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ISRO 2020 Electronics & Communication Engineering

Mega Mock Challenge

(08 Jan-09 Jan 2020)

Questions & Solutions

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1. If the appropriate system is used, what stage will output the name and artist of music selection being played by the station?
A. linear combiner
B. frequency doubler
C. QPSK demodulator
D. FM demodulator

Ans. C

Sol. QPSK demodulator

2. The plane wave with
$\bar{H}_i = 50\sin(wt - \beta z)\hat{a}y \text{ mA/m}$ in
A lossless medium (ε_r = 4, μ_r = 1) encounters free space at z = 0. The reflected electric field $\bar{E}_r$ is
A. π sin (ωt + βz) $\hat{a}_x$ mV/m
B. π sin (ωt + βz) $\hat{a}_x$ mV/m
C. −π sin (ωt + βz) $\hat{a}_x$ V/m
D. 3π sin (ωt + βz) $\hat{a}_x$ V/m

Ans. B

Sol. $\bar{H}_i = 50\sin(wt - \beta z)\hat{a}y \text{ mA/m}$

Ei = E_0 sin (ωt − βz) $\hat{a}_x$

Where, $E_0 = 50 \times \frac{120\pi}{\sqrt{\varepsilon_r}} \text{mV/m}$

= 50 × 60π mV/m
= 3π V/m
and
$\hat{a}E_i = \hat{a}_H \times \hat{a}_x$
$= \hat{a}y \times \hat{a}z$
$= \hat{a}_x$
$\bar{E}_i = 3\pi \sin(\omega t - \beta z)\hat{a}_x \text{ V/m}$

Reflection coefficient $= \frac{\eta_2 - \eta_1}{\eta_2 + \eta_1}$

$= \frac{120\pi - 60\pi}{120\pi + 60\pi}$

$= \frac{1}{3}$

$\bar{E}_r = \Gamma \bar{E}_i$

$= \frac{1}{3} \times 3\pi \sin(\omega t - \beta z)\hat{a}_x \text{ V/m}$

= π sin (ωt − βz) $\hat{a}_x$ V/m

3. The forward path gain of a unity negative feedback system is given by G(s) = k/[s(s+4)(s+8)(s+10)]. If a unit ramp signal is provided to the system as input then what will be the minimum value of the steady state error.

A. 0.18 B. 0.19
C. 0.20 D. 0.16

Ans. D

Sol. For the given system, open loop transfer function

$G(S) = \frac{K}{S(S+4)(S+8)(S+10)}$ it's a type one system

So, it will have finite steady state error for ramp unit (input) given by

$e_{ss} = \frac{A}{K_V}$ Here $K_V = \lim_{S\to 0} SG(S)$

Again ,

$K_V = \lim_{S\to 0} S\left[\frac{K}{S(S+4)(S+8)(S+10)}\right] \Rightarrow K_V = \frac{K}{320}$

Also, A = 1 ∴ input is an unit ramp

So, $e_{ss} = \frac{320}{K}$ ⇒for steady state error to be minimum , the K(System gain value) maximum without effecting the stability of the system.

Now, the characteristic equation of the system is

1 + G(S)H(S) = 0 ⇒ $S^4 + 22S^3 + 152S^2 + 320S + K = 0$

So

S^4	1	152	K
S^3	22	320	
S^2	137.4	K	
S^1	$(43968 - 22k)\vert$	137.4	
S^o	K		

So, system will be marginally stable if S_1 row is zero

i.e. $\frac{43968-22K}{137.4} = 0$ so, K_{max} = 1998.54

So, for stable system 0 < K < 1998.54

So, $e_{ss}(min) = \left(\frac{320}{1998}\right)$=0.16

4. A continuous time system is described by $y(t) = x(t^2)$ is
A. causal, linear, time variant
B. causal, non-linear, time invariant
C. non-causal, linear, time variant
D. non-causal, non-linear, time invariant

Ans. C

Sol. $y(t) = x(t^2)$

$\therefore y(-2) = x((-2)^2)$

$\therefore y(-2) = x(4)$

∴ It is non-causal system

Now

$$ax_1(t) \xrightarrow{\text{system}} ax_1(t^2)$$

$$ax_2(t) \xrightarrow{\text{system}} ax_2(t^2)$$

$$a(x_1(t)+x_2(t)) \xrightarrow{\text{system}} a\left[x_1(t^2)+x_2(t^2)\right]$$

∴ It is linear system

Now

$$x(t) \xrightarrow{\text{system}} x(t^2)$$

$$x(t-t_0) \xrightarrow{\text{system}} x\left((t-t_0)^2\right)$$

$$x(t-t_0) \xrightarrow{\text{system}} x\left(t^2+t_0^2-2tt_0\right) \quad \text{(i)}$$

$$\therefore y_1(t) = x\left(t^2+t_0^2-2tt_0\right)$$

And

$y_2(t) = x(t^2 - t_0)$

since $y_1(t) \neq y_2(t)$

It is time variant system.

5. A 'DMA' transfer implies

A. Direct transfer of data between memory and accumulator

B. Direct transfer of data between memory and I/O devices without the use of microprocessor

C. Transfer of data exclusively within microprocessor registers

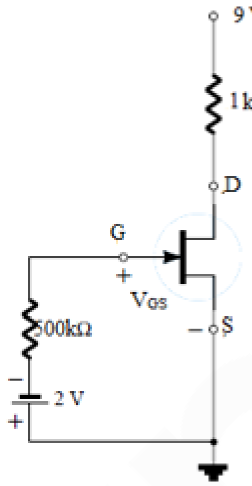
D. A fast transfer of data between microprocessor and I/O devices

Ans. B

Sol. DMA : Direct memory access

In microprocessor environment the D MA concept arised only to increase speed of access between memory and I/O devices. The is lot of difference between the speed of CPU, memory and I/O devices and DMA takes care of all those issues.

6. Determine V_{DS}. I_{DSS}= 1mA, Vp = -5V



A. 20.7 V B. 1.9 V

C. 0.19 V D. 8.64 V

Ans. D

Sol. $I_{DQ} = I_{DSS}(1 - V_{GS}/V_p)^2$

$= 1\text{mA} \, (1- (-2/-5))^2$ since V_{GS}

$= -V_{GG} = -2\text{V}$

$= 0.36$ mA

$V_{DS} = V_{DD} - I_D R_D = 9 - 0.36 \text{ mA} \times 1\text{k}$

$= 8.64$ V.

7. The wear and tear of bearing and increased maintenance costs in the bearings of Positive Displacement Flowmeter exists due to:

i) dirty fluids

ii) fluid impurities

iii) wastewater

A. both i and ii B. both ii and iii

C. both i and iii D. all of these

Ans. A

Sol. Positive Displacement Flowmeter should not be used for dirty fluids as it results in plugging and increased maintenance costs. The bearings of the meter should be selectively used for fluids, impurities and dirt as they can increase bearing wear and tear, but can be used comfortable for wastewater, chemical, power, pharmaceutical, food and beverage, pulp and paper.

8. Two systems with impulse responses $h_1(t)$ and $h_2(t)$ are connected in cascade. Then the overall impulse response of the cascaded system is given by

A. Product of $h_1(t)$ and $h_2(t)$

B. Sum of $h_1(t)$ and $h_2(t)$

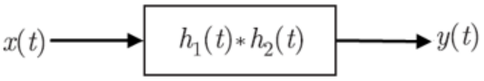
C. Convolution of $h_1(t)$ and $h_2(t)$

D. Subtraction of $h_1(t)$ and $h_2(t)$

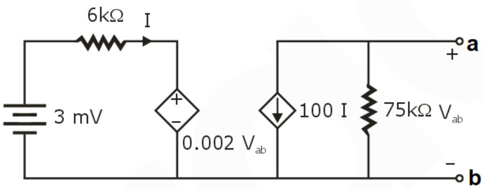
Ans. C

Sol. Given that the two systems with impulse responses $h_1(t)$ and $h_2(t)$ are connected in cascaded configuration. If they are connected as shown:

Then, the overall response of the system is the convolution of the individual impulse responses as shown below:



9. In the circuit shown in figure below, find the value of resistor connected across terminals a and b such that maximum power is transferred to that resistor or it will absorb maximum power?

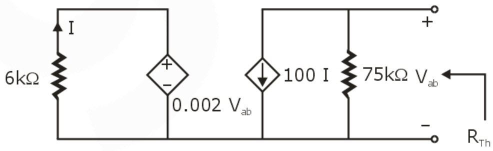


A. 100 KΩ B. 50 KΩ

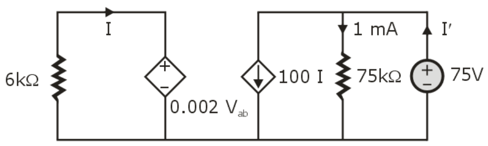
C. -50 KΩ D. -100 KΩ

Ans. C

Sol. For R_{Th} across ab terminals, replace the all independent sources by their internal resistances.



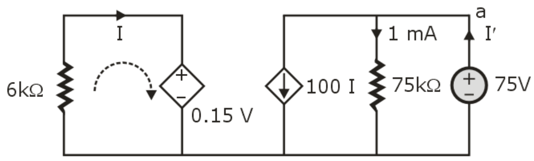
Assume V_{ab} or take 75 V voltage source across a-b terminal.



$$R_{Th} = \frac{75}{I'}\Omega$$

$I' = 100I + 1$ mA

$V_{ab} = 75$ V



$(-6K\Omega \times I) - 0.15 = 0$

$$I = \frac{-0.15}{6k\Omega}$$

$I = -0.025$ mA

$I' = -100 \times 0.025$ mA $+ 1$ mA

$I' = -2.5$ mA $+ 1$ mA

$I' = -1.5$ mA

$$R_{Th} = \frac{75V}{-1.5\text{ mA}}$$

$R_{Th} = -50$ kΩ

10. A silicon bar is doped with 10^{15} donor atoms per cm^3 at room temperature (T = 300k) and the minority carrier life time is $\tau_p = 10^{-6}$ sec.

