1) $109.328_{(10)} = 109_{10} + 0.328_{10}$

2	109	
2	54	1 → LSB
2	27	0
2	13	1
2	6	1
2	3	0
2	1	1
	→ MSB	

$109_{(10)} = 0110\ 1101_{(2)}$

$0.328 \times 2 = 0 + 0.656$

$0.656 \times 2 = 1 + 0.312$

$0.312 \times 2 = 0 + 0.624$

$0.624 \times 2 = 1 + 0.248$

$0.248 \times 2 = 0 + 0.496$

$0.496 \times 2 = 0 + 0.992$

$0.992 \times 2 = 1 + 0.984$

$0.328_{(10)} = 0.0101001$

$109.328_{(10)} = 0110\ 1101 . 0101\ 001_{(2)}$

2) $47_{(10)}$.

2	47	
2	23	1
2	11	1
2	5	1
2	2	1
2	1	0

$47_{(10)} = 00101111_{(2)}$

Sign-bit representation

$-47_{(10)} = 10101111_{(2)}$

<u>1's complement</u>

$47_{(10)} = 0010\ 1111_{(2)}$

1's complement $11010000_{(2)}$

$-47_{(10)} = 11010000$

2's complement

$47_{(10)} = 0010\ 1111_{(2)}$

1's complement $= 11\ 01\ 0000_{(2)}$

$+1_{(2)}$

$1101\ 0001_{(2)}$

$-47_{(10)} = 1101\ 0001_{(2)}$ 2's complement.

3)

A	B	C	Y	POS	SOP
0	0	0	0	$(A+B+C)$	
0	0	1	0	$(A+B+\bar{C})$	
0	1	0	0	$(A+\bar{B}+C)$	
0	1	1	1		$\bar{A}BC$
1	0	0	0	$(\bar{A}+B+C)$	
1	0	1	1		$A\bar{B}C$
1	1	0	1		$AB\bar{C}$
1	1	1	0	$(\bar{A}+\bar{B}+\bar{C})$	

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

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

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

$$(A+B+\bar{C})(A+\bar{B}+C) = \underline{AA + AB + A\bar{C} + A\bar{B}} + B\cancel{\bar{B}} + \bar{B}\bar{C} + \underline{AC} + BC + \cancel{C\bar{C}}$$

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

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

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

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

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

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

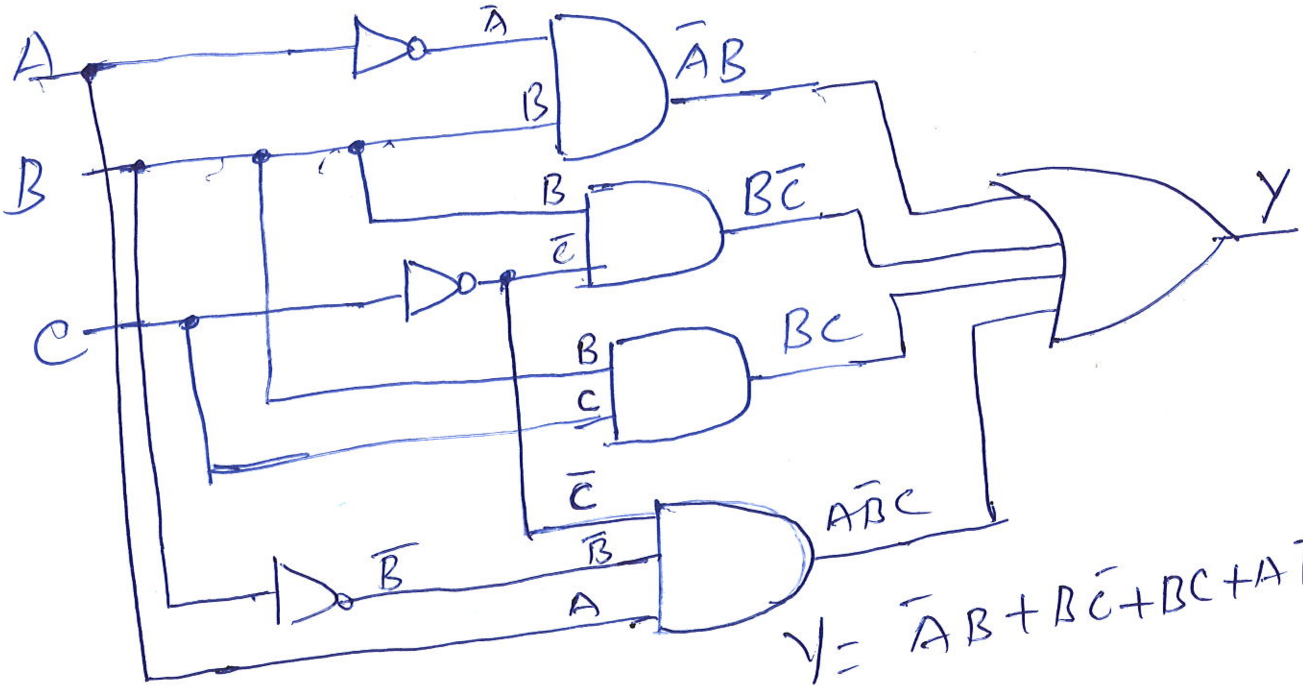
$$= (\bar{A}BC + \bar{A}\bar{B}\bar{C} + AB + BC + CA)\cdot(A\bar{B} + \bar{A}B + \bar{B}C + \bar{C}B + A\bar{C} + \bar{A}C)$$

