

BSNL Junior Telecom Officers-JTO 2009 SOLUTIONS

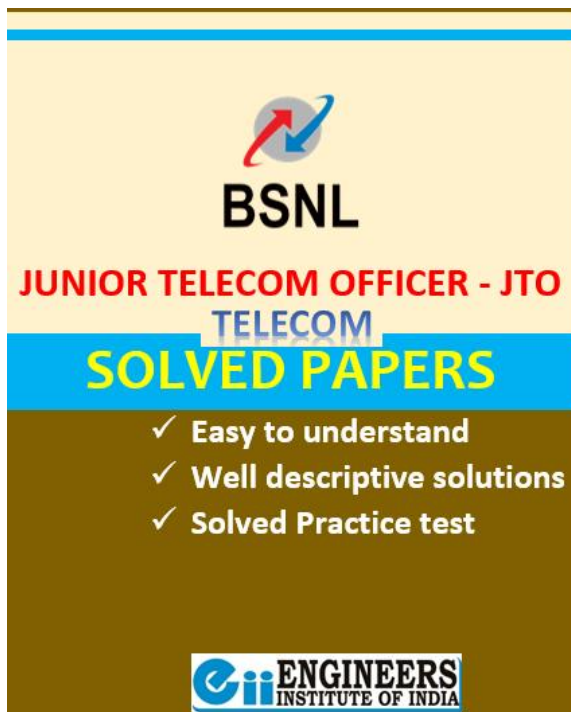
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Technical Section - I

4. Pinch off voltage is define as the minimum drain to source voltage where I_D enters into saturation.
 7. GaAs is the direct bandgap material in which most of the energy will be released in the form of light during recombination.
 9. Schottky diode contains a metal-semiconductor junction.

10. In n type semiconductor, concentration of holes is equal to $P_n = \frac{n_i^2}{n_n}$

12. Given: $V_1 = AV_2 - BI_2$, $I_1 = CV_2 - DI_2$

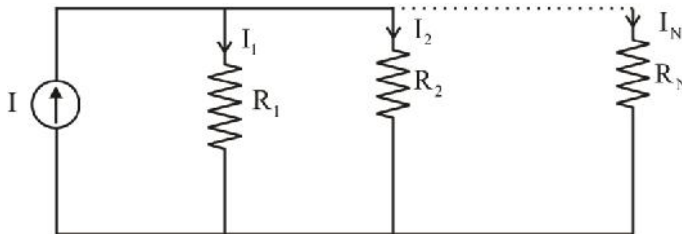
Now the admittance looking into the port-1 is, $Y = \frac{I_1}{V_1} = \frac{CV_2 - DI_2}{AV_2 - BI_2}$

Now $V_2 = -I_2R_L$

$$\Rightarrow Y = \frac{-CI_2R_L - DI_2}{-AI_2R_L - BI_2} = \frac{CR_L + D}{AR_L + B}$$

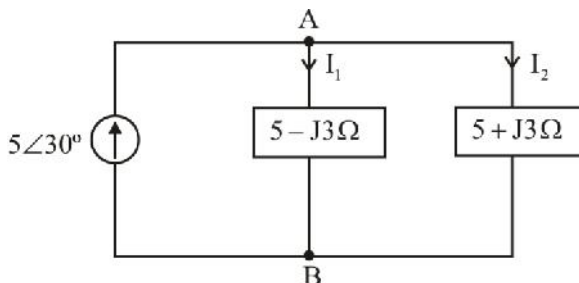
13. LED is device which converts electrical energy into optical energy, this process is called electroluminescence.

- 14.



$$I_k = \left(\frac{\frac{1}{R_k}}{\frac{1}{R_1} + \frac{1}{R_2} + \dots + \frac{1}{R_N}} \right) I$$

- 15.



$$I_1 = \frac{5\angle 30^\circ \times (5 + j3)}{5 - j3 + 5 + j3}$$

$$I_1 = \frac{14 \angle 30^\circ \times (5 + j3)}{2}$$

$$V_{AB} = (5 - j3)I_1 = \frac{1 \angle 30^\circ}{2} (25 + 9) = 17 \angle 30^\circ$$

16. Given: $l = \frac{\lambda}{2}$, we know that, for $\frac{\lambda}{2}$ lossless transmission line $Z_{in} = Z_L$

18. We know that, for a rectangular waveguide cut off frequency is given by;

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

For $m = 1, n = 0$ or $n = 1, m = 0$ i.e., TE_{10} and TE_{01} mode have the least f_c .

If $a > b$, then TE_{10} is dominant mode, having least f_c .

