GATE 2016 – A Brief Analysis

(Based on student test experiences in the stream of IN on 31st January, 2016 – (Afternoon Session)

Section wise analysis of the paper

Section Classification	1 Mark	2 Marks	Total No of Questions
Engineering Mathematics	4	4	8
Networks	4	3	7
Digital Circuits	3	4	7
Signals and Systems	2	3	5
Control Systems	1	3	4
Measurements	2	3	5
Analog Circuits	2	4	6
Communication	2	2	4
Transducers	3	2	5
Optical Instrumentation	2	2	4
Verbal Ability	2	3	5
Numerical Ability	3	2	5
	30	35	65

Type of Questions asked from each section

Network	Questions came from Transient, Resonance, A.C Circuit, Fundamentals
Digital Circuits	Questions came from Logic Gate, MUX, Boolean Algebra, Converter, Counter.
Signal and Systems	Questions came from Periodic signal, Fourier series, Convolution
Control Systems	Questions came from Stability, Nyquist plot, Second order system, Time response.
Analog Circuits	Questions came Diode based, OPAMP based
Communication	Questions came from SSB, F.M. Noise.
Optical Instrumentation	Questions came from LED.
Transducers	Questions came from Piezoelectric, strain gauge, Pressure measurement.
Measurements	Questions came from Potentiometer, Bridge, Power Measurement.

Questions from the paper
General Aptitude

1. If y=mx+c curve passes through (0,0) and (2,6) then m= _____.

Key: 3

Exp: y=mx+c passing through $(0,0) \Rightarrow 0 = 0 + c \Rightarrow c = 0$

y=mx+c passing through $(2,6) \Rightarrow 6 = 2m \Rightarrow m = 3$

2. It takes 10s, 15s for two trains moving in same direction, to completely pass a pole. Length of first train is 120 m and other is 150m. The magnitude of the difference between speeds is m/s.

(A) 2 (B) 10 (C) 12 (D) 22

Key: (A)

Exp: $\text{Speed} = \dfrac{\text{length}}{\text{time}} \Rightarrow \text{length} = \text{speed} \times \text{time}$

$120 = 10 \times s_1 \Rightarrow s_1 = 12$

$150 = 15 \times s_2 \Rightarrow s_2 = 10$

$|s_1 - s_2| = 2$

3. Four undergraduates are staying is a room. They agreed that older enjoys the more space. Manu is two months older than Sravan, who is one month younger than Trideep. Pavan is one month older than Sravan. Who will enjoy more space in room.

(A) Manu (B) Sravan (C) Trideep (D) Pavan

Key: (A)

4. The area bounded by 3x+2y=14 and 2x-3y=5 in the first quadrant is

(A) 14.95 (B) 15.25 (C) 15.70 (D) 20.35

Key: (B)

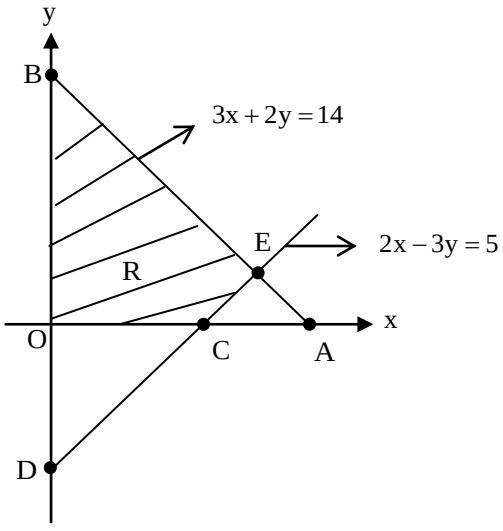
Exp $A = \left(\dfrac{14}{3}, 0\right)$

$B = (0, 7)$

$C = \left(\dfrac{5}{2}, 0\right)$

$D = \left(0, \dfrac{-5}{3}\right)$

$E = (4,1)$



Required area is area of

Δ OAB – area of Δ CEA

$= \dfrac{1}{2}\left(\dfrac{14}{3}\right)(7) = 15.25$ sq.units

Technical

1. $\lim_{n\to\infty}\left(\sqrt{n^2+n}-\sqrt{n^2+1}\right)=$ _____

Key: 0.5

Exp: $\lim_{n\to\infty}\left(\sqrt{n^2+n}-\sqrt{n^2+1}\right)\times\frac{\sqrt{n^2+n}+\sqrt{n^2+1}}{\sqrt{n^2+n}+\sqrt{n^2+1}}$

$$=\lim_{n\to\infty}\frac{n^2+n-n^2-1}{\sqrt{n^2+n}+\sqrt{n^2+1}}=\lim_{n\to\infty}\frac{\left(1-1/n\right)}{\sqrt{1+\frac{1}{n}}+\sqrt{1+\frac{1}{n^2}}}=\frac{1}{2}$$