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

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

Then $F(POS) = F(SOP)$

4)



$Y = \bar{A}B + B\bar{C} + BC + A\bar{B}\bar{C}$

$Y = \bar{A}B + B\bar{C} + BC + A\bar{B}\bar{C}$ $\qquad B\bar{C} + B\bar{C} = B\bar{C}$

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

$= \bar{A}B + B(\bar{C} + C) + (B + A\bar{B})\bar{C}$ $\qquad \bar{C} + C = 1$

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

$= B(\bar{A} + 1) + (B + A)\bar{C}$ $\qquad \bar{A} + 1 = 1$

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

$= B(1 + \bar{C}) + A\bar{C}$ $\qquad 1 + \bar{C} = 1$

$= B + A\bar{C}$

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

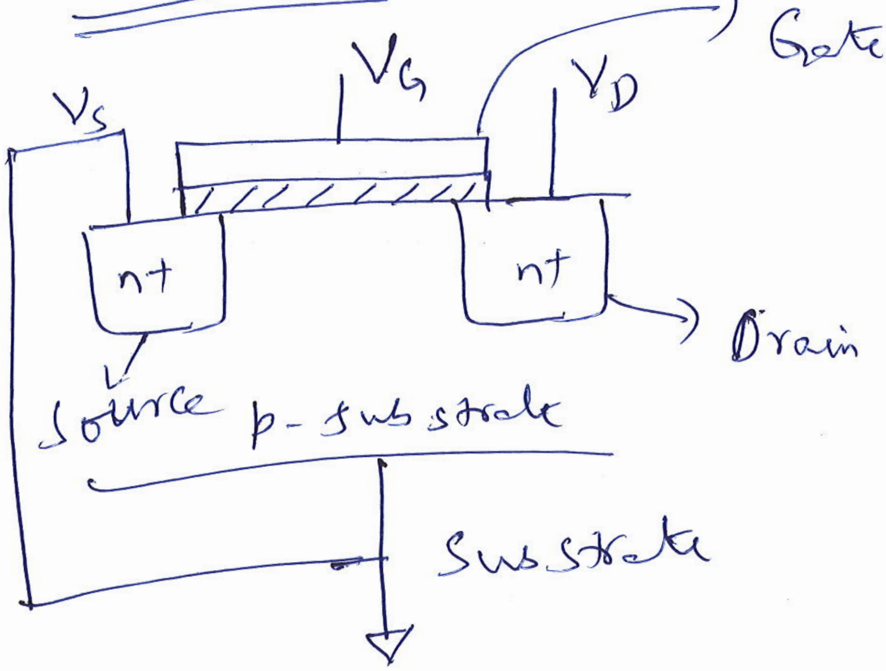
$= AB + A\bar{B} + B$

$= (A+1)B + A\bar{B} = B + A\bar{B}$

Thus,

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

5)



$V_S = 0$

$V_{GS} < 0$ MOSFET OFF

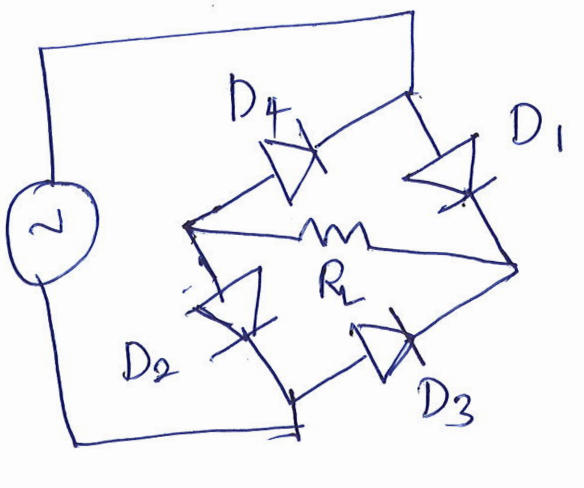
$V_{GS} \geq 0$ $V_G < V_T$ MOSFET OFF

$V_{GS} \geq V_T$ MOSFET ON

$V_{GS} \geq V_T$ $V_{DS} > 0$ MOSFET ON $I_D \neq 0$

$V_{GS} \geq V_T$ $V_{DS} = 0$ MOSFET ON, $I_D = 0$

6)



