \\ 0 & 1 & 1 \\ 1 & 0 & 1\end{array}\right]$
$\mathrm{G}=\left[\mathrm{I}_{3} \mathrm{P}^{\mathrm{t}}\right]=\left[\begin{array}{llllll}1 & 0 & 0 & 1 & 1 & 0 \\ 0 & 1 & 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & 1 & 0 & 1\end{array}\right]$
Transmitted code $=\mathrm{dG}=\left[\begin{array}{lll}1 & 0 & 1\end{array}\right]\left[\begin{array}{llllll}1 & 0 & 0 & 1 & 1 & 0 \\ 0 & 1 & 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & 1 & 0 & 1\end{array}\right]$
$C=\left[\begin{array}{llllll}1 & 0 & 1 & 0 & 1 & 1\end{array}\right]$
40. Calculate majority and minority carrier concentrations to convert an intrinsic silicon into an
$n$-type silicon of resistivity of 10 ohm- cm . [ $\mu_{\mathrm{n}}=1350 \mathrm{~cm}^{2} / \mathrm{V}$-sec, $\left.\mathrm{n}_{\mathrm{i}}=1.5 \times 10^{10} \mathrm{~cm}^{-3}\right]$
A. $4.63 \times 10^{15} \mathrm{~cm}^{-3}$ and $4.86 \times 10^{5} \mathrm{~cm}^{-3}$
B. $4.63 \times 10^{16} \mathrm{~cm}^{-3}$ and $4.86 \times 10^{4} \mathrm{~cm}^{-3}$
C. $4.63 \times 10^{14} \mathrm{~cm}^{-3}$ and $4.86 \times 10^{5} \mathrm{~cm}^{-3}$
D. $4.63 \times 10^{15} \mathrm{~cm}^{-3}$ and $4.86 \times 10^{8} \mathrm{~cm}^{-3}$

Sol.: For intrinsic to $n$-type conversion
Majority carrier concentration $=N_{D}$
Minority carrier concentration $=N_{A}=\frac{n_{i}^{2}}{N_{D}}$
$\sigma=N_{D} \mu_{\mathrm{n}} \mathrm{q}$
$0.1=\mathrm{ND}_{\mathrm{D}} \times 1350 \times 1.6 \times 10^{-19}$
$N_{D}=4.63 \times 10^{14} \mathrm{~cm}^{-3}$
$N_{A}=\frac{n_{i}^{2}}{N_{D}}=\frac{2.25 \times 10^{20}}{4.63 \times 10^{14}}$
$N_{A}=4.86 \times 10^{5} \mathrm{~cm}^{-3}$
41. Match List I (interrupts ) with List II (corresponding characteristics) and select the correct answers using the codes given below the lists:

## List I (interrupts)

A. TRAP
B. INTR
C. RST 7.5
D. RST 6.5

## List II (Corresponding characteristics )

(1) Level triggered
(2) Non-Maskable
(3) For increasing the number of interrupts.
(4) Positive edge triggered.
(5) Maskable
A. A-1, 2

B-1, 3, 5
C-4, 5
D-1, 5
B. A-1, 3

B-1, 3, 5
C-1, 5
D-4, 2
C. A-2, 4

B-1, 3, 5
C-1, 5
D-4, 5
D. A-1, 2

B-1, 3, 5
C-1, 5
D-4, 5
Sol.: TRAP: This interrupt has high priority. It is hardware vectored interrupt. It is nonmaskable interrupt. It is both Level and Edge triggered.