2. If $L\{f(t)\}=\frac{s+2}{(s+1)(s+2)}$ Thus $\lim_{t\to\infty} f(t)=$ _____

Key: 0

Exp: $\lim_{t\to\infty} f(t)=\lim_{s\to0} s\,\frac{s+2}{(s+1)(s+2)}=0$

3. Which of the following is not perpendicular to $(i+J+k)$ and $(i+2J+3K)$

(A) $i-2J+K$ (B) $-i+2J+K$ (C) $0i+0J+0K$ (D) $4i+3J+5k$

Key: (D)

Exp: We know that if $\vec{a}\,.\,\vec{b}=0$ then $\vec{a}$ and $\vec{b}$ are perpendicular

Verify options (a) , (b), (c) are perpendicular

Option (d) is not perpendicular

4. If the eigen value of A = $\begin{pmatrix}2&1&1\\2&3&4\\-1&-1&-2\end{pmatrix}$ are -1, 1, 3 then trace of $(A^3-3A^2)=$ _____

Key: -6

Exp: eigen values of A^3-3A^2 corresponding to – 1, 1, 3 are -4, - 2, 0 respectively.

$\therefore$ Trace of $\left(A^2-3A^2\right)=-4-2+0=-6$

5. The value of $\frac{1}{2\pi J}\oint_c\frac{z^2+1}{z^2-1}dz$ value C is circle centre at 1 + 0J with unit radius is _____

Key: 1

Exp: Given $\frac{1}{2\pi J}\oint_c\frac{z^2+1}{z^2-1}dz=\frac{1}{2\pi J}\oint_c\frac{z^2+1}{(z-1)(z+1)}dz$

Poles are z = 1, - 1

Given C is $(x-1)^2+y^2=1$

Clearly 1 lies inside of C and -1 outside of C

$$\left[\text{Re sf}(z)\right]_{z=1} = \lim_{z\to 1}(z-1)\frac{z^2+1}{(z-1)(z+1)}=1$$

$\therefore$ By Cauchy's Residue theorem

$$\frac{1}{2\pi J}\oint_C \frac{z^2+1}{z^2-1}dz = \frac{1}{2\pi J}\times 2\pi J\times 1 = 1$$

6. If $f(z) = 1-(1-z)+(1-z)^2+---$

(A) $\frac{1}{z}$ (B) $\frac{-1}{z-2}$ (C) $\frac{z-1}{z+1}$ (D) $\frac{1}{2z-1}$

Key: (A)

Exp: $1+(1-z)+(1-z)^3+---$

$=1+w+w^2+w^3+---$

$=\frac{1}{1-w}$

$=\frac{1}{z}$

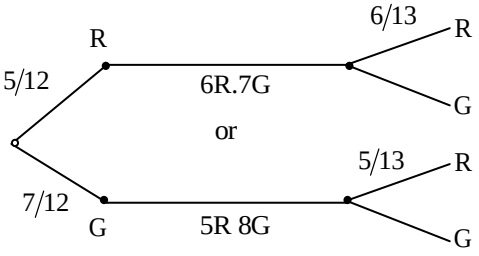
$w=1-z$

$\Rightarrow 1-w=z$

7. A box contains 5 red and 7 Green balls. A ball is selected and its color is noted. The ball is kept is the box along with one more ball of same color. what is the probability of getting Red ball in the next drawn

Key: 0.416

Exp: $\frac{5}{12}\times\frac{6}{13}+\frac{7}{12}\times\frac{5}{13}=\frac{65}{12\times 13}=\frac{65}{156}=0.416$



8. If $f:[-1,1]\to R$ is given as

$f(x)=2x^3-x^4-10$ then the minimum of f(x)