$R_L = 1k\Omega$

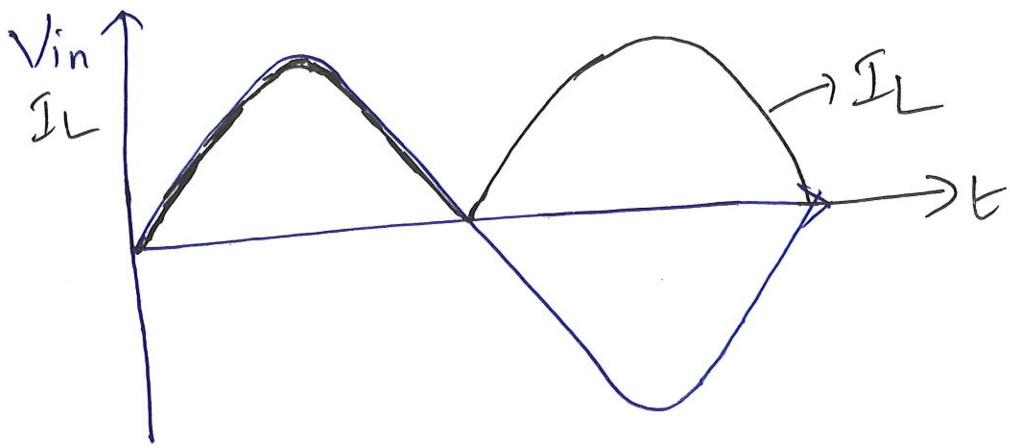
Each diode can withstand 50V.
Thus 50+50= 100V can withhold by the diodes.

Thus, amplitude of sine wave is 100V
$V_{in} = 100 \sin\omega t$
$V_D = 0.7V$

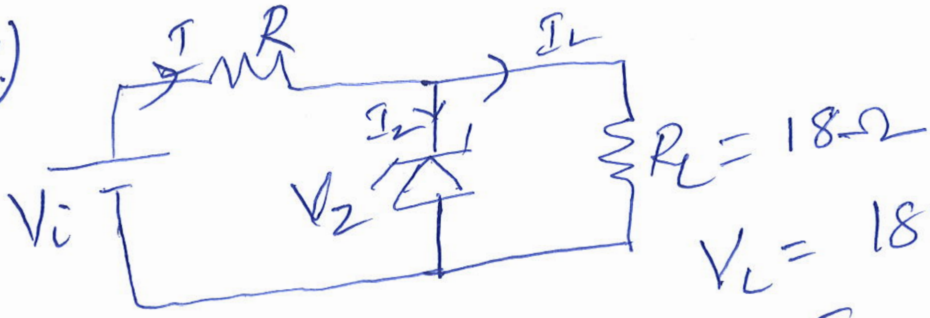
$$I_{L_{max}} = \frac{100 - 2V_D}{R_L}$$

$$= \frac{100 - 1.4}{1k\Omega} = 98.6\,mA$$

$I_L = 98.6 \sin\omega t$



7)



$V_L = 18V$

$V_Z = V_L = 18V$ $\quad I_L = \frac{18}{18} = 1A$

$I_{Zmax} = 1A$ $\quad I_{max} = 1A + 1A = 2A$

I_Z is minimum when input is minimum. At this condition the Zener should conduct. Thus,

$R = \frac{V_i - V_Z}{I}$ $\quad I = I_{Zmin} + I_L$
$= 0.2 + 1A = 1.2A$

$= \frac{22 - 18}{1.2A} = 3.33\Omega$

$P_{Z,max} = V_Z \cdot I_{Zmax} = \underline{18W}$

8) $X_L = j\omega L = j4000L$

$X_C = \frac{-j}{\omega C} = -26.04j$

$Z_{eq} = 50 + (X_L \| X_C \| 25)$

for phase to be zero, imaginary part is zero

$$X_L \| X_C \| 25 = \frac{X_L X_C 25}{X_C X_L + X_C 25 + X_L 25}$$

$L' = 1000L$

$$= \frac{2604 L'}{104.16L' + j100L' - 651j} + 50$$

$$= \frac{2604L'(104.16L' + (-j100L' + 651j))}{(104.16L')^2 + (100L' - 651)^2} + 50$$