The diffusion length of the holes is ? (Assume kT/q = 0.026 V, mobility of holes $\mu_p = 500$ cm^2/V–sec)

A. 1.8×10^{-3} cm

B. 2.5×10^{-3} cm

C. 3.6×10^{-3} cm

D. 5×10^{-3} cm

Ans. C

Sol. The diffusion lengthy of holes,

$L_p = \sqrt{D_p \tau_p}$

Where D_p = diffusion constant of minority carriers.

From Einstein relation,

$$\frac{D_p}{\mu_n} = \frac{kT}{q} = 0.026 \text{ V}$$

$D_p = 0.026 \times 500 = 13$ cm^2 /sec

∴ Diffusion length of holes,

$L_p = \sqrt{13 \times 10^{-6}} = 3.6 \times 10^{-3}$ cm

11. Certain 16-bit BCD digital to analog converter has a full-scale reading of 15 volt. Find error of the converter.

A. 0.00015 volt B. 0.0015 volt

C. 1.5 volt D. 0.015 volt

Ans. B

Sol. Error= resolution= (V_{FS} / 10^n – 1)

= ($15/10^4$ -1) volt [10^n – 1 because BCD have 10 possible numbers (0 to 9) and each number take 4 bits to represent it so n=16/4=4]

= 0.0015 volt

12. The r's compliment of an n-digit decimal number N in base r is defined for all values of N except for N = 0. If the given number is $(247)_9$, then its 9's compliment will be equal to

A. $(641)_9$ B. $(643)_9$
C. $(640)_9$ D. $(642)_9$

Ans. D

Sol. The given number has the base 9
So 8's complement $(888)_9 - (247)_9 = (641)_9$
9's complement = 8's complement + 1 = $(642)_9$

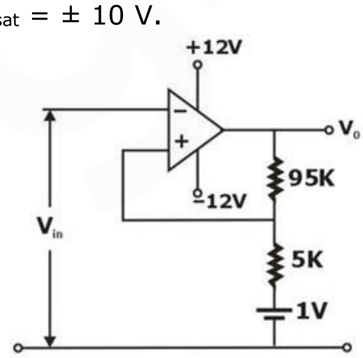
13. for a closed loop system to be stable, the nyquist plot of G(s)H(s) must encircle the point (-1, j0) as many times as the number of (given number of roots on RHS is zero)

A. zeroes of G(s)H(s) in the in the RHS of s- plane
B. zeroes of G(s)H(s) in the in the LHS of s- plane
C. poles of G(s)H(s) in the RHS of s- plane
D. poles of G(s)H(s) in the in the LHS of s- plane

Ans. C

Sol. The number of encirclements of nyquist plot about point (-1, j0) is
N = P – Z
Z= number of closed loop poles in RHS of s- plane for closed loop system to be stable → Z =0
So N = P = number of open loop poles in RHS of s- plane.

14. The hysteresis voltage for the Schmitt trigger circuit shown if figure below, if $V_{sat} = \pm 10$ V.



A. 1 B. 1.2
C. 1.45 D. 0.90

Ans. A

Sol. $V_{sat} = \pm 10$ (Given)

$$V_{UTP} = +10 \times \frac{5k}{100k} + 1 = 1.5V$$

$$V_{LTP} = -10 \times \frac{5k}{100k} + 1 = 0.5V$$

∴ hysteresis voltage, $V_H = V_{UTP} - V_{LTP}$
= 1.5 V — 0.5 V
= 1V

15. Amplitude shift keying refers to

A. keying in amplitude values to the carrier
B. amplitude modulation of digital carrier
C. shifting amplitude of digital message according to carrier
D. shifting amplitude of carrier between two levels according to digital message

Ans. D

Sol. Amplitude shift keying refers to shifting amplitude of carrier between two levels according to digital message

16. Calculate the steady state error of a type 1 system if the input is a unit parabolic.

A. 0 B. 1
C. ½ D. ∞

Ans. D

Sol. For a type-1 system,

$$K_a = \lim_{s \to 0} s^2 K \frac{(s+z_1).(s+z_2)\ldots}{s(s+p_1).(s+p_2)\ldots} = 0$$

⇒ Steady state error, $e_{ss} = 1/K_a = 1/0 = \infty$.

17. A cellular system operator A is allocated a total spectrum of 5 MHz for deployment of on analog cellular system based on the FDMA technique, with each simplex channel occupying 25 kHz bandwidth. Assuming no guard band, the maximum number of simultaneous call possible in the system is ....

A. 100 B. 50
C. 200 D. 210

Ans. A

Sol. Total Bandwidth, B_t = 5MHz
BW of each simplex channel,
B_a = 25 kHz
Total number of simplex channel,

$$N = \frac{5000}{25} = 200$$

Total number of duplex channel

$$M = \frac{N}{2} = 100$$

18. Which of the following modes can exist inside a parallel plate waveguide?
1) TE
2) TM
3) TEM
A. 1 and 2 only
B. 3 only
C. 1 and 3 only
D. 1, 2 and 3

Ans. D

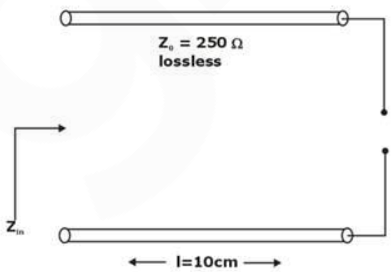
Sol. TE, TM, TEM modes can exist inside a parallel plate waveguide. Only TE and TM modes can exist inside hollow waveguides.

19. If all the elements in the first column of Routh's array has same sign then all the poles are in
A. left half of s-plane
B. right half of s-plane
C. both half of s-plane
D. no poles

Ans. A

Sol. Routh-Hurwitz's criterion said that if there are no sign change in the first column of Routh's array then all the poles are in the left half of the s-plane.

20. If the line shown below is operating at 400 MHz, then its input impedance Z_{in} will be



A. (80 + j225)Ω B. j225 Ω
C. –j225 Ω D. (80 – j225)Ω

Ans. C

Sol. $$Z_{in} = Z_0 \frac{Z_L + jZ_0 \tan\beta l}{Z_0 + jZ_L \tan\beta l}$$

Where, $\lambda = \frac{3 \times 10^{10}}{400 \times 10^6} = \frac{300}{4}$ cm

l = 10 cm

$$\tan\beta l = \tan\frac{2\pi}{300/4} \times 10$$

$$= \tan\left(\frac{4\pi}{15}\right)$$

= tan 48°

$$Z_{in} = Z0 \times \frac{1}{j\tan\beta l}$$

$$= -j\frac{250}{\tan(48°)}$$

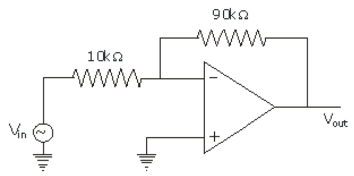
= –j 225Ω

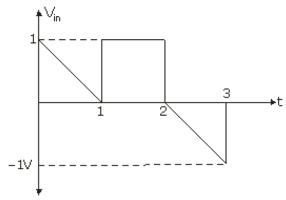
21. One form of NMOS circuit logic that minimizes power dissipation, and maximizes device density is called
A. pass transistor logic
B. sequential logic circuit
C. NMOS SRAM cell
D. NMOS transmission gate

Ans. A

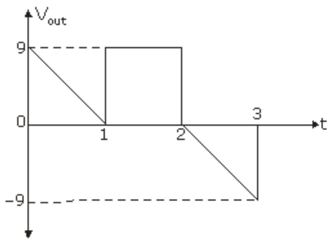
Sol. Pass transistor logic minimizes the power dissipation and maximizes device density.
∴ Option A

22. For the ideal OP-amp based circuit shown below, find the output waveform for the input waveform shown below.

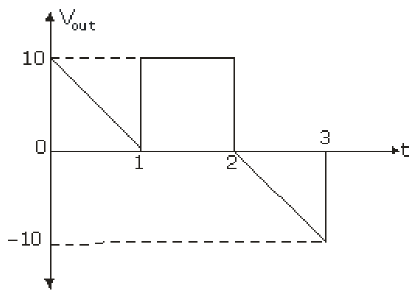




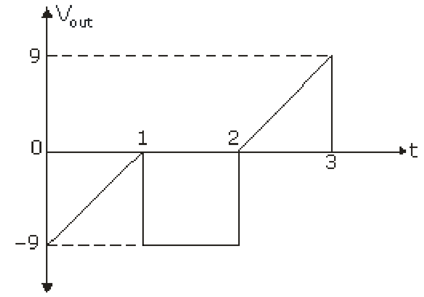
A.



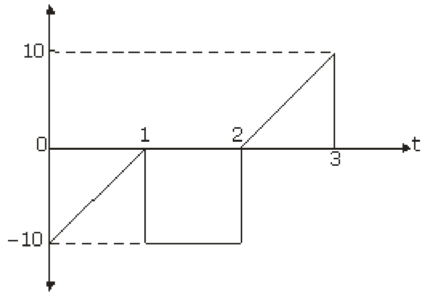
B.



C.