19. Radiation resistance of a quarter wave monopole is $R_r = 36.5 \Omega$

21. We know, shunt resistance $R_{sh} = \frac{R_m}{m-1}$

Here, $R_m = 10 \Omega$

$$m = \frac{I}{I_m} = \frac{1}{0.1} = 10$$

$$\Rightarrow R_{sh} = \frac{10}{10-9} = 1.111 \Omega$$

22. We know, Diode current $I_D = I_0 e^{V/V_T}$

$$\Rightarrow 200 = I_0 e^{(1/(2 \times 25.7 \times 10^{-3}))}$$

$$\Rightarrow I_0 = 7.108 \times 10^{-7} \text{ Amp}$$

30. Given: $D_2 = 2D_1$ and $l_2 = 4l_1$

We know that,

Resistance of wire is given by,

$$R = \frac{\rho l}{A} \quad \{ \dots \rightarrow \text{resistivity} \}$$

$$R = \frac{\rho l}{f D^2 / 4}$$

$$\Rightarrow R_1 = \frac{\rho l_1}{f D_1^2 / 4}$$

$$\Rightarrow R_2 = \frac{\rho l_2}{f D_2^2 / 4} = \frac{\rho 4l_1}{f 4D_1^2 / 4}$$

$$\Rightarrow R_2 = \frac{4l_1 \rho}{f D_1^2} = R_1$$

31. Given: $L = 4\pi \times 10^{-7} \text{ H}$, $A = 1 \text{ mm}^2$, $D = 1 \text{ m}$

$$\text{Now voltage, } V = L \frac{dI}{dt}$$

34. Given: $R_H = 3.6 \times 10^{-4} \text{ m}^3/\text{c}$ $\rho = 9 \times 10^{-3} \Omega\text{m}$

We know that,

Mobility $\mu = \sigma R_H$

$$= \frac{1}{9 \times 10^{-3}} \times 3.6 \times 10^{-4} = 0.04 \text{ m}^2 \text{ V}^{-1} \text{ S}^{-1}$$

and carrier density = $\frac{1}{qR_H}$

$$= \frac{1}{1.6 \times 10^{-19} \times 3.6 \times 10^{-4}} = 1.73 \times 10^{22} / \text{m}^3$$

35. The conductivity of a semiconductor is

$$\sigma = nq\mu_n + pq\mu_p \quad \dots(1)$$

By mass action law,

$$p = \frac{n_i^2}{n} \quad \dots(2)$$

From (1) and (2),

$$\sigma = nq\mu_n + \frac{n_i^2}{n} q\mu_p$$

$$\text{Now } \frac{d\sigma}{dn} = q\mu_n - \frac{1}{n^2} n_i^2 q\mu_p$$

$$\text{Now } \frac{d\sigma}{dn} = 0 \text{ for minimum conductivity,}$$

$$\Rightarrow n = n_i \sqrt{\frac{\mu_p}{\mu_n}}$$

36. We know that, $\left\{ \begin{matrix} \\ (-m) \end{matrix} \right\} = \frac{1.24}{E_g}$

$$\left\{ \begin{matrix} \\ 1.42 \end{matrix} \right\} = \frac{1.24}{1.42} \sim m = 0.875 \sim m$$

37. We know that,

For $\left\{ \begin{matrix} \\ 8 \end{matrix} \right\}$ lossless transmission line with $Z_L = 0$, the equivalent impedance, $Z_{in} = \left(\frac{Z_L + jZ_0}{Z_0 + jZ_L} \right) Z_0$

$$Z_{in} = jZ_0$$

$$Z_{in} = 50j$$

$$\Rightarrow j \times 2f \times 10^9 \times L = 50j$$

$$\Rightarrow L = \frac{25}{f} \text{ nH}$$

38. Given: $V_{BE} = 0.7\text{V}$, $\beta = 99$ and $V_c = 7.5\text{V}$

Apply KVL in base emitter loop,

$$-9 + R_B I_B + 0.7 = 0$$

$$R_B I_B = 8.3 \quad \dots(1)$$

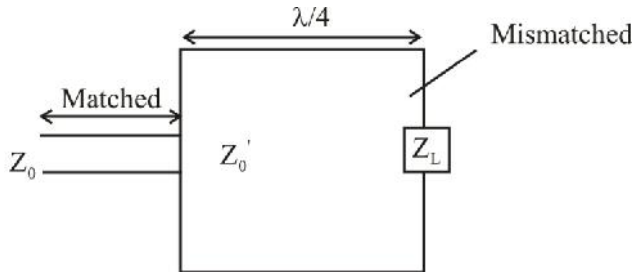
Apply KVL in collector emitter loop,

$$-100 + I_c \cdot 10 + 7.5 = 0$$

$$\Rightarrow I_c = 9.25 \text{ mA}$$

From (1), $R_B = 88.83 \text{ k}\Omega$

39.