Key: -13

Exp: $f(x)=2x^3-x^4-10$

$f'(x)=6x^2-4x^3$

$f''(x)=12x-12x^2$

$f'(x)=0\Rightarrow 6x^2-4x^3=0$

$x^2(6-4x)=0$

$\Rightarrow x=0,\ x=\frac{3}{2}$ are stationary points

$f''(0)=0$ neither maxima nor minima at x= 0

$x=\frac{3}{2}\notin -[1,\ 1]$

$\therefore$ minimum of $f(x)=$ minimum $\{f(-1), f(1)\}$

$=$ minimum $\{-13,-9\}$

$=-13$

9. The Boolean algebra $xy+(x'+y')z$ equals to

(A) $xyz'+x'y'z$ (B) $(x+z)(y+z)$ (C) $x'y'z'+xyz$ (D) $(x'+z)+(y'+z)$

Key: B

Exp: $F=XY+\bar{X}Z+\bar{Y}Z$

The min term of F are

	X	Y	–	$\bar{X}$	–	Z	–	$\bar{Y}$	Z
=	1	1	0	0	0	1	0	0	1
	1	1	1	0	1	1	1	0	1

$F=\sum m(1,3,5,6,7)$

If we go for option B

$F=(x+z)(y+z)=z+xy$

$\rightarrow$ Its minterms are

–	–	Z	X	Y	–
0	0	1	1	1	0
0	1	1	1	1	1
1	0	1			
1	1				

$F=\sum m(1,3,5,6,7)$

Since minterms are same these two functions are equal

10. The number of times the nyquist plot $G(s)=\frac{s-1}{s+1}$ will encircle the region in clockwise direction is_____.

Key: 1

Exp: $G(s)=\frac{s-1}{s+1}$

$$|G(s)| = \frac{\sqrt{1+\omega^2}}{\sqrt{1+\omega^2}} = 1$$

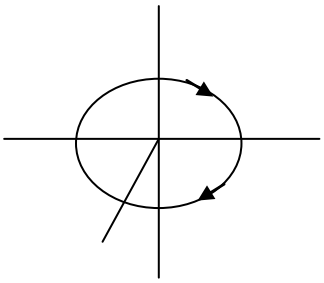
$$\underline{|G(s)} = 180 - 2\tan^{-1}(\omega)$$

$$G(s) = 1\underline{|180^o - 2\tan^{-1}(\omega)}$$

$$\rightarrow G(0) = 1\underline{|180^o}$$

$$G(\infty) = 1\underline{|0^o}$$

$$G(1) = 1\underline{|90^o}$$



Using G(0), G(1), G G(∞) information, the plot will look like

→ Hence it encircle the origin only 1 time in clockwise direction.

11. If all the roots of $s^3 + 3s^2 + 2s + a_0$ are in left half then a_0 =_____.

Key: 6

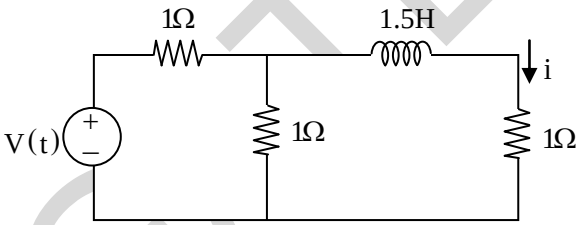
Exp:

S^3	1	2
S^2	3	a_0
S1	$\frac{6-a_0}{3}$	
S^0	a_0	

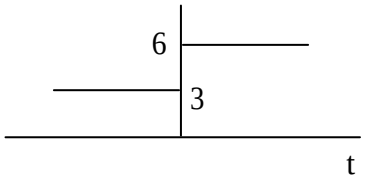
For Stability $\frac{6-a_0}{3} > 0 \Rightarrow a_0 < 6$

So in strict sense $a_0 = 6$.

12.



The voltage waveform V(t) is given by

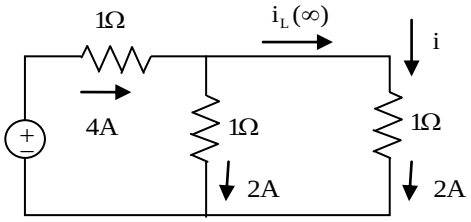


Then the value of current i at t = 1 sec is _____ Amp.