D.



Ans. C

Sol. As we can observe that it is a non-inverting amplifier.

$$\therefore V_{out} = -\frac{R_f}{R_1} V_{in}$$

$$= -\frac{90}{10} V_{in}$$

$$\therefore V_{out} = -9 \, V_{in}$$

∴ Option C is correct.

23. A circuit which work as AND GATE in positive level logic system will work as ……..GATE in negative level logic system.

A. NAND
B. NOR
C. OR
D. None of the above

Ans. C

Sol. (-)Ve logic transforms AND into OR, OR into AND, 0 into 1, 1 into 0, NOR into NAND, NAND into NOR, EX-OR into EX-NOR, EX-NOR into EX-OR

24. A particular medium has conductivity σ = 20 S/m, relative permittivity ε_r = 2 and electric field intensity $\bar{E}$ = 10 cos (ωt) V/m The frequency at which the magnitude of conduction current density equal to that of displacement current density is

$$\left(\varepsilon_0 = \frac{10^{-9}}{36\pi} F/m\right)$$

A. $\frac{10^{10}}{2\pi}$ Hz
B. 180 MHz
C. 180 GHz
D. 10^{10} Hz

Ans. C

Sol. $|J_C| = |J_d|$

$|\sigma E| = |j\omega\varepsilon E|$

$\sigma = \omega\varepsilon$

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

$$f = \frac{\sigma}{2\pi \times \varepsilon}$$

$$= \frac{20}{2\pi \times 2 \times \frac{10^{-9}}{36\pi}} = 180 \times 10^9 = 180\text{GHz}$$

25. A 50Ω lossless line has, $V_L = 15e^{j25°}$ V and $Z_L = 75e^{j30°}$Ω. The current at a distance $\frac{\lambda}{n}$ (n being natural number) from load is $0.2e^{j40°}$A. The value n is?

A. 2
B. 4
C. 8
D. 16

Ans. C

Sol. $$\beta\ell = \frac{2\pi}{\lambda} \cdot \frac{\lambda}{n} = \frac{2\pi}{n}$$

$$I_L = \frac{V_L}{Z_L} = \frac{15^{j25°}}{75e^{j30°}} = 0.2e^{-j5°}$$

$$I\left(\ell = \frac{\lambda}{Z_n}\right) = I_L e^{j\beta\ell} = 0.2e^{j40}$$

$0.2e^{-j5} e^{j\beta l} = 0.2 e^{j40}$

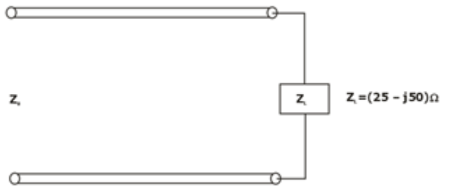
$e^{j\beta l} = e^{j45°}$

$$\beta\ell = 45° = \frac{\pi}{4}$$

$$\frac{2\pi}{n} = \frac{\pi}{4}$$

n = 8

26. The value of the characteristic impedance Z_0 (pure resistance) of the transmission line shown below, such that the standing-wave ratio is the smallest possible is



A. 55.9 Ω
B. 105.9 Ω
C. 65.9 Ω
D. 75.9 Ω

Ans. A

Sol. Maximum SWR = Maximum Possible $|\Gamma|^2$

$$\frac{\partial|\Gamma|^2}{\partial Z_0}=\frac{\partial}{\partial Z_0}\frac{|R_L+jX_L-Z_0|^2}{|R_L+jX_L+Z_0|^2}=0$$

$$=\frac{\partial}{\partial Z_0}\frac{(R_L-Z_0)^2+X_L^2}{(R_L+Z_0)^2+X_L^2}=\frac{4R_L(Z_0^2-(R_L^2+X_L^2))}{((R_L+Z_0)^2+X_L^2)^2}=0$$

$Z_0^2 = R_L^2 + X_L^2$

$$Z_0=\sqrt{(R_L)^2+(X_L)^2}$$

$$=\sqrt{(25)^2+(-50)^2}$$

= 55.9Ω

27. What is a type number of a system?
A. No. of poles of the transfer function of a system.
B. No. of poles of loop transfer function of a system.
C. No. of poles of loop transfer function of a system at the origin.
D. No. of zeroes of loop transfer function of a system.

Ans. C

Sol. Type no. is specified for loop transfer functions on, unlike order that is specified for any transfer function. It decides the steady state error of a system.

28. Three memory chips are of size 1 kB, 2 kB and 4kB. Their address bus is 10 bits. What are the data bus sizes o the chips?
A. 8 bits, 16 bits and 24 bits respectively
B. 8 bits, 16 bits and 32 bits respectively
C. 8 bits, 16 bits and 64 bits respectively
D. 8 bits, 16 bits and 128 bits respectively

Ans. B

Sol. Data bus size $=\frac{Memory\ chip\ size}{Address\ bus\ size}$

For 1 kB memory chips

data bus size $=\frac{2^{10}\times 8}{2^{10}}=8bits$

For 2 kB memory chips

data bus size $=\frac{2\times 2^{10}\times 8}{2^{10}}=16bits$

For 4 kB memory chips

data bus size $=\frac{4\times 2^{10}\times 8}{2^{10}}=32bits$

29. Transfer function of a system is given as

$$G(s)=\frac{K}{s^4+s^3}$$

Find the type and order of the system respectively
A. 2, 3 B. 4, 3
C. 3, 4 D. 3, 2

Ans. C

Sol. We can arrange G(s) as follows,

$$G(s)=\frac{K}{s^3(1+s)}$$

Thus, Type=3 and Order=4

30. In ASK system, bit 1 is represented with $2\cos(2\pi\times10^6 t)$ pulse, bit 0 is represented with no pulse where each pulse occupies a duration of 1 μ sec. Find the probability of error if it is affected by two-sided power spectral density of 2 × 10^{-6} W/Hz.
A. Q(1) B. $Q(\sqrt{2})$
C. $Q\left(\frac{1}{2}\right)$ D. $Q\left(\frac{1}{\sqrt{2}}\right)$

Ans. C

Sol. $Pe,ASK=Q\left(\sqrt{\frac{A_c^2T_b}{4N_o}}\right)$

A_c = 2, $\frac{N_o}{2}=2\times10^{-6}$

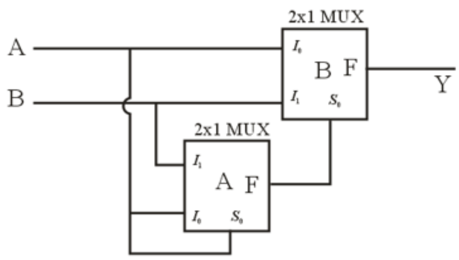
N_o = 4 × 10^{-6} W/Hz

T_b = 1 μ sec = 10^{-6}

$$Pe,ASK=Q\left(\sqrt{\frac{4\times10^{-6}}{4\times4\times10^{-6}}}\right)$$

$$Pe,ASK=Q\left(\frac{1}{2}\right)$$

31. Find the output of the circuit given below.



A. 0 B. A
C. B D. AB

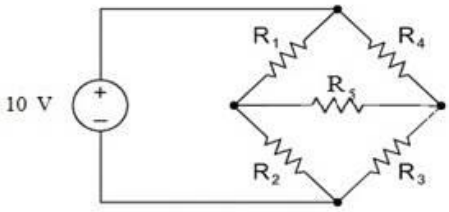
Ans. B

Sol. $F_A = \overline{A}.A + A.B = AB$

$Y = F_B = \overline{A.B}.A + A.B.B$

$= \left(\overline{A} + \overline{B}\right).A + A.B = A.\overline{B} + A.B = A$

32. Find i(in A) through R5 resistor in the given circuit using Thevenin's theorem:

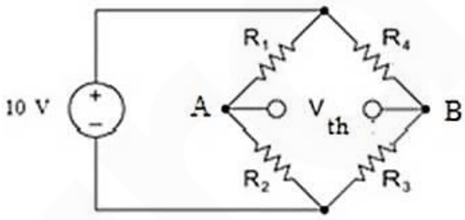


R1=5 Ω
R2=2 Ω
R3=1 Ω
R4=5 Ω
R5=5 Ω

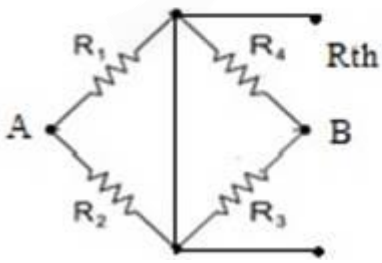
A. 0.164 B. 1.450
C. 0.230 D. 0.426

Ans. A

Sol. Using Thevenin's, 5 Ω is considered as load. Open circuiting it and considering the voltage across it as Thevenin's voltage ,

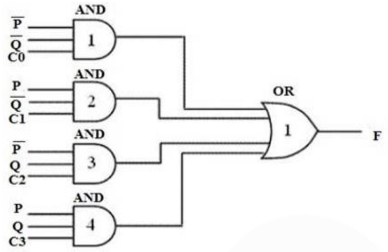


Va= 10 V x (R2/ R1+R2) = 10 x (2/ 2+5) = 20/7
Vb= 10 V x (R3/ R3+R4) = 10 x (1/ 1+5) = 10/6
Vab = Vth = Va- Vb = 20/7 - 10/6 = 1.19 V



Rth = 5||2 + 5||1 = 2.262 Ω
Using Vth and Rth, I across 5 Ω = Vth/Rth = 1.19/(2.262 +5)= 0.164 A.