Here, $Z_0' = \sqrt{Z_0 Z_L}$

$$Z_0' = \sqrt{120 \times 30} = 60 \Omega$$

41. For maximum power transfer, $R = 1 \Omega$ and

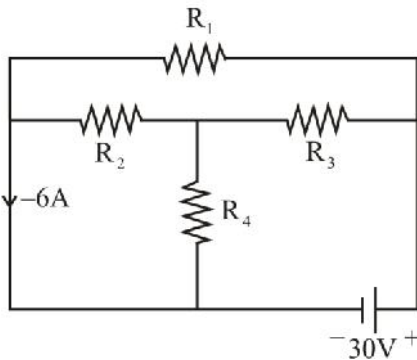
$$P_{\max} = \frac{1^2}{4 \times 1} = 0.25 \text{ watt}$$

50% of $P_{\max} = 0.125 \text{ watt}$

$$\Rightarrow 0.125 = \left(\frac{1}{1+R} \right)^2 \times R$$

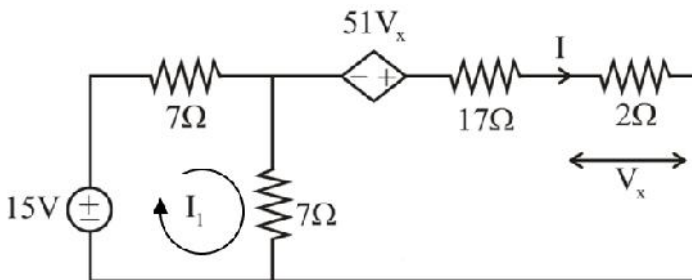
$$\Rightarrow R = (3 - \sqrt{8}) \Omega$$

42. By applying reciprocity theorem, we get,



$$I_2 = -6A$$

43. By source transformation



By KVL

$$-15 + 14I_1 - 7I = 0 \quad \dots(1)$$

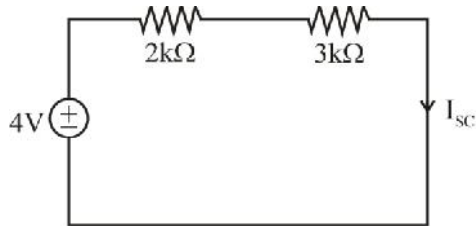
$$26I - 7I_1 - 51V_x = 0$$

$$\Rightarrow 26I - 7I_1 - 51 \times 2I = 0$$

$$\Rightarrow -76I - 7I_1 = 0 \quad \dots(2)$$

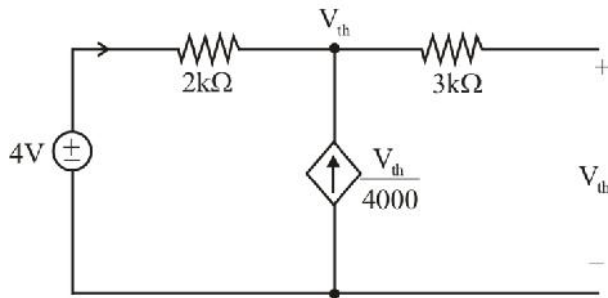
From (1) and (2) $I = -94.34 \text{ mA}$

44. Calculation of I_{sc} :



$$I_{sc} = \frac{4}{5} = 0.8 \text{ mA}$$

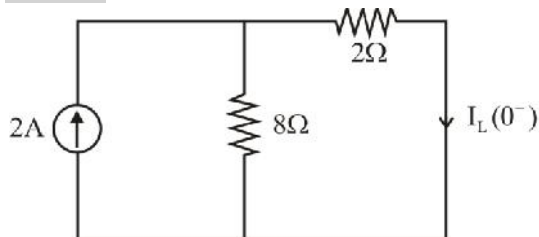
Calculation of V_{th} :



By Nodal analysis $\frac{4 - V_{th}}{2000} + \frac{V_{th}}{4000} = 0 \quad \therefore V_{th} = 8V$

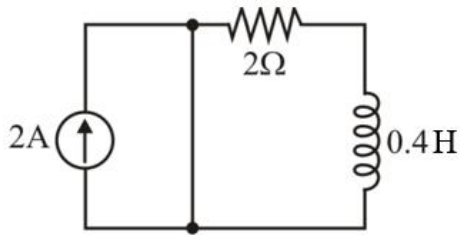
$$\Rightarrow R_{th} = \frac{V_{th}}{I_{sc}} = \frac{8}{0.8 \times 10^{-3}} = 10 \text{ k}\Omega$$