Key: 1.632

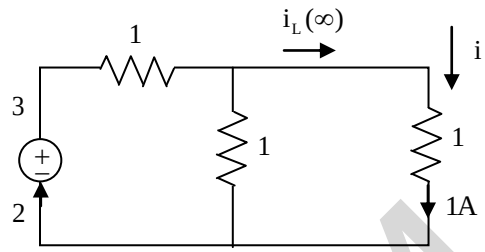
Exp: $i_L(t) = i_L(\infty) + \left[i_L(0^-) - i_L(\infty) \right] e^{-\frac{t}{\tau}}$

at $t = \infty$, supply is 6V



$i_L(\infty) = 2A$

$\rightarrow$ at $t = 0^-$



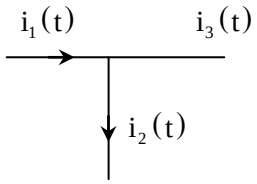
$i_L(0^-) = 1A$

$$\rightarrow \tau = \frac{L}{R_{in}} = \frac{1.5}{1.5} = 1$$

$$\rightarrow i_L(t) = 2 - e^{-t}$$

$$i_L(t) = 2 - e^{-1} = 1.632$$

13.



If $i_1(t) = 3\cos\omega t$, $i_2(t) = 4\sin\omega t$, $i_3(t) = I_3\cos(\omega t + \theta)$, then I_3 = _____.

Key: 5

Exp: By KCL $i_1(t) = i_2(t) + i_3(t)$

$\Rightarrow i_3(t) = i_1(t) - i_2(t)$

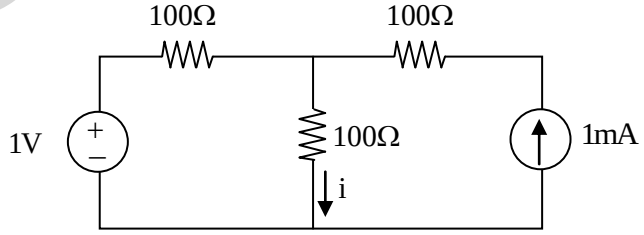
By phasor $I_3 = \bar{I}_1 - \bar{I}_2$

$$= \left[3 < 0 \right] - \left[4 < -90^\circ \right] = 5 \angle 53.13$$

$\Rightarrow i_3(t) = 5\cos(\omega t + 53.13)$

So by comparison $I_3 = 5$.

14. Define the value of current i in mA _____.



Key: 5.5

Exp: Writing nodal equation.

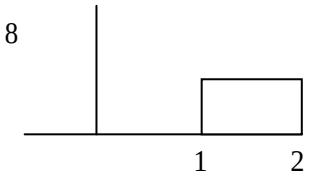
$$\Rightarrow V\left(\frac{1}{100}+\frac{1}{100}\right)=\frac{1}{100}+(1\times10^{-3})$$

$$\Rightarrow 2V=1+\left(1\times10^{-1}\right)$$

$$\Rightarrow V=\frac{1+(1\times10^{-1})}{2}=\frac{1.1}{2}$$

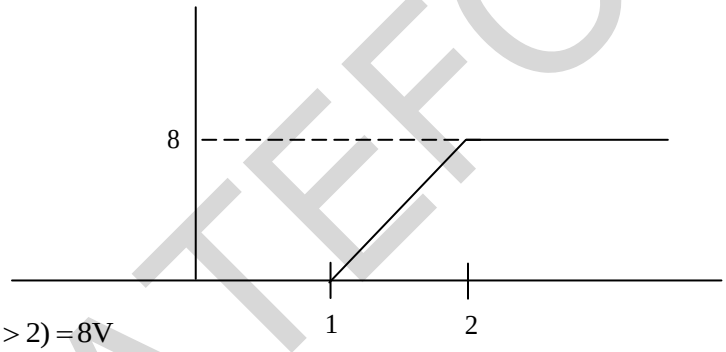
$$\Rightarrow \text{but } i=\frac{V}{100}=\frac{1.1}{200}=5.5\text{mA}$$

15. The following voltage waveform is applied to a 1F capacitor then the voltage across the capacitor at t = 2 sec is _____ A.