INTR: It is a Non-vectored interrupt. It is level triggered. It is maskable- interrupt.
RST 7.5: it is maskable and positive edge-triggered.
RST 6.5: it is level-triggered and maskable interrupt.
42. An analog voltage in the range 0 to 8 V is divided in 16 equal intervals for conversion to 4bit digital output. The maximum quantization error (in V ) is $\qquad$
A. 0.20
B. 0.25
C. 0.30
D. 0.40

Sol.: Maximum Quantization Error $= \pm \Delta / 2$, where $\Delta=$ Step Size
$\Delta=$ Step Size $=\left(V_{\max }-V_{\min }\right) /$ No. of levels $=(8-0) / 16=0.5$
$M a x^{m}$ Quantization Error $=(0.5) / 2=0.25 \mathrm{~V}$
43. The size of air cored transducers in comparison to the iron core parts is
A. smaller
B. larger
C. same
D. unpredictable

Sol.: Size of air cored transducers is same as iron core
44. AN infinite line charge of $1 \mu \mathrm{C} / \mathrm{m}$ is on the z -axis. Electric field due to the line charge at point $(-2,-1,5)$ will be
A. $2.4 a_{x}+1.8 a_{y}$
B. $7.2 a_{x}+14.4 a_{y}$
C. $-7.2 a_{x}-3.6 a_{y}$
D. $-2 a_{x}-a_{y}$

Sol.: Electric field intensity in free space at a distance $R$ form an infinite line charge with charge density $\rho_{\mathrm{L}}$ is defined as
$\mathrm{E}=\frac{\rho_{\mathrm{L}} \mathrm{R}}{2 \pi \varepsilon_{0} \mathrm{R}^{2}}$
Given $\rho_{\mathrm{L}}=1 \mu \mathrm{C} / \mathrm{m}=1 \times 10^{-6} \mathrm{C} / \mathrm{m}$
$R=-2 a_{x}-a_{y}$
So, $\mathrm{E}=\frac{\left(1 \times 10^{-6}\right)}{2 \pi \varepsilon_{0}}\left(\frac{-2 \mathrm{a}_{\mathrm{x}}-\mathrm{a}_{\mathrm{y}}}{5}\right)=-7.2 \mathrm{a}_{\mathrm{x}}-3.6 \mathrm{a}_{\mathrm{y}} \mathrm{kV} / \mathrm{m}$
45. Consider an air-filled rectangular waveguide with inside dimensions $5 \mathrm{~cm} \times 2 \mathrm{~cm}$. If the wave impedance is $222.24 \Omega$ for $T M_{11}$ mode of propagation. Then the operating frequency (in GHz )is given by
A. 5
B. 7.5
C. 20
D. 10

Sol.: Given $a=5 \mathrm{~cm}, \mathrm{~b}=2 \mathrm{~cm}$, $\eta_{\text {тм11 }}=222.24 \Omega$
$\eta_{T M_{1}}=n \sqrt{1-\left(\frac{\lambda}{\lambda_{c}}\right)^{2}}$
where $\lambda_{c}=\left.\frac{2}{\sqrt{\left(\frac{m}{a}\right)^{2}+\left(\frac{n}{b}\right)^{2}}}\right|_{\substack{m=1 \\ n=1}}=\frac{2 a b}{\sqrt{a^{2}+b^{2}}}=\frac{2 \times 5 \times 2}{\sqrt{5^{2}+2^{2}}}$
$\lambda_{c}=3.71 \mathrm{~cm}$
$\left(\frac{\eta_{\text {TM11 }}}{\eta}\right)^{2}=1-\left(\frac{\lambda}{\lambda_{\tau}}\right)^{2}$
$\Rightarrow \lambda=\lambda_{\mathrm{c}} \sqrt{1-\left(\frac{222.24}{120 \pi}\right)^{2}}$
$\Rightarrow \lambda \approx 3 \mathrm{~cm}$

But $\lambda=\frac{\mathrm{C}}{\mathrm{t}}$
$\Rightarrow \mathrm{f}=\frac{\mathrm{c}}{\lambda}=\frac{3 \times 10^{10}}{3}=10 \mathrm{GHz}$
46. An ergodic random power $x(t)$ has an Auto-correlation function,

$$
\mathrm{R}_{\mathrm{xx}}(\tau)=40+\frac{4}{8+\tau^{2}}+6 \cos (18 \tau)
$$

The $|\bar{x}|$ is?
A. $\pm \sqrt{40}$
B. $\pm \sqrt{31}$
C. $\pm \sqrt{39}$
D. $\pm \sqrt{40} \pm \sqrt{39}$