45. **At $t = 0^-$**



$$\Rightarrow I_L(0^-) = 1.6 \text{ Amp}$$

At $t > 0$

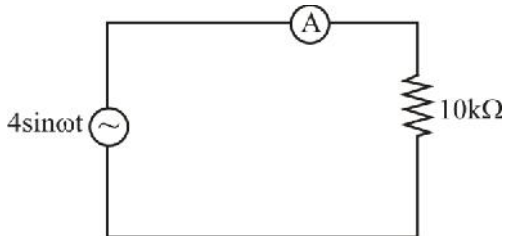


Now $\tau = \frac{L}{R} = \frac{0.4}{2} = 0.2$

$$i(t) = i_L(0^-)e^{-t/\tau} = 1.6e^{-5t}$$

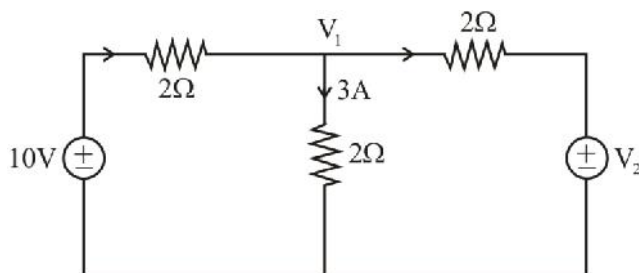
$$i(0.15) = 0.755 \text{ Amp}$$

47. Here D_1 will be short-circuited and D_2 will be open circuited.



$$\Rightarrow I = \frac{4 \sin \omega t}{10 \times 10^3} = \frac{4}{\sqrt{2} \times 10} \text{ mA} = \frac{0.4}{\sqrt{2}} \text{ mA}$$

50.



By nodal analysis,

$$\frac{10 - V_1}{2} - 3 - \left(\frac{V_1 - V_2}{2} \right) = 0$$

$$10 - V_1 - 6 - V_1 + V_2 = 0$$

$$4 - 2V_1 + V_2 = 0 \quad \dots(1)$$

Now $V_1 = 3 \times 2 = 6\text{V}$

From (1)

$$4 - 12 + V_2 = 0$$

$$\Rightarrow V_2 = 8\text{V}$$

Technical Section - II

1. TWT is a specialized vacuum tube in which the radio waves interact with the electron beam while traveling down a wire helix which surrounds the beam. These have wide bandwidth, but output is limited to a few hundred watts.
2. Given:- $F(A, B, C) = \pi M(0, 2, 3)$

$$= \sum m(1, 4, 5, 6, 7)$$

$$= \bar{A}\bar{B}C + A\bar{B}\bar{C} + A\bar{B}C + AB\bar{C} + ABC$$

$$= \bar{B}C(A + \bar{A}) + A\bar{B}\bar{C} + AB(C + \bar{C})$$

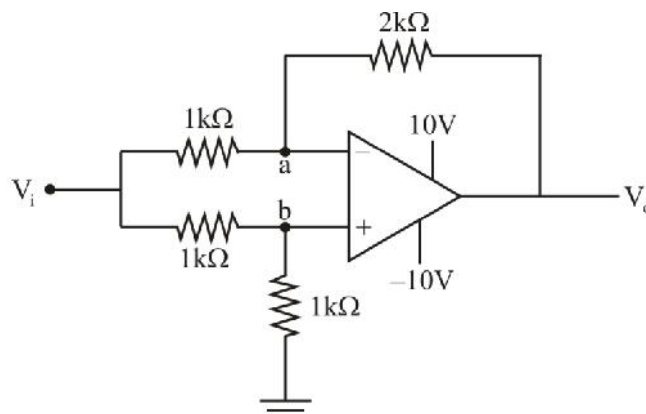
$$= \bar{B}C + A\bar{B}\bar{C} + AB$$

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

$$= \bar{B}C + A[(B + \bar{B})(B + \bar{C})]$$

$$= \bar{B}C + AB + A\bar{C}$$

$$= A + \bar{B}C$$
3. Number of address lines required to address 8K bytes of memory is 13.
As, $2^{13} = 8192 = 8K$ bytes
4. ASCII is a character encoding scheme. ASCII code represent text in computer, communication equipment and other devices that use text.
5. Binary number = 1101100
1's complement = 0010011
2's complement = 0010011+1
= 0010100
= 14 in BCD
- 6.



$$V_a = \frac{V_i \times 2 + V_o \times 1}{2+1} = \frac{2V_i + V_o}{3}$$

$$V_b = \frac{V_i \times 1}{1+1} = \frac{V_i}{2}$$

Due to virtual short circuit.

$$V_a = V_b$$

$$\frac{2V_i + V_0}{3} = \frac{V_i}{2}$$

$$4V_i + 2V_0 = 3V_i$$

$$2V_0 = -V_i$$

$$\frac{V_0}{V_i} = -0.5$$

7. If $V_0 = +10V$, then D_2 ON and D_1 OFF.

$$V_{UT} = \frac{10 \times 2}{2 + 0.5} = 8V$$

If $V_0 = -10V$, then D_1 ON and D_2 OFF.

$$V_{LT} = \frac{-10 \times 2}{2 + 2} = -5V$$

8. (i) $\overline{x + y} = \bar{x} \bar{y}$ (Demorgan's theorem)

$$(ii) \overline{\bar{x} + y} = \overline{\bar{x} + y} = \bar{x} \bar{y}$$

$$(iii) \overline{\bar{x} \bar{y}} = \overline{\bar{x} \bar{y}} = \bar{x} + \bar{y}$$

$$(iv) \overline{\bar{x} + \bar{y}} = \overline{\bar{x} + \bar{y}} = xy \neq \bar{x} \bar{y}$$

9. A Boolean function can be expressed as sum of products (SOP) i.e., sum of minterms and product of sums i.e., product of maxterm.
10. CMOS logic family having the lowest power dissipation 0.01 mW and highest noise margin as $(V_{OH})_{\min}$ is closer to the power supply voltage and $(V_{OH})_{\max}$ is closer to zero.