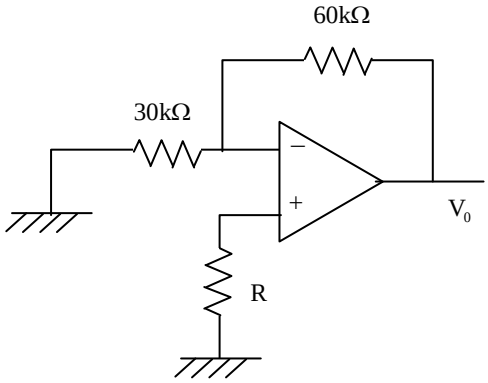
Key: 8

Exp: $V_c=\frac{1}{C}\int idt=\frac{1}{1}\int 8\left[u(t-1)-u(t-2)\right]dt=8\left[r(t-1)-r(t-2)\right]$



$V_c(t>2)=8V$

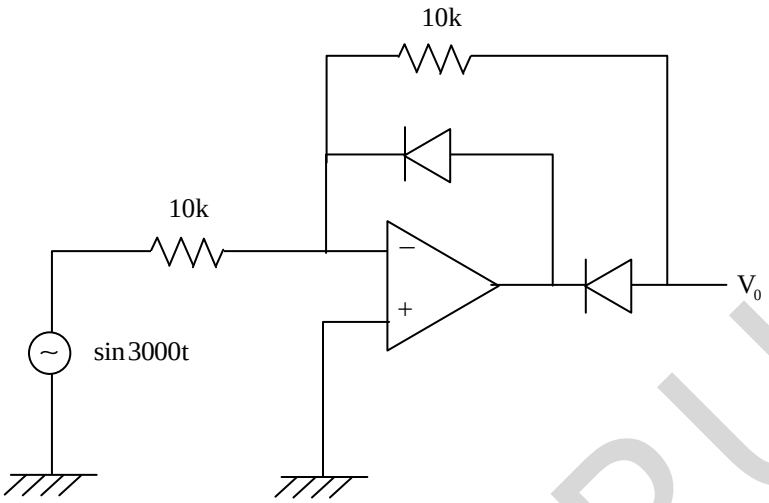
16. The given opamp circuit draw a bias current of 10 nA, then what should be the value of R (kΩ) to make V_o=0V.



Key: 20

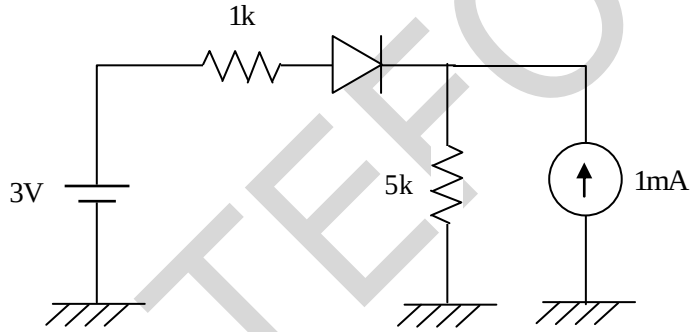
Exp: $R=(60/30)=20k\Omega$

17.



If the cut-in voltage of diodes are 0.6V then the –ve peak output voltage is _____V.

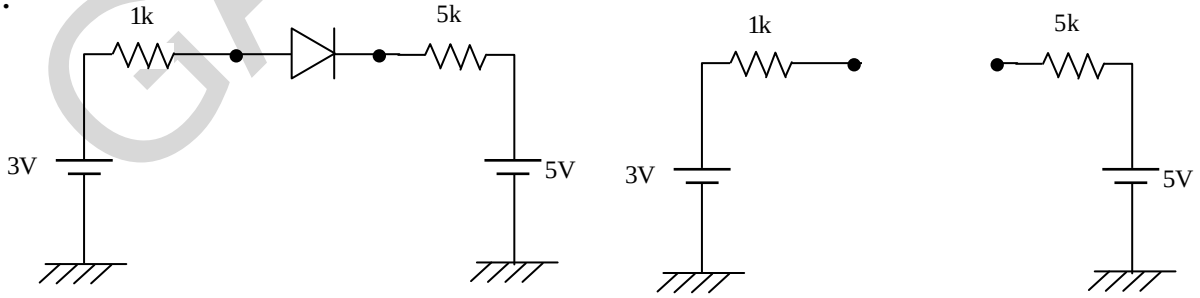
18.



The voltage across $1k\Omega$ resistor is _____V.