33. Consider the circuit shown below; where C0 C1 C2 C3 are control inputs, their values must be either 0 or 1. For what values of C0 C1 C2 C3, the output of F is Ex-NOR of P & Q?



A. $C_0=C_3= C_1=C_2=0$
B. $C_0=C_3=0$ & $C_1=C_2=1$
C. $C_0=C_3=C_1=C_2=1$
D. $C_0=C_3=1$ & $C_1=C_2=0$

Ans. D

Sol. $F=\overline{P}\overline{Q}C_0 + P\overline{Q}C_1 + \overline{P}QC_2 + PQC_3$
According to question required output $F = \overline{P}\overline{Q} + PQ$
So $C_0=C_3=1$ & $C_1=C_2=0$

34. The applications of photomultipliers are seen in

A. night vision equipment, medical equipment
B. mechanical counters, timers
C. translational, optical instruments
D. ultrasonic transducer, infrared imaging

Ans. A

Sol. Photo – multipliers have very high sensitivity so they can be used in night vision equipment and medical equipment for precise capture of object.
∴ Option A

35. A radar transmits pulse with a duration of 1.5 μs at a pulse repetition frequency (PRF) of 8 kHz. If the peak power of this radar is 500 kW, then the average power will be

A. 500 kW B. 6 kW
C. 12 kW D. 250 kW

Ans. B

Sol. $\text{Duty Cycle} = \frac{\text{Pulse width}}{\text{Pulse repetition time}}$

$= \frac{1.5 \times 10^{-6}}{1/800}$ = 0.012

Average power = Peak power × Duty cycle
= 500 × 0.012 kW
= 6 kW

36. A quartz piezoelectric crystal having a thickness of 2 mm and voltage sensitivity of 0.055 V m/N is subjected to a pressure of 1.5 MN/m^2. The voltage output will be

A. 165V B. 174V

C. 183V D. 192V

Ans. A

Sol. $V_O = P \times g \times t$

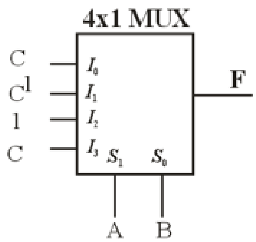
$= 1.5 \times 10^6 \times 0.055 \times 2 \times 10^{-3}$

$V_O = 165$ V

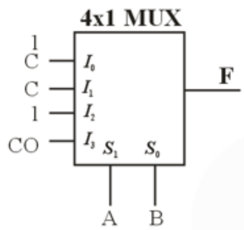
∴ Option A

37. Let a 3-variable function be given as $F(A,B,C) = \prod m(1,2,6)$ with A as the MSB (Most Significant Bit) and C as the LSB (Least Significant Bit). If the above function is implemented using a 4 × 1 Multiplexer, then identify the correct option.

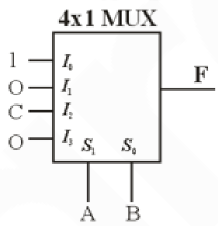
A.



B.



C.



D. None of these

Ans. B

Sol. $F(A,B,C) = \prod M(1,2,6) = \sum m(0,3,4,5,7)$

The Boolean expression of the function is,

$F = \bar{A}.\bar{B}.\bar{C} + \bar{A}.B.C + A.\bar{B}.\bar{C} + A.\bar{B}.C + A.B.C$

Now, drawing the implementation table by considering the select lines as $S_0 = B$ (LSB) and $S_1 = A$ (MSB).

	$\bar{A}\bar{B}$	$\bar{A}B$	$A\bar{B}$	AB
$\bar{C}$	1	0	1	0
C	0	1	1	1
	I_0	I_1	I_2	I_3

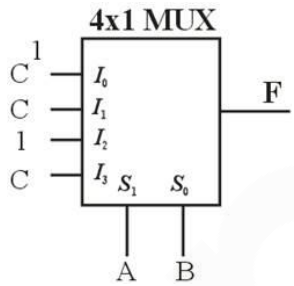
Thus, we get

$I_0 = \bar{C}$

$I_1 = C$

$I_2 = 1$

$I_3 = C$



Hence, B. is the correct option.

38. What will be the value of

$$\int_{-\infty}^{\infty} \cos^3(t-3)\delta(4t-5)dt$$

A. $-\frac{1}{4}\cos^3\left(\frac{3}{4}\right)$

B. $\frac{1}{4}\cos^3\left(\frac{7}{4}\right)$

C. $-\frac{1}{4}\cos^3\left(\frac{7}{4}\right)$

D. $\frac{1}{4}\cos^3\left(\frac{5}{4}\right)$

Ans. B

Sol.

$$\int_{-\infty}^{\infty} \cos^3(t-3)\delta(4t-5)dt$$

Taking 4t = z, we get:

$$\frac{1}{4}\int_{-\infty}^{\infty} \cos^3\left(\frac{z}{4}-3\right)\delta(z-5)dz$$

We know:

$$\int_{-\infty}^{\infty} x(\tau)\delta(\tau-a)d\tau = x(a)$$

Therefore the given integral becomes:

$\frac{1}{4}\cos^3\left(\frac{5}{4}-3\right) = \frac{1}{4}\cos^3\left(-\frac{7}{4}\right) = \frac{1}{4}\cos^3\left(\frac{7}{4}\right)$ since $\cos(-x) = \cos x$

39. Match List-I (semiconductor device) with List-II (Application) and select the correct answer using the codes given below the lists:

List- I	List- II
A. Varactor diode	1. High frequency switching circuit
B. Tunnel diode	2. High frequency tuning circuit
C. Triac	3. Current controlled attenuator
D. Pin diode	4. Used in HVDC system

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

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

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

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

Ans. C

Sol. Varactor diode can be used in high frequency tuning circuit. Tunnel diode switching time is in pico seconds. In triac two SCRs are connected in parallel but in opposite direction. Pin diode can be used as current controlled attenuator because At high frequencies, the PIN diode appears as a resistor whose resistance is an inverse function of its forward current.

40. Any modulation process produces

A. carriers
B. sidebands
C. noise
D. amplification

Ans. B

Sol. Any modulation process produces sidebands.

41. Electric field intensity at any point (x, y, z) in free space is $E = x^2a_x + 2xya_y$

The electric flux density at the point (−1, 0, 1) will be

A. 0
B. $\epsilon_0 a_x$
C. $-\epsilon_0 a_x$
D. $4\pi\epsilon_0 a_y$

Ans. B

Sol. Electric flux density in a certain region for the given electric field intensity is defined as

$D = \varepsilon_0 E = \varepsilon_0(x^2a_x + 2xya_y)$

So, at the point (−1, 0, 1), $D = \varepsilon_0\, a_x$

42. The average collision time (t) of electrons in a semiconductor is 2.5×10^{-14} sec, then the mobility (m) of electrons will be equal to

(Assume mass of an electron (m_e) is 9.1×10^{-31} kg)

A. 2.5×10^{-4} m² / V–sec
B. 4.4×10^{-3} m² / V–sec
C. 7.5×10^{-4} m² / V–sec
D. 9×10^{-3} m² / V–sec

Ans. B

Sol. Mobility of electrons,

$$\mu = \frac{e\tau}{m}$$

$$= \frac{1.6 \times 10^{-19} \times 2.5 \times 10^{-14}}{9.1 \times 10^{-31}}$$

$= 4.4 \times 10^{-3}$ m² / V – sec

43. Consider the system described by the state equation given below,

$$\dot{x}(t) = \begin{bmatrix} 0 & 1 \\ -1 & -2 \end{bmatrix} . x(t) + \begin{bmatrix} 1 \\ -1 \end{bmatrix} . u(t)$$

$$x(0) = \begin{bmatrix} 0 \\ 1 \end{bmatrix}, y(t) = \begin{bmatrix} 1 & 1 \end{bmatrix} . x(t)$$

If u(t) is unit step input, then find the output 'y(t)' of the system.

A. e^t

B. te^{-t}

C. $-1 + 2e^{-t} - te^{-t}$

D. e^{-t}

Ans. D

Sol. Here,

$$A = \begin{bmatrix} 0 & 1 \\ -1 & -2 \end{bmatrix}, B = \begin{bmatrix} 1 \\ -1 \end{bmatrix} and\ C = \begin{bmatrix} 1 & 1 \end{bmatrix}$$

Taking Laplace transform on both sides of the state equation,

$$s.X(s) - x(0) = A.X(s) + B.U(s)$$

$$\Rightarrow X(s) = (sI - A)^{-1} .x(0) + (sI - A)^{-1} .BU(s)$$

And,

$$Y(s) = C.X(s) = C.(sI - A)^{-1} .x(0) + C.(sI - A)^{-1} .BU(s)$$

The system matrix is given as,

$$A = \begin{bmatrix} 0 & 1 \\ -1 & -2 \end{bmatrix}$$

$$(sI - A) = \begin{bmatrix} s & -1 \\ 1 & s+2 \end{bmatrix} \Rightarrow |sI - A| = s^2 + 2s + 1 = (s+1)^2$$

$$(sI - A)^{-1} = \frac{adj(sI - A)}{|sI - A|} = \frac{1}{(s+1)^2} . \begin{bmatrix} s+2 & 1 \\ -1 & s \end{bmatrix}$$

$$= \begin{bmatrix} \frac{s+2}{(s+1)^2} & \frac{1}{(s+1)^2} \\ -\frac{1}{(s+1)^2} & \frac{s}{(s+1)^2} \end{bmatrix}$$

$$C.(sI - A)^{-1} = \begin{bmatrix} 1 & 1 \end{bmatrix} . \begin{bmatrix} \frac{s+2}{(s+1)^2} & \frac{1}{(s+1)^2} \\ -\frac{1}{(s+1)^2} & \frac{s}{(s+1)^2} \end{bmatrix}$$

$$= \begin{bmatrix} \frac{1}{s+1} & \frac{1}{s+1} \end{bmatrix} = \frac{1}{s+1} . \begin{bmatrix} 1 & 1 \end{bmatrix}$$

Now,

$$Y(s) = \frac{1}{s+1} . \begin{bmatrix} 1 & 1 \end{bmatrix} . \begin{bmatrix} 0 \\ 1 \end{bmatrix} + \frac{1}{s+1} . \begin{bmatrix} 1 & 1 \end{bmatrix} . \begin{bmatrix} 1 \\ -1 \end{bmatrix} . \frac{1}{s}$$

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

$$\Rightarrow y(t) = e^{-t}$$

44. Which of the following signals are periodic?
A. X(t) = e^{-at}
B. X(t) = e^{bt}
C. X(t) = 5
D. X(t) = cos (4πt)

Ans. D

Sol. A signal X(t) is said to be periodic if x(t) = x(t+nt_0). Hence, exponential signals and constant (i.e. DC) signals are aperiodic.