11. **T Flip flop:**

Characteristic table:

T	Q	Q(n+1)
0	0	0
0	1	1
1	0	1
1	1	0

$$Q(n+1) = \bar{T}Q + T\bar{Q}$$

12. The nyquist plot of $G(j\omega)H(j\omega)$ of a closed loop control system encloses the point $(-1, j0)$
 \Rightarrow Gain Margin < 1

⇒ Gain Margin = -ive (dB)

13. Given:-

$$\frac{2d^2y(t)}{dt^2} + \frac{3dy(t)}{dt} + 4y(t) = r(t) + 2r(t-1)$$

$$\Rightarrow 2s^2Y(s) + 3sY(s) + 4Y(s) = R(s) + 2R(s)e^{-s}$$

$$\Rightarrow \frac{Y(s)}{R(s)} = \frac{1 + 2e^{-s}}{2s^2 + 3s + 4}$$

14. We know that, DSB-SC signal is given by:-

$s(t) = A_c m(t) \cos 2f_c t$. Where, $A_c \cos 2f_c t$ is carrier signal.

Here, $s(t) = (1 + a_m \cos 2f_a t) \cos 2f_m t \cos 2f_c t$

$$\Rightarrow m(t) = (1 + a_m \cos 2f_a t) \cos 2f_m t$$

15. FM signal is given by,

$$s(t) = A_c \cos(n_i(t))$$

$$\text{Where, } n_i(t) = \int_0^t \tilde{S}_i dt = \int_0^t (f_c + k_f m(t)) 2\pi dt = 2\pi f_c t + 2\pi k_f \int_0^t m(t) dt$$

$$\Rightarrow s(t) = A_c \cos \left[2\pi f_c t + 2\pi k_f \int_0^t m(t) dt \right]$$

16. Given:- $P(t) \xrightarrow{F.T} P(f)$

Condition for zero inter symbol interference in the absence of noise is

$$\sum_{n=-\infty}^{\infty} P(f - nR_b) = 1$$

$$\sum_{n=-\infty}^{\infty} P \left(f - \frac{n}{T_b} \right) = 1$$

17. The magnitude response of an ideal equalizer for rectifying a distortion characterized by

$T \operatorname{sinc}(fT) e^{-jffT}$ is

$$\left| \frac{1}{T \operatorname{sinc}(fT) e^{-jffT}} \right| = \left| \frac{1}{\frac{T \operatorname{sinc}(fT)}{fT} e^{-jffT}} \right| \Rightarrow \frac{fT}{\operatorname{sinc}(fT)}$$

18. We know that, Minimum sampling frequency $f_s = 2f_m$ is also known as Nyquist rate.

$$\Rightarrow 8\text{kHz} = 2f_m$$

$$\Rightarrow f_m = 4\text{ kHz}$$

19. A klystron is a linear beam vacuum tube, in which bunching of electrons is caused by velocity modulation.
20. Program counter points to the address location from where the next byte i.e., next instruction is to be fetched.

21. Given: $f = 1\text{GHz}$
 $d = 30\text{ km}$
 $P_t = 1\text{ Watt}$
 $P_r = -30\text{ dBm}$

We know that,

$$P_r = \frac{P_t G_t G_r}{\left(\frac{4\pi f d}{c}\right)^2} = \frac{P_t G^2}{\left(\frac{4\pi f d}{c}\right)^2} \quad \{G_t = G_r\}$$

$$10^{-6} = P_r = \frac{1G^2}{\left(\frac{4\pi \times 30 \times 10^3}{0.3}\right)^2} \Rightarrow G = 400f$$

22. In memory mapped I/o, the processor can manipulate I/o data residing in interface register with the same instructions that are used to manipulate memory location.

23. When $i = 1.0$
- $\Rightarrow dx = 0.0$
 - $\Rightarrow \text{sum} = 0.0$
 - $\Rightarrow x = 4.0 \quad \{\text{sum} < x\}$
 - when $i = 2$
 - $\Rightarrow dx = 4.0$
 - $\Rightarrow \text{sum} = 4.0$
 - $\Rightarrow x = 8.0 \quad \{\text{sum} < x\}$
 - when $i = 3$
 - $\Rightarrow dx = 16.0$
 - $\Rightarrow \text{sum} = 20.0$
 - $\Rightarrow x = 16.0 \quad \{\text{sum} > x\}$
 - $\Rightarrow \text{sum} = 20.0$

24. Total number of comparison of 200 element is section sort is $O(n^2) = (200)^2 = 40000$ comparison
 40,000 comparisons takes 3ms.