Equating imaginary part to zero,

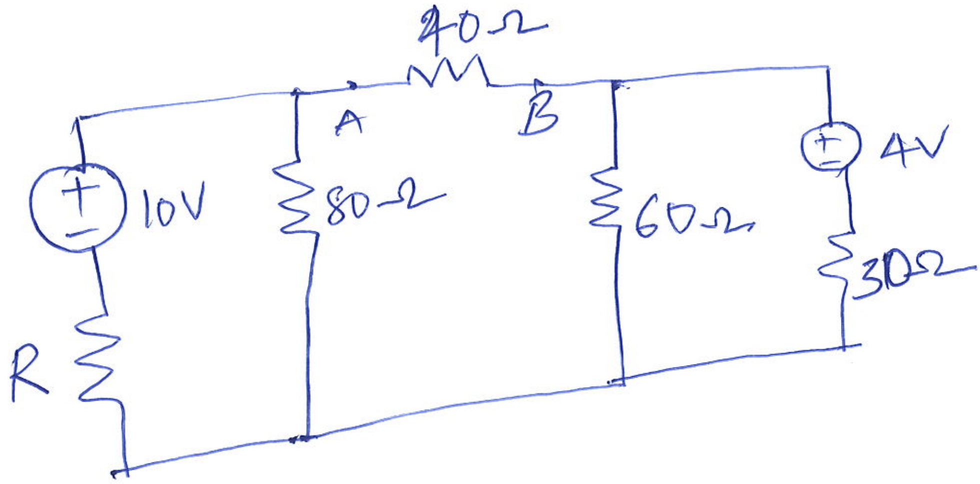
$100L' - 651 = 0$

$L' = \frac{651}{100} = 6.51$

$L' = 1000L = 6.51$

$\underline{L = 651 \text{ mH}}$

9)

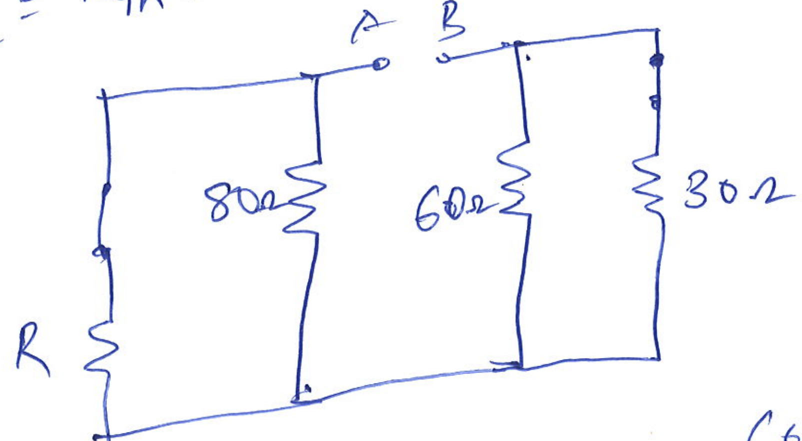


$R_L = 40\Omega$

For maximum power to be transferred to load,

$R_L = R_{Th}$.

R_{Th}:



$(R\|80) + (60\|30) = 40$

$60\|30 = \frac{60\times30}{60+30} = 20\Omega$

$R\|80 = 20\Omega$

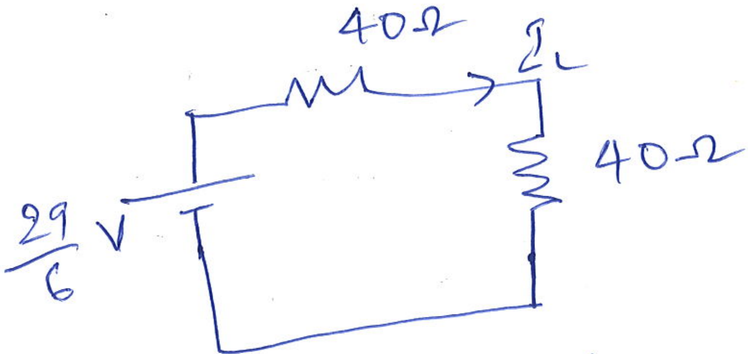
$\frac{R.80}{R+80} = 20 \Rightarrow R = \frac{80}{3}\Omega$

To find $V_{Th} = V_{AB}$.

$V_A = \frac{10\cdot 80}{\frac{80}{3}+80} = \frac{15}{2}\ V$

$$V_B = \frac{4 \times 60}{\cancel{60} + 30} = \frac{24}{9} V = \frac{8}{3} V$$

$$V_{Th} = V_A - V_B = \frac{15}{2} - \frac{8}{3} = \frac{29}{6} V$$



$$I_L = \frac{29/6}{40+40} = 0.0604 A$$

$$\text{Power} = I^2 R = 0.146 W$$