45. If a two-port network is reciprocal as well as symmetrical, which one of the following relationship is correct?
A. $Z_{12} = Z_{21}$ and $Z_{11} = Z_{22}$
B. $Y_{12} = Y_{21}$ and $Y_{11} = Y_{22}$
C. $AD - BC = 1$ and $A = D$
D. All of the above

Ans. D

Sol. Condition for reciprocity:
$$Z_{12} = Z_{21}$$
$$Y_{12} = Y_{21}$$
$$AD - BC = 1$$
Condition for symmetry:
$$Z_{11} = Z_{22}$$
$$Y_{11} = Y_{22}$$
$$A = D$$

46. Match List-I (Modes) with List-II (Characteristic) and select the correct answer using the code given below the lists:
List-I
A). Evanescent mode
B). Dominant mode
C). TM_{10} and TM_{01}
List-II
1). Rectangular waveguide does not support
2). No wave propagation
3). Lowest cut-off frequency
A. A-1, B-2, C-3
B. A-2, B-3, C-1
C. A-1, B-3, C-2
D. A-2, B-1, C-3

Ans. B

Sol. (i) In evanescent mode, waveguide is excited under cut-off frequency. Therefore there is no wave propagation.
(ii) The dominant mod in a particular waveguide is the mode having the lower cut-off frequency.
(iii) In TM_{00}, TM_{01} and TM_{10} modes, all field components (E_x, E_y, H_x, H_y)vanish. Hence, these modes do not exist.

47. The minimum voltage along a transmission line is 260V, while the maximum is 390V. The standing wave Ratio (SWR) is
A. 0.67 B. 1.0
C. 1.2 D. 1.5

Ans. D

Sol. VSWR=V_{max}/V_{min}
= 390/260
= 1.5

48. Which of the following modulation schemes in the most spectral-efficient scheme ?
A. 256 PSK B. 8PSK
C. QPSK D. 16PSK

Ans. A

Sol. 256 PSK is the most spectral-efficient scheme.

49. A distortion less line has characteristic Z_0 = 100 Ω, attenuation constant **α**= 10 mNp/m and phase velocity v= 2 × 10^8 m/s. The primary constants R and L are respectively.
A. 10 Ω/m, 0.5 μH/m
B. 1 Ω/m , 5μH/m
C. 1 Ω/m, 50μH/m
D. 1 Ω/m, 0.5 μH/m

Ans. D

Sol. For a distortion less line,
RC = GL
$$G = \frac{RC}{L}$$
$$Z_0 = \sqrt{\frac{L}{C}}$$
$$\alpha = \sqrt{RG} = R\sqrt{\frac{C}{L}}$$
$$= \frac{R}{Z_0}$$
R = αZ_0 = 10 × 10^{-3} × 100 = 1Ω/m
$$v = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{LC}} \times \sqrt{\frac{C}{L}}$$

$$= \frac{1}{L}\sqrt{\frac{L}{C}}$$

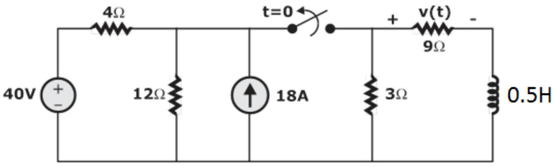
$$= \frac{1}{L} \times Z_0$$

$$L = \frac{Z_0}{v} = \frac{100}{2 \times 10^8}$$

$= 50 \times 10^{-8}$

$= 0.5\ \mu H/m$

50. The switch is figure opens at t = 0 after having been closed for a long time. The voltage v(t), for t > 0 will be given by



A. $v(t) = 96e^{-24t}$ V

B. $v(t) = 36\ (1 - e^{-24t})$ V

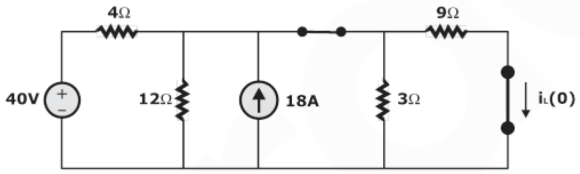
C. $v(t) = 36e^{-24t}$ V

D. $v(t) = 18\ (1 + e^{-24t})$ V

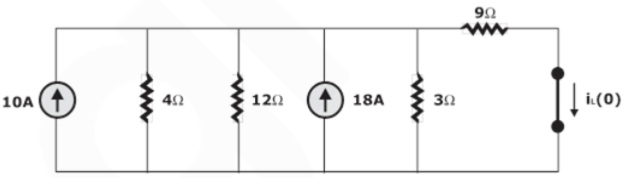
Ans. C

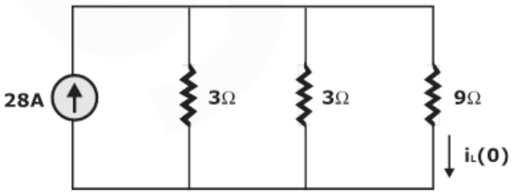
Sol. First, we find inductor current for t ≥0.

For t < 0: Switch is closed, in steady state inductor acts as a short circuit



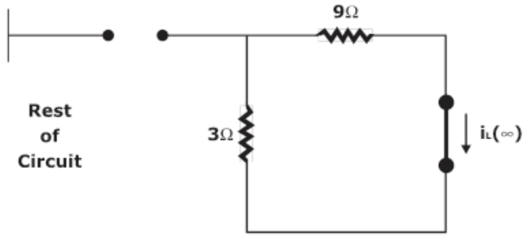
Using source transformation





$$i_L(0) = \frac{3 \| 3}{3 \| 3 + 9} \times 28 = 4A$$

For t > 0: Switch is open, again circuit reaches in steady state. At t = ∞ inductor is replaced by a short circuit.

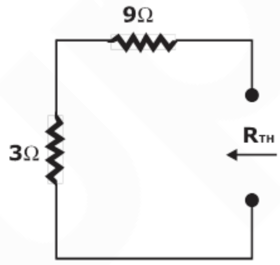


$i_L(\infty) = 0$

Inductor current is given as

$i_L(t) = i_L(\infty) + [i_L(0) - i_L(\infty)]e^{-t/T}$ ....(1)

Time constant, $T = \frac{L}{R_{Th}}$



$R_{Th} = 3 + 9 = 12\ \Omega$

So, $T = \frac{0.5}{12} = \frac{1}{24}$ sec

Substituting values into equation (1)

$i_L(t) = 0 + [4 - 0]\ e^{-24t} = 4e^{-24t}$ A, t > 0

Voltage across 9 Ω resistor

$V(t) = i_L(t) \times 9 = 36e^{-24t}$ V

51. No. of comparators required for a flash type ADC to convert 15 volts to a 3-bit binary expression.

A. 8
B. 7
C. 3
D. 2

Ans. B

Sol. For flash type ADC, no of comparators = $(2^n - 1)$

$= 2^3 - 1$

$= 7$

52. Which of the following condition holds good for a Energy signal?

A. P = finite; E = ∞

B. P = finite; E = 0

C. P = ∞; E = finite

D. P = 0; E = finite

Ans. D

Sol. For a power signal, Energy is infinity and Power is a finite value. For an energy signal, Energy is finite and Power of the signal is zero.

53. Consider the matrix

$$A = \begin{bmatrix} 2 & -1 & 1 \\ -1 & 2 & -1 \\ 1 & -1 & 2 \end{bmatrix}.$$

The sum of its eigen values is ______.

A. 4 B. 6

C. 8 D. 12

Ans. B

Sol. Sum of eigen values = Sum of diagonal elements

= 2 + 2 + 2 = 6

54. Which of the following gives maximum probability of error?

A. ASK B. BPSK

C. QPSK D. DPSK

Ans. A

Sol. ASK gives maximum probability of error.

55. A Gap has on indirect band gap of 2.26 eV at temperature of 300K. If produces light with a wavelength (λ) of .... µm.

A. 0.13 µm B. 0.55 µm

C. 0.23 µm D. 1.71 µm

Ans. B

Sol. Given,

Indirect energy gap of Gap is

Eg = 2.26 eV

Wavelength,

λ = 1.24/Eg (ev) µm

$$= \frac{1.24}{2.26}\,\mu m$$

λ = 0.55 µm

56. If fixed positive charges are present in the gate oxide of an n-channel enhancement type MOSFET, it will lead to

A. a decrease in the threshold voltage

B. channel length modulation

C. an increase in substrate leakage current

D. an increase in accumulation capacitance

Ans. A

Sol. For n channel enhancement type MOSFET as V_{GS} is positive, the density of free carriers in the induced channel will increase, resulting in an increased level of drain current.