Now, 4000 elements takes $(4000)^2$ comparisons

So, 40000 comparisons required 3 ms

$$\therefore 1 \quad ,, \quad ,, \quad \frac{3 \times 10^3 s}{40,000}$$

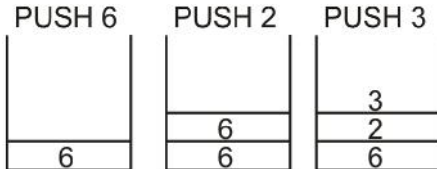
$$\therefore (4000)^2 \quad \text{,,} \quad \text{,,} \quad \frac{3 \times 10^3 s}{40,000} \times 4000 \times 4000$$

$$= 1200 \times 10^{-3} s = 1.2 \text{sec}$$

25. Post fix expression is ABC*/D-EF/+

Given: A = 6, B = 2, C = 3, D = 3, E = 4 and F = 2

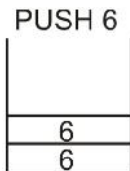
So, ABC*/D-EF/+ = 66/3-2+ = 13-2+ = -22+ = 0



*operator encounter

Pop top 2 element 3 and 2

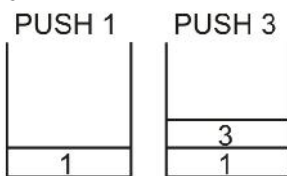
$$2 * 3 = 6$$



Again encounter '/' operator

pop top two element and find the value

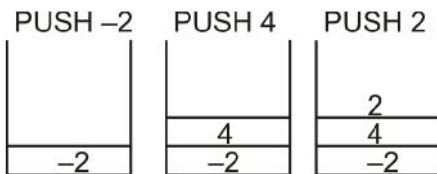
$$\frac{6}{6} = 1$$



'-' operator encounter

pop top two element and find the value

$$1 - 3 = -2$$



'/' operator encounter

pop top two element and find the value

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



'+' operator encounter

pop top two element and find the value

$$-2 + 2 = 0$$

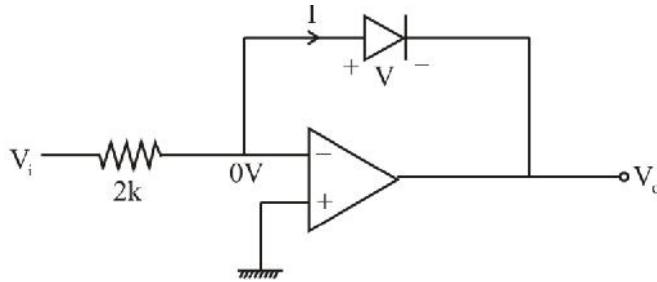
Value printed 0

26. Address range : CC00 to CFFF
So, first 4 bits are 1100
So, address lines are A_{15} , A_{14} , \bar{A}_{13} , \bar{A}_{12} . Next byte is changing from C to F. i.e., 1100 to 1111.
So next two address lines are A_{11} , A_{10} .
27. ALE → Address Latch Enable
PSW → Program Status Word
CMA → Complement Accumulator
RLC → Rotate Accumulator Left
28. LXIB 2070 H
⇒ B = 20H , C = 70H
MVI A, 8FH MVI C, 68H
⇒ A = 8FH ⇒ C = 68 H
SUB C
⇒ A = A - C = 27H
ANI 0FH
⇒ A AND 0F = 07 H
STAX B
⇒ Content of memory location 2070H is 07H.
29. There are total 9 jump instruction.
- | | | |
|----|----------------------------------|-----------------|
| 1. | JC, Jump if carry flag is set | → 3 bytes |
| 2. | JNC, Jump if carry flag is reset | → 3 bytes |
| 3. | JZ, Jump if zero flag is set | → 3 bytes |
| 4. | JNZ, Jump if zero flag is reset | → 3 bytes |
| 5. | JP, Jump if positive | → 3 bytes |
| 6. | JM, Jump if minus | → 3 bytes |
| 7. | JPE, Jump if parity even | → 3 bytes |
| 8. | JPO, Jump if parity odd | → 3 bytes |
| 9. | JMP, Unconditional Jump | → 3 bytes |
| | | <u>27 bytes</u> |

$$30. \quad \xi = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{10 \times 10^{-3} \times 0.01 \times 10^{-6}}} = 10^5 \text{ rad/sec}$$

$$31. \quad \text{Minimum size of ROM} = 2^n \times n = 4 \times 2$$

32.



$$\Rightarrow V_o = -V$$

$$I = I_s e^{V/V_T}$$

$$I = I_s e^{-V_o/V_T}$$

$$\ln\left(\frac{I}{I_s}\right) = \frac{-V_o}{V_T} \Rightarrow V_o = -V_T \ln\left(\frac{I}{I_s}\right)$$