Sol.: We know if
(i) $\mathrm{X}(\mathrm{t})$ has a periodic component then $\mathrm{R}_{\mathrm{xx}}(\mathrm{T})$ will have a periodic component with the same period.
(ii) If $E[X(t)]=x=0$ and $x(t)$ is ergodic with no periodic component then $\lim _{|t| \rightarrow \infty} R_{x x}(\tau)=|X|^{2}$ Thus we get $|X|^{2}=40$ or $\bar{X}= \pm \sqrt{40}$
47. The sharing of a medium and its link by two or more devices is called $\qquad$ .
A. modulation
B. multiplexing
C. encoding
D. line discipline

Sol.: In multiplexing two or more devices send data over a common link / channel and efficiency of transmission increases.
48. A bipolar binary signal $\mathrm{S}_{\mathrm{i}}(\mathrm{t})$ is +A or -A , rectangular pulse in interval 0 to T . Assume $\sigma_{n}^{2}=0.1$ and $P\left(S_{1}\right)=0.7$. Find optimum detection threshold of detector.
A. $\frac{0.042}{\mathrm{~A}}$
B. $-\frac{0.042}{\mathrm{~A}}$
C. $\frac{\mathrm{A}}{0.042}$
D. $-\frac{\mathrm{A}}{0.042}$

Sol.: Using formula,
$V_{t h}=\frac{a_{1}+a_{2}}{2}+\frac{\sigma_{n}^{2}}{a_{1}-a_{2}} \ln \left[\frac{P(0)}{P(1)}\right]=\frac{A+(-A)}{2}+\frac{(0.1)}{A-(-A)} \ln \left(\frac{0.3}{0.7}\right)=-\frac{0.042}{A}$
49. The $\qquad$ layer is responsible for moving frames from one hop (node) to the next.
A. transport
B. data link
C. physical
D. none of the above

Sol.: The data link layer is responsible for moving frames from one hop (node) to the next.

The network layer is responsible for moving packets from one end to other.
50.


What is frequency fout if frequency of 20 KHz is applied to Schmitt trigger ?
A. 5 KHz
B. 2 KHz
C. 2.5 KHz
D. None

Sol.: Schmitt trigger converts any wave to rectangular pulse at $\mathrm{T}^{-}$flip flop output frequency is halved.

After $1^{\text {st }} \mathrm{T}$ - flip flop frequency $\mathrm{f}=\frac{20}{2} \mathrm{KHz}$
After $2^{\text {nd }} \mathrm{T}$ - flip flop frequency $\mathrm{f}=\frac{10}{2} \mathrm{KHz}$
After $3^{\text {rd }} \mathrm{T}$ flip flop frequency $\mathrm{f}=\frac{5}{2}=2.5 \mathrm{KHz}$
(c) option is correct
51. Match List-I (Program Required in System Software) with List-II (Definition) and select the correct answer using the code given below the lists:

## List-I

A). Linker
B). Loader
C). Interpreter
D). Compiler

## List-II

1). It is a program which combines smaller programs to form a single program, and also links subroutines with the main program.
2). It is a program which loads machine codes of a program into the system memory
3). It is a program which translates a high- level program into machine code, executes it an dreads one statement at a time, executes and then goes to the next statements of the program
4). It is a program which translates a high- level program into a machine language, reads the entire program and then executes it.
A. A-1, B-2, C-3, D-4
B. A-3, B-4, C-1, D-2
C. A-1, B-4, C-3, D-2
D. A-3, B-2, C-1, D-4
52. A vector magnetic potential is given by
$\overline{\mathrm{A}}=20 \cos \theta \hat{a}_{\theta} \mathrm{wb} / n$
The magnetic flux density at $(2, \pi, 0)$ will be
A. 0
B. $5 \hat{a}_{\phi} \quad w b / n^{2}$
C. $10 \hat{a}_{\mathrm{r}} \mathrm{wb} / \mathrm{n}^{2}$
D. $-10 \hat{a}_{\phi} w b / n^{2}$