$I_D \propto V_{GS}-V_{TH}$

Hence, V_{TH} decreases.

Thus option A is correct.

57. In an experiment, positive and negative values are equally likely to occur. The probability of obtaining at most one negative value in 5 trials will be

A. $\frac{1}{32}$ B. $\frac{2}{32}$

C. $\frac{3}{32}$ D. $\frac{6}{32}$

Ans. D

Sol. Let X = Number of times we get negative values.

By using Binomial Distribution, required probability = $P(X \leq 1)$

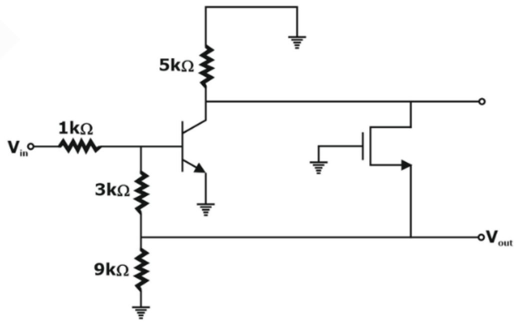
$= P(X=0) + P(X=1)$

$= {}^5C_0\,(0.5)^5 + {}^5C_1(0.5)^5$

$= \frac{1+5}{32}$

= 6/32

58. Determine the type of feedback topology is



A. series-series B. series-shunt

C. shunt-shunt D. shunt-series

Ans. C

Sol. **At output:**

By replacing output with short circuit, output voltage becomes zero hence it's voltage (shunt) sampling.

At input:

Feedback element is directly connected across it's base hence it's mixing shunt.

Therefore, the above configuration is shunt-shunt configuration.

59. The X and Y components of the electric fields for TE_{10} mode are given in a rectangular wave guide as

$$\overline{E_y} = -j570\sin\left(\frac{\pi}{a}x\right)e^{-j\beta}10^2\widehat{a_y}V/m$$

$$\overline{H_x} = j1.2\sin\left(\frac{\pi}{a}x\right)e^{-j\beta}10^2\widehat{a_x}A/m$$

If the operating frequency is 10 GHz, then the group velocity in TE_{10} mode is

A. 1.79×10^7 cm/sec

B. 2.38×10^8 m/sec

C. 1.79×10^7 m/sec

D. 2.9×10^8 m/sec

Ans. B

Sol. $V_{g_{10}} = C\sqrt{1-\left(\frac{f_{c_{10}}}{f}\right)^2}$ ....(1)

$$\eta_{T_{E_{10}}} = \frac{|E_Y|}{|H_x|} = \frac{570}{1.2} = 475\Omega$$

$$\eta_{T_{E_{10}}} = \frac{\eta}{\sqrt{1-\left(\frac{f_{c_{10}}}{f}\right)^2}}$$

$$\Rightarrow 1-\left(\frac{f_{c_{10}}}{f}\right)^2 = \left(\frac{\eta_{10}}{\eta_{T_{E_{10}}}}\right)^2 = \left(\frac{120\pi}{475}\right)^2 = 0.6299$$

f_{c10} = 6.083 GHz

From (1)

$$V_{g_{10}} = C\sqrt{1-\left(\frac{f_{c_{10}}}{f}\right)^2} = 3\times10^8\sqrt{1-\left(\frac{6.083\times10^9}{10\times10^9}\right)^2}$$

$$\therefore V_{g_{10}} = 2.38\times10^8 m/sec$$

60. For the recording of very fast random signals, the most suitable instrument would be

A. dual-trace

B. sampling oscilloscope

C. real-time spectrum analyzer

D. scanning-type spectrum analyzer

Ans. C

Sol. With the advent of wide bandwidth analog-to-digital converters (ADCs), high-speed memory, fast processors, and efficient fast-fourier transforms (FFTs), tens to hundreds of megahertz of instantaneous bandwidth can be processed as fast as it is received. Using overlapping FFTs on a continuous stream of input data produces a real-time representation of an active frequency spectrum. These modern advances enable the effective sensing and processing of the most complicated modern communications techniques, and ensure intercept of nonrecurring waveforms or pulse signals.

Real-time SA (RTSA) is a new method that leverages overlapping FFTs and high-speed memory to have a 100% probability of intercept (POI) in even extremely dense environments. Real-time bandwidth, the maximum frequency span offering gap-free overlapping FFT processing, is an important variable parameter of an RTSA that can enable more detailed analysis of a spectrum, based upon the type of signal content under scrutiny. Hence, the correct answer is option (C).

61. Sampling rate of Delta modulation compared to pulse code modulation is

A. higher

B. very much higher

C. equal

D. lesser

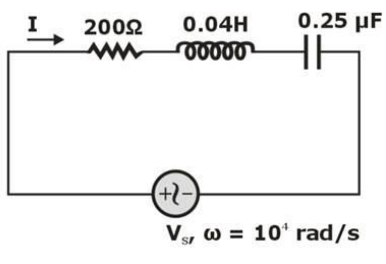
Ans. B

Sol. In delta modulation, quantizer assigns either + D or −D based on sign of the quantity [present sample value-previous sample value]

So, more number of sample per sec, more correction between two successive samples.

$\therefore \quad f_{s\,deltamodulution} >> f_{sPCM}$

62.



In the shown circuit, if I = 30 ∠45° mA then phasor voltage V_S is

A. 6∠0°V

B. 17∠45° V

C. 12∠−45°V

D. 6∠45°V

Ans. D

Sol. R = 200 Ω

jωL = j(10^4) (0.04) = j400 Ω

$$\frac{1}{j\omega C} = \frac{1}{j(10^4)(0.25\times10^{-6})} = -j400\ \Omega$$

$V_S = IZ = (30\angle45° \times 10^{-3})$ (200 + j400 – j400)

$= 30\angle45° \times 10^{-3} \times 200 = 6\angle45°$ V

63. Match List- I (Type of Memory) with List-II (Used as) and select the correct answer using the code given below the lists:

List-I

A). DRAM

B). SRAM

C). Parallel Access Registers

D). ROM

List-II

1). Cache memory

2). Main memory

3). BIOS memory

4). CPU registers

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

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

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

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

Ans. B

Sol. DRAM used in main memory. SRAM used in cache memory. Parallel access is done by CPU registers system programs are written and stored in ROM which we can only read. BIOS is loaded in the main memory by the bootstrap loader to initialize the system.

64. The ability to halt the CPU temporarily and use this interval of time to send information on buses is called.

A. Cycle stealing

B. Vectoring an interrupt

C. Polling

D. Direct memory access

Ans. A

Sol. The ability to temporarily halt the CPU and use this time to send information buses is called **Cycle Stealing Cycle Stealing** mode is similar to Burst Transfer mode, but instead of the data being transferred all at once, it is transferred one byte at a time. The DMA controller, after transferring one byte of data, releases control of the system buses by sending a bus grant signal through the control bus, lets the CPU process an instruction and then requests access to the bus by sending the bus request signal through the control bus and then transfers another byte of data. This keeps going on until all the data has been transferred. The transfer rate is slower but it prevents the CPU from staying idle for a long period of time

65. The electric field of a plane wave propagating in + Z direction in a certain medium ($\varepsilon_r = 72$, $\mu_r = 1$, $\sigma = 4$ S/m) is given by $\bar{E} = 10\cos(10^7 \pi t)\,\hat{a}_x$ at z = 0. The intrinsic impedance of the medium is.

$$\left(\text{Assume } \varepsilon_0 = \frac{10^{-9}}{36\pi} F/m\right)$$

A. $2\pi e^{j\pi/4}\ \Omega$

B. $\pi e^{j\pi/4}\ \Omega$

C. $\pi e^{j\frac{\pi}{2}}\Omega$

D. $2\pi e^{j\pi/2}\ \Omega$

Ans. B

Sol. $\omega = 10^7 \pi \Rightarrow f = 5 \times 10^6$ Hz

$\frac{\sigma}{\omega\varepsilon} \approx 200 >> 1 \Rightarrow$ good conductor

$$\eta_c = (1+j)\sqrt{\frac{\pi f \mu_r \mu_0}{\sigma}} = (1+j)\sqrt{\frac{\pi\times5\times10^6\times4\pi\times10^{-7}}{4}}$$

$$= (1+j)\frac{\pi}{\sqrt{2}}$$

$= \pi e^{j\pi/4}\ \Omega$

66. What is the main advantage of a JFET-cascade amplifier?

A. High voltage gain

B. Low output impedance

C. Very low input capacitance

D. High input impedance

Ans. A

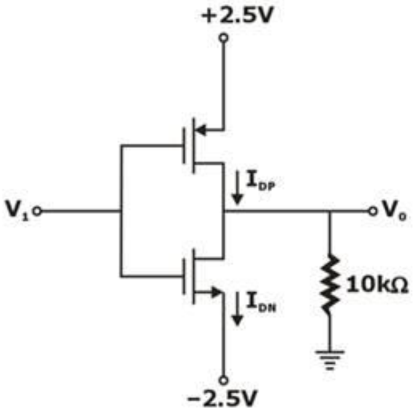
67. Consider the circuit shown below. The transistors are perfectly matched with the parameters

$$k_n' \frac{W_n}{L_n} = k_p' \frac{W_p}{L_p} = 1mA / V^2$$

$V_{TN} = 1V$

V_{TP} = – 1V

Assume λ = 0 for both transistor



For the value of V_1 = 2.5 V, then the value of I_{DN} and I_{DP} is?