Now from the figure,

$$V_i = 2I \Rightarrow V_o = -V_T \ln\left(\frac{V_i}{2I_s}\right)$$

$$\text{Case 1: } V_i = 2V \Rightarrow V_{o1} = -V_T \ln\left(\frac{1}{2I_s}\right) \quad \dots(1)$$

$$\text{Case 2: } V_i = 4V \Rightarrow V_{o2} = -V_T \ln\left(\frac{2}{I_s}\right) \quad \dots(2)$$

Now (2) – (1)

$$V_{o2} - V_{o1} = -V_T \ln\left(\frac{2}{I_s}\right) + V_T \ln\left(\frac{1}{I_s}\right) = V_T \ln\left[\frac{1}{I_s} \times \frac{I_s}{2}\right]$$

$$V_{o2} - V_{o1} = V_T \ln\left(\frac{1}{2}\right)$$

$$V_{o2} = V_{o1} - V_T \ln(2)$$

$$33. \quad g_{mo} = \frac{i_o}{V_i} = \frac{i_o}{I_1} \cdot \frac{I_1}{V_i} \Rightarrow \frac{i_o}{I} \cdot g_{m1} \cong g_{m1}$$

$$34. \quad G(s)H(s) = \frac{k(s+4)}{s(s+1)}$$

$$q(s) = 1 + G(s)H(s) = 0$$

$$s^2 + s + ks + 4k = 0$$

$$\Rightarrow k = \frac{-s^2 - s}{s + 4}$$

$$\text{Now, } \frac{dk}{ds} = 0$$

$$\Rightarrow (2s + 1)(s + 4) - (s^2 + s) = 0$$

$$\Rightarrow 2s^2 + 8s + s + 4 - s^2 - s = 0$$

$$\Rightarrow s^2 + 8s + 4 = 0$$

$$\Rightarrow s = -0.53, -7.46$$

36. $P = \bar{x} \bar{y} \bar{z} + \bar{x} y z + x \bar{y} z + x y \bar{z}$

$$P = \bar{z}(x \odot y) + z(x \oplus y)$$

$$P = z(x \oplus y) + \bar{z}(\overline{x \oplus y})$$

$$P = \overline{x \oplus y \oplus z}$$

37. Given: $q(s) = s^4 + s^3 + 2s^2 + 2s + 3 = 0$

RH Table:

s^4	1	2	3	
s^3	1	2	0	
s^2	a	3	0	{a → 0}
s^1	$\frac{2a-3}{a}$	0	0	
s^0	3	0	0	

When, $a = 0$, then $\frac{2a-3}{a} = -\infty$. So, there are 2 sign changes in the first column. So, there are 2 roots in the right half of the s plane.

38. There are 3 variables, out of which 2 are required for select lines and 1 will be used for input. Let A be the input variable.

Let A be the input variable.

	I_0	I_1	I_2	I_3
\bar{A}	0	①	2	③
A	4	⑤	⑥	7
	0	1	A	A

39.	Clk	$\overline{\text{CLR}}$	L	C	
	↑	1	1	X	→ Load inputs
	↑	1	0	1	→ Count next binary state
	X	0	X	X	→ Clear outputs
	X	1	0	0	→ No change

40. D flip flop is set initially

So,

$$\begin{array}{r} \oplus 11011 \\ 11011 \\ \oplus \quad \quad 1 \\ \hline 110111 \end{array}$$

Sum = 10111, carry = 1

41. Here, $P_1 = \frac{3}{(s+1)(s+4)}$

$$L_1 = \frac{-1}{s+1}, L_2 = \frac{-3}{(s+1)(s+4)}$$

From the Mason's gain formula,

$$\frac{Y(s)}{R(s)} = \frac{P_k \Delta_k}{\Delta}$$

$$\begin{aligned} &= \frac{\frac{3}{(s+1)(s+4)} \times 1}{1 + \frac{1}{s+1} + \frac{3}{(s+1)(s+4)}} \\ &= \frac{3}{s^2 + 5s + 4 + s + 4 + 3} \Rightarrow \frac{3}{s^2 + 6s + 11} \end{aligned}$$

42. $G(s)H(s) = \frac{(k + 0.366s)}{s(s+1)}$

$$G(J\check{S})H(J\check{S}) = \frac{k + 0.366J\check{S}}{J\check{S}(J\check{S} + 1)} = |G(J\check{S}_{gc})H(J\check{S}_{gc})| = 1$$

$$\Rightarrow \frac{\sqrt{k^2 + (0.366)^2 \check{S}_{gc}^2}}{\check{S}_{gc} \sqrt{\check{S}_{gc}^2 + 1}} = 1$$

$$\Rightarrow \frac{k^2 + (0.366)^2}{1(1+1)} = 1$$

$$\Rightarrow k = 1.366$$

43. Given:- $k = 96$, $f_s = 8\text{kHz}$, $n = 8$, $s = 1$

We know that, for TDM, data rate = $(nk+s)f_s = 6152 \text{ kbps} \Rightarrow 6.152 \text{ Mbps}$