Sol.: $\bar{B}=\bar{\nabla} \times \bar{A}=\frac{1}{r^{2} \sin \theta}\left|\begin{array}{ccc}\hat{a}_{r} & r a_{\theta} & r \sin \theta \hat{a}_{\phi} \\ \frac{\partial}{\partial r} & \frac{\partial}{\partial \theta} & \frac{\partial}{\partial \phi} \\ 0 & r(20) \cos \theta & 0\end{array}\right|=\frac{1}{r^{2} \sin \theta}[0+0+r \sin \theta(20) \cos \theta] \hat{a}_{\phi}$
$\bar{B}(2, \pi, 0)=\frac{1}{r} 20 \cos \theta \hat{a}_{\phi}=\frac{1}{2} 20 \cos (\pi) \hat{a}_{\phi}=-10 \hat{a}_{\phi} w b / n^{2}$
53. Given $x(n)=1, n= \pm 1=2, n= \pm 2=3, n= \pm 3=0$, otherwise

The number of nonzero samples in $x(2 n)$ are
A. 3
B. 4
C. 2
D. 1

Sol.: $x(n)=[3,2,1,0,1,2,3]$
$x(2 n)=[2,0,2]$
$\therefore$ Number of non zero samples are 2
54. Two vectors extending from the origin are given as $R_{1}=4 u_{x}+3 u_{y}-2 u_{z}$ and $R_{1}=3 u_{x}-4 u_{y}-6 u_{z}$. The area of triangle defined by $\mathrm{R}_{1}$ and $\mathrm{R}_{2}$.
A. 12.47
B. 20.15
C. 10.87
D. 15.46

Sol.: Area $=\frac{1}{2}\left|R_{1} x R_{2}\right|=\frac{1}{2}\left[\begin{array}{ccc}u_{x} & u_{y} & u_{z} \\ 4 & 3 & -2 \\ 3 & -4 & -6\end{array}\right]=\mathrm{cu}_{x}(-18-8)-u_{y}(-24+6)+u_{z}(-16-9)$ $=-26 \mathrm{u}_{\mathrm{x}}+18 \mathrm{u}_{\mathrm{y}}-25 \mathrm{u}_{\mathrm{z}}$
$\left|R_{1} \times R_{2}\right|=\sqrt{26^{2}+18^{2}+25^{2}}=40.31$
area $=\frac{1}{2} 40.31=20.15$
55. In hot wire instruments the sensing wire is made of
A. copper
B. silver
C. platinum-iridium
D. copper-nickel

Sol.: In hot wire instruments the sensing wire is made of platinum-iridium.
56. For the circuit shown in fig, the switch is closed for a long time and it is opened at $t=0$. Determine $V_{L}(t)$ for $t \geq 0$.

A. $2.4 \mathrm{e}^{-10 \mathrm{t}} \mathrm{V}$
B. $-2.4 \mathrm{e}^{-10 \mathrm{t}} \mathrm{V}$
C. $120 \mathrm{e}^{-10 \mathrm{t}} \mathrm{V}$
D. $-120 \mathrm{e}^{-10 \mathrm{t}} \mathrm{V}$

Sol.: Evaluation of initial condition, here inductor act as short circuit at $\mathrm{t}=0^{-}$(here switch is closed)
$\mathrm{I}_{( }\left(0^{-}\right)=(24 / 10)=2.4 \mathrm{~A}=\mathrm{I}_{\mathrm{l}}\left(0^{+}\right)$
(since current through inductor cannot change instantaneously)
at $\mathrm{t}=\infty$, here inductor act as a open circuit (here switch is open)
$\mathrm{I}(\infty)=0 \mathrm{~A}$
Evaluation of time constant T
$T=\frac{L}{R_{\text {eq }}}=\frac{5}{40+10}=\frac{1}{10}$
Current through inductor is given by
$I_{1}(t)=I_{1}\left(0^{-}\right) e^{-t / T}+I_{1}(\infty)\left(1-e^{-t / T}\right) A=2.4 e^{-10 t} A$
$\mathrm{V}_{\mathrm{L}}(\mathrm{t})=\mathrm{L} \frac{\mathrm{dII}(\mathrm{t})}{\mathrm{dt}}=5 \times 2.4 \times(-10) \mathrm{e}^{-10 \mathrm{t}} \mathrm{V}=-120 \mathrm{e}^{-10 \mathrm{t}} \mathrm{V}$
57. The potential of node $B$ with respect to $G$ in the network shown in figure is