Key: 0

Exp:



Since $V_P < V_N$ diode is open circuit and no current flow through 1k, So $V_{1k\Omega}=0V$.

19. A system transfer function $G(s)=\frac{8}{(s+10)^2}$, if input to the system is i(t)= $2\sin(3t+\pi)$ then g(t) amplitude is _____.

Key: 0.1467

Exp: $G(s)=\frac{8}{(s+10)^2}+\frac{8}{s^2+20s+100}=\frac{8}{(100-\omega^2)+j(20\omega)}$

$$G(s)=\frac{8}{\sqrt{(100-\omega^2)^2+3600}}\Big|\underline{-\tan^{-1}\frac{60}{91}}=\frac{8}{109}\Big|\underline{-33.4^o}$$

$$y(t)=\left(2\times\frac{8}{109}\right)\sin(3t+\pi-33.4^o)=0.1467\sin(3t+146.6^o)$$

So amplitude is 0.1467.

20. To a piezo electric transducer a constant pressure 10KPa is applied, its sensitivity is 1mV/KPa and its Bandwidth is from 30Hz to 30kHz. Then its output is _____V.

Key: 0

Exp: Piezoelectric transducer produces output for changing input, but here input is constant, So output is 0.

21. $x(n)=[1,\underset{\uparrow}{1},-1]$

If x(n) is convolved with itself to generate y(n) then y(-2) = _____.

Key: 2

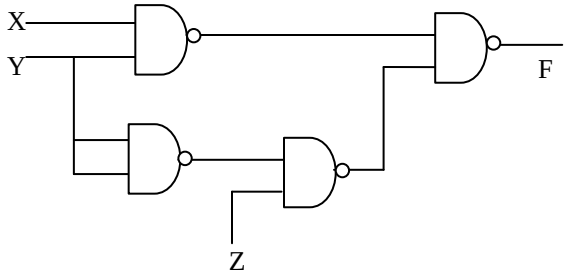
Exp:

$$\begin{array}{ccccc} 1 & 1 & -1 & & \\ 1 & 1 & -1 & & \\ \hline 1 & 1 & -1 & & \\ & 1 & 1 & -1 & \\ & & 1 & 1 & -1 \\ \hline 1 & 2 & 1 & 0 & -1 \end{array}$$

$y(n)=[1,2,\underset{\uparrow}{1},0,-1]$

$y(-1)=2$

22. The output F is



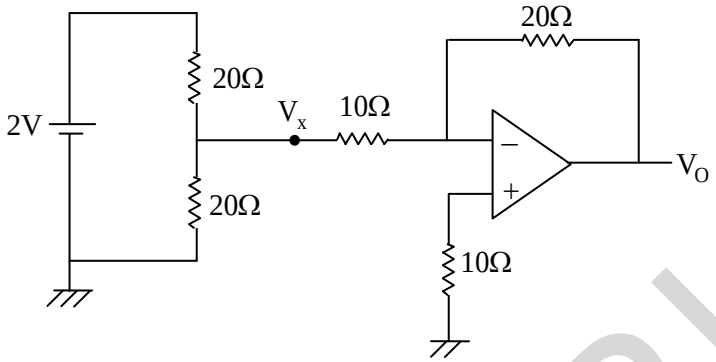
(A) $XY+Y\overline{Z}$ (B) $XY+\overline{Y}Z$ (C) $XY+YZ$ (D) $X+Z$

Key: B

Exp: From the circuit

$$F = \overline{\overline{XY}.\overline{YZ}} = XY + \overline{YZ}$$

23. Assuming an ideal opamp V_O = _____V.



Key: -1

Exp:

$$\frac{V_x - 2}{20} + \frac{V_x}{20} + \frac{V_x}{10} = 0$$

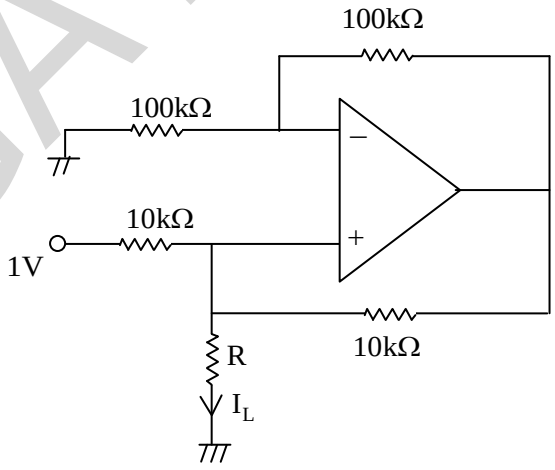
$$\Rightarrow V_x\left(\frac{1}{20} + \frac{1}{20} + \frac{1}{10}\right) = \frac{2}{20}$$