A. 1.125 mA, 1.125 mA

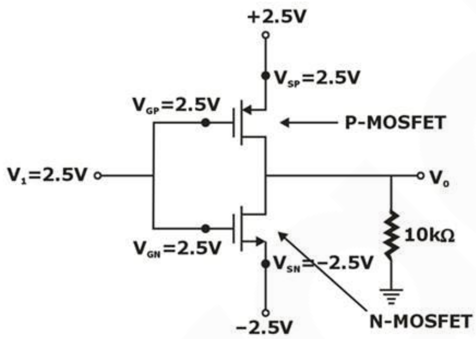
B. 0.244 mA, 0 mA

C. 0 mA, 0.244 mA

D. 1.125 mA, 0 mA

Ans. B

Sol. Again, we have the dc equivalent of MOSFET circuit as



For p-MOSFET, we obtain

$V_{SGP} = V_{SP} – V_{GP}$

= 2.5 V – 2.5 V

= 0 V

or $V_{SGP} < |V_{TH}|$

So, p-MOSFET is in cut-off region, and therefore

I_{DP} = 0

Again, for n-MOSFET, we have

$V_{GSN} = N_{GN} – V_{SN}$

= 2.5 – (– 2.5V)

= 5V

Also, $V_{DS} = V_0 – (– 2.5)$

$V_{DG} = V_D – 2.5 = V_0 – 2.5$

Therefore, $V_{DG} < – V_{TH}$

Or $V_{DS} < V_{GS} – V_{TH}$

So, n-MOSFET is operating in triode region. Thus, we have

$$I_{Dn} = k_n'\frac{W_n}{L_n}\left[(V_{GS} - V_{TN})V_{DS} - \underbrace{\frac{1}{2}V_{DS}^2}_{\text{neglect this term}}\right]$$

$$= k_n'\frac{W_n}{L_n}\left[(V_{GS} - V_{TN})V_{DS}\right]$$

$$= 1m\left[(5-1)(V0-(-2.5))\right] \quad \text{.........(1)}$$

At the output terminal, we have

$$I_{DN} = \frac{0 - V_0}{10\ k\Omega} \quad \text{..........(2)}$$

Comparing equations (1) and (2), we get

$$1m \times 4(V_0 + 2.5) = -\frac{V_0}{10k}$$

or $40(V_0 + 2.5) = – V_0$

V_0 = – 2.44V

Thus, we obtain

$$I_{DN} = \frac{0 - V_0}{10k} = \frac{0-(-2.44)}{10k}$$

= 0.244mA

I_{DP} = 0

68. A carrier wave of 1 MHz and amplitude 3 V is frequency modulated by a sinusoidal modulating signal frequency of 500 Hz and of peak amplitude of 1 V. The peak frequency deviation is 1 kHz. The peak level of the modulating wave form is changed to 5 V and the modulating frequency is changed to 2 kHz. The expression for the new modulated wave from is

A. cos[2π × 10^6+2.5 sin (4π 10^3t)

B. cos[2π × 10^6t+5 sin (4π 10^3t)]

C. 3 cos[2π × 10^6t+2.5 sin (4π 10^3t)]

D. 3 cos [2π × 10^6 + 5 sin (4π 10^3t)]

Ans. C

Sol. Given the carrier frequency, f_c =1 MHz = 10^6 Hz

Amplitude of carrier wave, A_c =3 volt

Initially, the modulating signal frequency, f_{m1} = 500 Hz

Peak amplitude of modulating signal, A_{m1} = 1 V

The frequency deviation for the 1^{st} case, $\Delta f_1 = 1kHz$

So, we have the FM signal for the 1^{st} case as

$$x_1(t) = A_c \cos\left[2\pi f_c t + 2\pi k_f \int_{-\infty}^{t} m_1(\tau)d\tau\right]$$

= 3cos[2π 10^6t+2π $k_f\int A_{m1}$ cos(2πf_{m1}t)dt]
=cos[2π 10^6 t+2π $k_f\int$ cos(2π 500t)dt]
Now, the maximum frequency deviation is given by

$$\Delta f_1 = \max\left\{\frac{1}{2\pi}\frac{d}{dt}\left[2\pi k_f \int \cos(2\pi 500t)dt\right]\right\}$$

Substituting the given values, we have

$$1 = \frac{1}{2\pi}\times 2\pi k_f$$

Or, k_f = 1kHz = 10^3 Hz
This is the frequency sensitivity constant, which will be same for the second case. Now, we have the peak level of modulating signal,
A_{m2} = 5 V
The modulating frequency,
f_{m2} =2 kHz
So, we have the expression of new FM signal

$$x_2(t) = A_c \cos\left[2\pi f_c t + 2\pi k_f \int_{-\infty}^{t} m_2(\tau)d\tau\right]$$

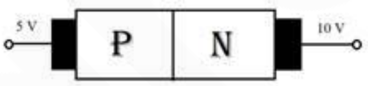
$$= 3\cos\left[2\pi 10^6 t + 2\pi k_f \int A_{m2}\cos(2\pi f_{m2}t)dt\right]$$

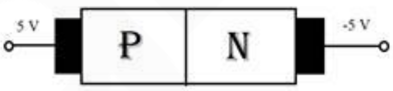
$$= 3\cos\left[2\pi 10^6 t + 2\pi \times 10^3 \int 5\cos(2\pi\times 2\times 10^3 t)dt\right]$$

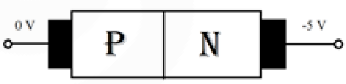
$$= 3\cos\left[2\pi\times 10^6 t + 2\pi\times 10^3 \times \frac{5\sin(4\pi\times 10^3 t)}{4\pi\times 10^3}\right]$$

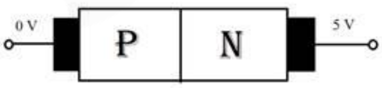
=3cos[2π10^6t+2.5 sin(4π 10^3t)]

69. Which of the following diodes are forward biased?

i)


ii)


iii)


iv)


A. Only (ii) & (iii).
B. Only (i) & (iv).
C. Only (ii).
D. None of the above.

Ans. A

Sol. For a diode to be forward biased, the necessary and sufficient condition is Voltage at P terminal (Anode A) must be greater than the voltage at N terminal (Cathode K).

70. Which of the following is not a main type of modulation used in modern modems?
A. frequency-shift keying
B. phase- shift keying
C. frequency modulation
D. quadrature amplitude modulation

Ans. B

Sol. phase- shift keying is not used in modern modems.

71. An FM modulator has output

$$x(t) = 200cos\left(\omega_c t + 2\pi k_f \int_0^t (\tau)d\tau\right)$$

Where k_f =30 Hz/V. The m(t) is the rectangular pulse $m(t) = 8rect\left[\frac{1}{4}(t-2)\right]$

The frequency deviation would be
A. 240u(t)-720u(t-4)
B. 240u(t)+720u(t-4)
C. 240u(t)-80u(t-4)
D. 240[u(t)-u(t-4)]

Ans. D

Sol. Given, the FM signal

$$x(t) = 200\cos\left(\omega_c t + 2\pi k_f \int_0^t m(\tau)d\tau\right)$$

Frequency sensitivity, k_f =30 Hz/V
Modulating signal, $m(t)$ = 8 $rect\left[\frac{1}{4}(t-2)\right]$

So, we have the phase

$$\theta(t) = 2\pi k_f \int_0^t m(\tau)d\tau$$

$$= 2\pi k_f \int_0^t 8rect\left[\frac{1}{4}(\tau-2\right]d\tau$$

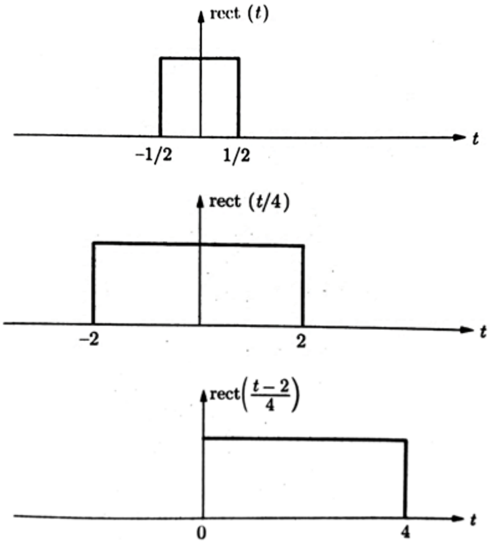
Therefore, the frequency deviation is given by

$$\Delta f = \frac{1}{2\pi}\frac{d\theta(t)}{dt}$$

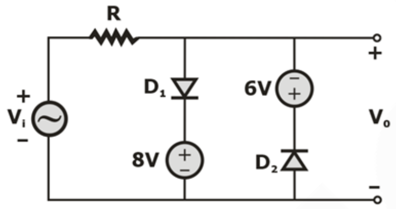
$$= \frac{1}{2\pi}2\pi k_f 8rect\left[\frac{1}{4}(t-2)\right]$$

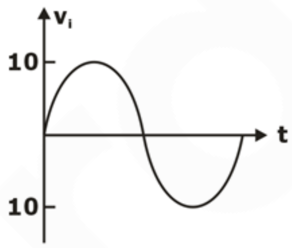
= 8× 30[u(t)-u(t-4)]
=240[u(t)-u(t-4)]

NOTE :
The rectangular function is defined as

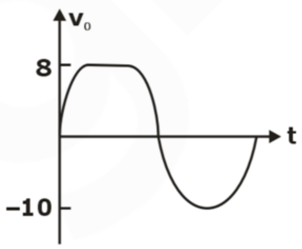


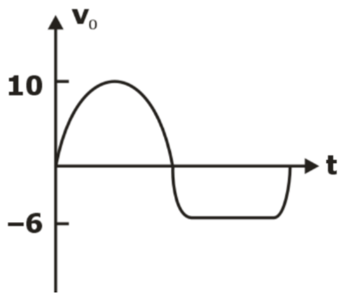
72. Consider the given circuit and a waveform for the input voltage. The diode in circuit has cut-in voltage V_γ = 0

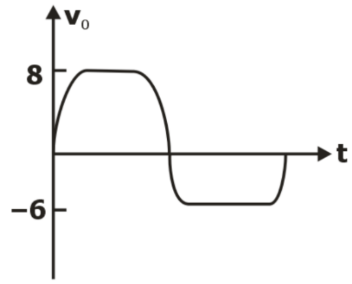


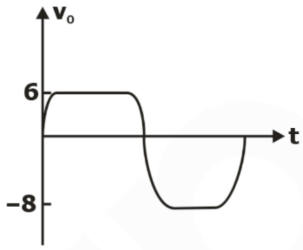


The waveform of output voltage v_0 is

A.