A. $\frac{64}{63} \mathrm{~V}$
B. $\frac{63}{64} \mathrm{~V}$
C. $\frac{32}{31} \mathrm{~V}$
D. $\frac{31}{32} \mathrm{~V}$

Sol.: Applying MilliMan's Theorem

$\mathrm{V}_{\mathrm{th}}=\left[\frac{\frac{2}{2}-\frac{4}{4}+\frac{8}{8}-\frac{16}{16}+\frac{32}{32}}{\frac{1}{2}+\frac{1}{4}+\frac{1}{8}+\frac{1}{16}+\frac{1}{32}}\right]=\frac{32}{31} \mathrm{~V}$
$\mathrm{R}_{\mathrm{th}}=\frac{32}{31} \Omega$
$V_{B G}=\frac{32}{31} \times\left[\frac{64}{64+\frac{32}{31}}\right]$
$\Rightarrow \frac{32}{31} \times \frac{64 \times 31}{64 \times 31+32}$
$\frac{32 \times 64}{32(63)}=\frac{64}{63} \mathrm{~V}$
58. The tracking error at different input carrier frequencies of an AM super heterodyne receiver, operating in the range ( 550 to 1650 ) KHz is shown in:


The intermediate frequency of receiver is 450 KHz . If the maximum frequency of modulating signal is 7 KHz , find minimum bandwidth (in kHz ) required by IF Amplifier of receiver
A. 5
B. 10
C. 15
D. 20

Sol.: Minimum Bandwidth required for an IF Amplifier of an AM super-heterodyne receiver is $(B W)_{\min }=2 f_{m(\max )}+($ Peak to Peak swing of tracking error curve $)$
$=2(7)+(5-(-1)) \mathrm{KHz}=14+6 \mathrm{KHz}=20 \mathrm{KHz}$
59. A uniform plane wave propagating in free space is incident on a lossless dielectric $\left(\epsilon_{r}=4, \mu_{r}=1\right)$ is totally transmitted. The angle of transmission is given by $\qquad$ degrees.
A. 26.56
B. 34.56
C. 16.23
D. 35.23

Sol.: Total transmission occurs at Brewster's angle $\theta_{B}$

$$
\begin{aligned}
& \theta_{\mathrm{B}}=\theta_{\mathrm{i}}=\tan ^{-1} \sqrt{\frac{\epsilon_{2}}{\epsilon_{1}}}=\tan ^{-1} \sqrt{4} \\
& \Rightarrow \theta_{\mathrm{B}}=\theta_{\mathrm{i}}=63.43^{\circ}
\end{aligned}
$$

From smells law
$\sqrt{\epsilon_{2}} \sin \theta=\sqrt{\epsilon_{1}} \sin \theta_{\mathrm{i}}$
$\Rightarrow \theta_{\mathrm{t}}=\sin ^{-1}\left(\frac{\sin 63.43^{\circ}}{2}\right)=26.56^{\circ}$
60. In the transmission line shown, the impedance $Z_{\text {in }}$ (in ohms) between node $A$ and the ground is $\qquad$ .

A. 22.22
B. 33.33
C. 44.44
D. 55.55

Sol.: Here $I=\frac{\lambda}{2}$

$$
Z_{\text {in }}(I=\lambda / 2)=Z_{L}=50 \Omega
$$

$\therefore \mathrm{Z}_{\mathrm{in}}=(100 \| 50)=\frac{100}{3}=33.33 \Omega$

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