44. Given: $d = 36000 \text{ km}$, $f_d = 10 \text{ GHz}$

$$\begin{aligned} \text{We know that, Downlink loss} &= \left(\frac{4fd}{3} \right)^2 \\ &= \frac{4f \times 36000 \times 10^3}{3 \times 10^8 / (10 \times 10^9)} = 2.27 \times 10^{20} \Rightarrow 203.56 \text{ dB} \end{aligned}$$

So, uplink loss = $203.56 + 1.583 = 205.15 \text{ dB}$

45. In uniform quantizer, the quantization noise is given by;

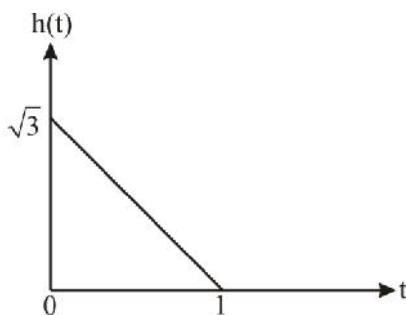
$$N_q = \frac{\Delta^2}{12}$$

Where, Δ is step size and it is given by $\Delta = \frac{V_{(\text{Peak to peak})}}{2^n}$

$$\Rightarrow N_q = \frac{V_{(\text{Peak to peak})}^2}{2^{2n} \times 12}$$

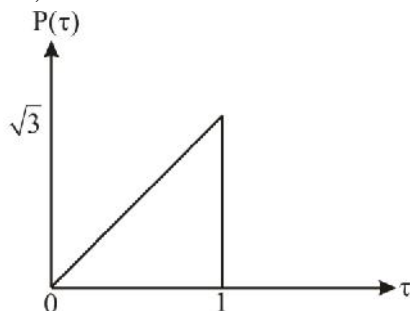
46. For Matched filter, impulse response $h(t) = P(T - t) = P(1 - t)$

\Rightarrow

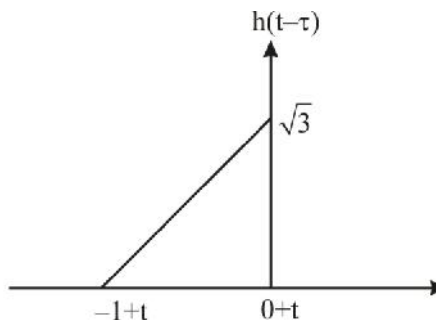


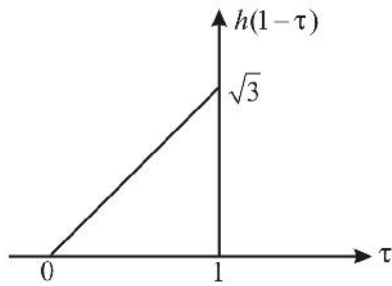
$$\text{Now output } y(t) = P(t) * h(t) = \int_{-\infty}^{\infty} p(\dagger) h(t - \dagger) d\dagger \quad \dots(1)$$

Now,



Put $t = 1$





$$\Rightarrow y(1) = \int_0^1 \sqrt{3}\tau \cdot \sqrt{3}\tau \, d\tau \Rightarrow 3 \left[\frac{\tau^3}{3} \right]_0^1 = 1$$

47. Given: Responsivity $R = 0.5 \text{ A/W}$

$$\Rightarrow \frac{I_p}{P} = 0.5 \Rightarrow \frac{25 \times 10^{-6}}{P} = 0.5 \Rightarrow P = 5 \times 10^{-5} \text{ Watt}$$

$$\text{Power loss} = \alpha L = 1 \times 3 = 3 \text{ dB} = 2$$

So, the required transmitted power is $= 2 \times 5 \times 10^{-5} = 10^{-4} \text{ watt} = -10 \text{ dBm}$

48. Given: Coupling $C = 20 \text{ dB}$ and directivity $D = 30 \text{ dB}$

$$\Rightarrow C = -10 \log_{10} \left(\frac{P_3}{P_1} \right) \text{ dB}$$

$$20 = C = -10 \log_{10} \left(\frac{P_3}{10} \right) \text{ dB}$$

$$\Rightarrow D = -10 \log_{10} \left(\frac{P_4}{P_3} \right) \text{ dB}$$

$$30 = D = 10 \log_{10} \left(\frac{P_3}{P_4} \right) \text{ dB}$$

$$\Rightarrow P_3 = 0.1 \text{ watt}$$

$$\Rightarrow 1000 = \frac{0.1}{P_4}$$

$$\Rightarrow P_4 = 0.1 \text{ mwatt}$$

50. Given: $D = 2$, $f = 300 \text{ MHz}$

We know that,

$$\text{Directivity } D = \frac{4f}{\lambda^2} A_e$$

$$\Rightarrow 2 = \frac{4f}{[3 \times 10^8 / (300 \times 10^6)]^2} A_e$$

$$\Rightarrow A_e = \frac{1}{2f} m^2$$

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