$$\Rightarrow V_x(1+1+2) = 2$$

$$\Rightarrow V_x = \frac{1}{2}$$

$$V_0 = \frac{-R_f}{R}V_x = -\left(\frac{20}{10}\right)\frac{1}{2} = -1V$$

24. Assuming ideal opamp I_L in μA is _____.



Key: 100

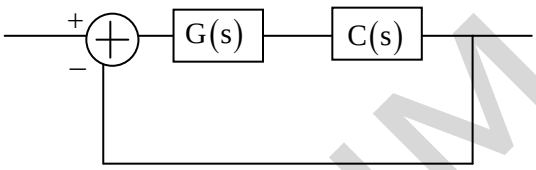
Exp: It is standard V to I converter, where [100k × 10k] = [10k × 100] i.e. the balanced bridge is formed so the current.

$$I_L = \frac{1}{10\times10^3} = 100\,\mu A$$

25. If $G(s) = \frac{1}{(s+1)^2}$ which of the following C(S) will make the overall system unstable

(A) $3+\frac{7}{s}$ (B) $\frac{1}{s}$

(C) $3+\frac{9}{s}$ (D) $1+\frac{3}{s}$



Key: (C)

Exp: The characteristic equation of system is 1+G(S)(S) = 0

$$\Rightarrow 1+\frac{C(S)}{S^2+2S+1}=0$$

$$\Rightarrow S^2+2S+1+C(S)=0$$

if we take $C(S)=3+\frac{9}{5}$ then

$$S^2+2S+1+3+\frac{9}{S}=0$$

$$\Rightarrow S^3+2S^2+4S+9=0$$

S^3	1	4
S^2	2	9
S^1	$-1/2$	
S^0	9	

So system is unstable, remaining options gives stable.

26. In a Q-meter at a certain frequency resonance is obtained by tuning the capacitor to 110pF. When the frequency is doubled once again the resonance is obtained by tuning the capacitor to 20pF then the value of distributed capacitance is _____ pF.

Key: 10

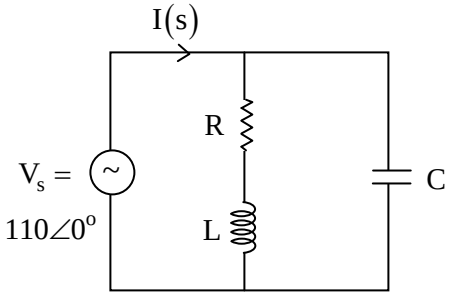
Exp: $C_d = \frac{C_1 - n^2C_2}{n^2-1} \Rightarrow \frac{110-(4\times20)}{4-1} = 10\,pf$

here $C_1 = 110\,pf$

$C_2 = 20\,pf$

$\frac{f_2}{f_1} = n = 2$

27. At certain frequency V_{01} and I(s) are in phase, it is known that $R = 10\Omega, \omega L = 100\Omega$ then value of I(s) is _____.



Key: 0.1089

Exp: In phase means circuit is under resonance and the admittance seen by source must be real i.e. imaginary part of $Y_{eq} = 0$

$$\Rightarrow Y_{eq} = \frac{1}{R + j\omega L} + \frac{1}{(1/j\omega c)}$$

$$= \frac{R - j\omega l}{R^2 + (\omega L)^2} + j\omega L$$

$$\rightarrow \text{Real}(y) = \frac{R}{R^2 + (\omega L)^2} = \frac{10}{100 + (100)^2} = \frac{1}{1010}$$

$$I = VY$$
$$= \frac{110}{1010}$$
$$= 0.1089$$

28. The Fundamental period of $x(n) = \sin\left(\frac{301}{4}\pi n\right)$ is _____.

Key: 8

Exp: In discrete case $\omega_0 N = 2\pi m$

$$N = \frac{2\pi}{\omega_0} m$$

Where m is the smallest positive integer that makes integer.