B.


C.


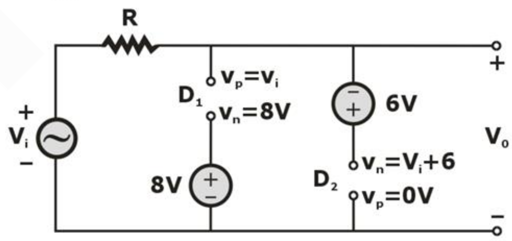
D.


Ans. C

Sol. For the given circuit, we first determine the linear region (forward bias or reverse bias) in which the two diodes are operating, and then obtain the output.

Step 1: Assume that both the didoes are OFF, and replace it by open circuit.

So, equivalent circuit is,



Step 2: For the assumption, the voltage across diode D_1 is obtained as

V_{p1} = v_i at the p-terminal

V_{n1} = 8 V at the n-terminal

Step 3: Voltage across the diode D_2 is obtained as

v_{p2} = 0V at the p-terminal

$v_{n1} = v_i + 6$ at the n-terminal

Step 4: Now, we have the condition for both the diodes

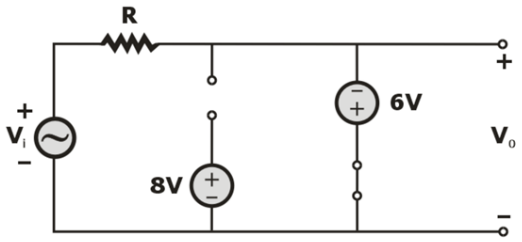
$v_p > v_n$ diode is ON

$v_p < v_n$ diode is OFF

Applying these conditions, we determine the output voltage,

CASE I:

If $v_i + 6 < 0$ or $v_i < -6$ diode D_1 is OFF and diode D_2 is ON. So, the equivalent circuit is

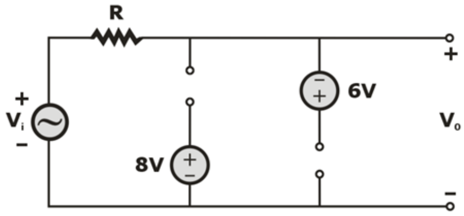


So, the output voltage is,

$v_0 = -6V$

CASE II:

If $-6V < v_i < 8V$, then both didoes D_1 and D_2 are OFF. So, the equivalent circuit is

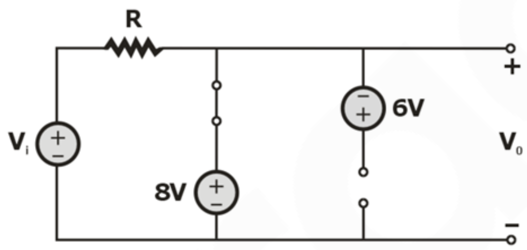


So, the output voltage is

$v_0 = v_i$

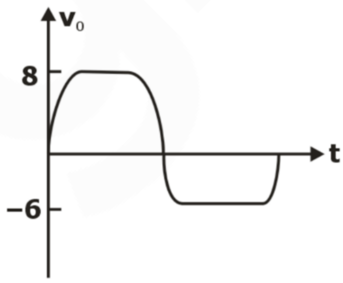
CASE III:

When $v_i > 8V$, then diode D_1 is ON and D_2 is OFF. So, the equivalent circuit is,



$v_0 = 8V$

Step 5: From the result obtained in the above step, we sketch the output waveform as shown below.



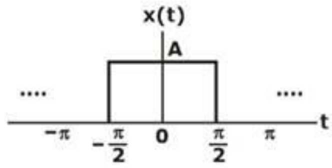
73. There is a system which has multiple outputs, then which of the following can be used to select only one of the many outputs?

A. Multiplexer B. Demultiplexer
C. Decoder D. Encoder

Ans. A

Sol. Multiplexer is used for selecting one input lines from many, i.e. it is used as a data selector.

74. The trigonometric Fourier series for the periodic signal shown below is



A. $\frac{A}{2}+\frac{2A}{\pi}\left(\sin t-\frac{1}{3}\sin 3t+\frac{1}{5}\sin 5t...\right)$

B. $\frac{A}{2}+\frac{2A}{\pi}\left(\cos t-\frac{1}{2}\cos 2t+\frac{1}{3}\cos 3t..\right)$

C. $\frac{A}{2}+\frac{2A}{\pi}\left(\cos t-\frac{1}{3}\cos 3t+\frac{1}{5}\cos 5t...\right)$

D. $\frac{A}{2}+\frac{2A}{\pi}\left(\sin t+\cos t+\frac{1}{3}\sin 3t+\frac{1}{3}\cos 3t..\right)$

Ans. C

Sol. x(t) is even so coefficient b_n = 0. Therefore, it contains cosine terms only. It also has half wave symmetry if A/2 is subtracted. So, it contains only odd harmonics. Thus, we conclude that trigonometric FS of x(t) will contain only odd harmonics of cosine terms. Average value of x(t) is A/2.

75. Without any additional circuitry, all functions of 4 variables can be obtained by:

(1) 16:1 MUX
(2) 4 to 16 Decoder
(3) 8:1 MUX
(4) 3 to 8 Decoder

Which of the above are true?

A. 2 & 3 B. 1 & 2
C. 1 & 3 D. All are true

Ans. B

Sol. 16:1 MUX has 4 select lines, thus all functions of 4 variables can be realized.

4 to 16 decoder has 16 minterms as the output, thus we get all the functions of 4 variables.

8:1 MUX has 3 select lines, thus all functions of 3 variables and some of 4 variables can be realized.

3 to 8 decoder generates 8 minterms, thus we can get all functions of 3 variables.

76. A resistance wire strain gauge with a gauge factor of 2 is bonded to a steel structural member subjected to a stress of 100 MN/m^2. The modulus, of elasticity of steel is 200 GN/m^2. The change in the value of gauge resistance due to the applied stress will be

A. 0.05% B. 0.10%

C. 0.30% D. 0.60%

Ans. B

Sol. Young's modulus = $\frac{stress}{strain}$

$\therefore$ Strain = $\frac{stress}{Y}$

$= \frac{100\times10^6}{200\times10^9}$

$\therefore$ Strain = 0.5×10^{-3}

GF = 2

$\therefore \frac{\Delta R}{R} = GF \times strain$

$\therefore \frac{\Delta R}{R}\times100\% = GF\times strain\times100$

$= 2\times0.5\times10^{-3}\times100$

$\therefore \frac{\Delta R}{R}\times100\% = 0.1\%$

$\therefore$ Option B

77. If a system has a gain margin which is close to unity then the system is

A. relatively stable

B. highly stable

C. Stable

D. Oscillatory

Ans. D

Sol. If a system has gain margin ≈ 1 then the system is oscillatory because it will be tending to marginally stable system.

78. Two microwave signals, travelling in the free space have a path length difference of *3 cm* when operating at 10 GHz. what is the relative phase difference of the signals?

A. 2π B. π

C. 3π D. 4π

Ans. A

Sol.

$$Phase\ difference = \frac{2\pi}{\lambda}(Path\,difference)$$

$$= \frac{2\pi f}{c}(Path\,difference)$$

$$= \frac{2\pi\times10\times10^9}{3\times10^8}(3\times10^{-2})$$

$$= 2\pi$$

79. Which of the following uses 'transferred electron effect' for production of micro- waves?

A. Silicon

B. Germanium

C. Metal-semiconductor Junction

D. Gallium Arsenide

Ans. D

80. Find $I_{D(Q)}$ of the MOSFET whose V_T=4V, $I_{D\,on}$ = 5 mA at $V_{GS\,on}$ = 8V and $V_{GS(Q)}$ = 6.9V.

A. 3.24 mA B. 2.63 mA

C. 1.72 mA D. 6.48 mA

Ans. B

Sol. The MOSFET parameter, $k_o = I_{D\,on}/(V_{GS\,on} - V_T)^2 = (5\text{x}10^{-3})/(8-4)^2 = 0.3125\text{x}10^{-3}$ A/V^2.

$I_{D(Q)} = k_o \cdot V_T^2[1-(V_{GS(Q)} / V_T)]^2 = (0.3125\text{x}10^{-3})(4)^2 [1-(6.9/4)]^2 = 2.63$ mA.

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