$$\rightarrow N = 2\pi \times \frac{4}{301\pi} \times m = \left[\frac{8}{301} m\right]$$

If $m = 301$

$N = 8$

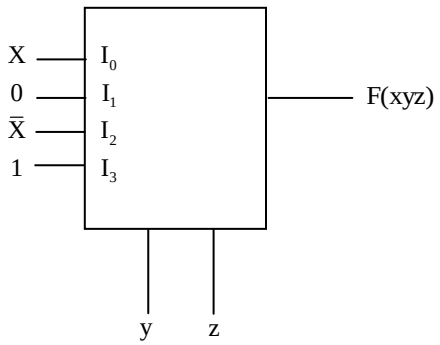
29. The minimum of F(xyz)

(A) $\sum m(2,3,4,7)$

(B) $\sum m(0,2,5,6)$

(C) $\sum m(1,2,4,7)$

(D) $\sum m(2,3,5,7)$



Key: (A)

Exp: $F = x\bar{y}\bar{z} + o\bar{y}z + \bar{x}\bar{y}\bar{z} + 1.yz$

$= x\bar{y}\bar{z} + \bar{x}\bar{y}\bar{z} + yz$

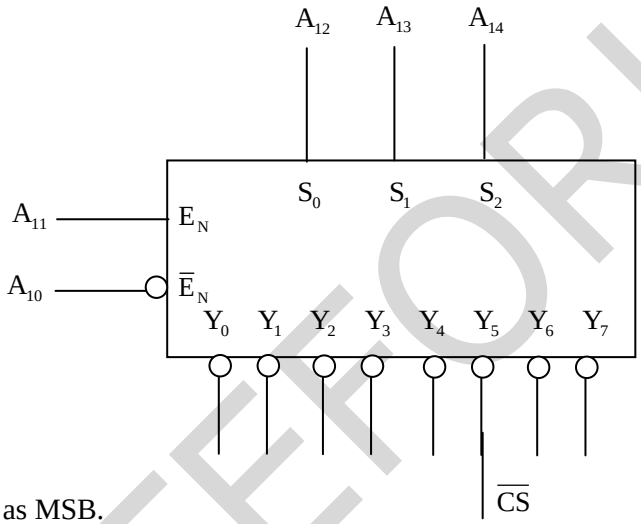
$= 100 \quad 100 \quad -111$

011

111

$F(x, y, z) = \Sigma m = (2, 3, 4, 7)$

30. To a 8 bit microprocessor, 1 kB memory is to be interfaced, the interfacing circuit is shown, then which of the following can be address range of the chip.



Assume S_2 as MSB.

(A) 5800 to 5BFF (B) D800 to DBFF

(C) 5800 to 5BFF and D800 to DBFF (D) 5800 to 5FFF

Key: (C)

Exp: → 1kB memory means 10 adress lines A_9 to A_0

→ Since A_{15} line is missing it should be taken as don't care.

→ 5th output of decoder should be activated means $A_{14} = 1; A_{13} = 0; A_{12} = 1$

→ A_{11} = 1 since active high enable

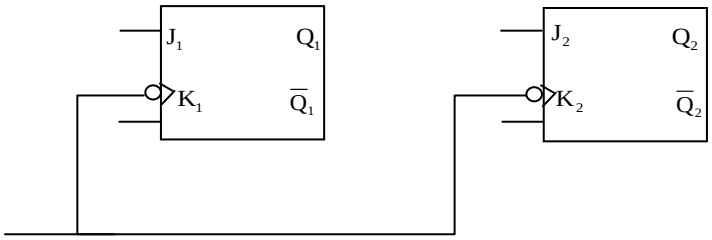
→ A_{10} = 0 since active low enable

	A_{15}	A_{14}	A_{13}	A_{12}	A_{11}	A_{10}	A_9	A_8	A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0
→		1	0	1	1	0	0	0	0	0	0	0	0	0	0	0
		1	0	1	1	0	1	1	1	1	1	1	1	1	1	1

→ If A_{15} = 0 then the range is 5800 to 5BFF

→ If A_{15} = 1 then the range is D800 to DBFF.

31. What must be the connection to the input J_1, K_1, J_2, K_2 such that the counter goes through the sequence $00 \rightarrow 10 \rightarrow 01 \rightarrow 11 \rightarrow 00...$



(A) $J_1 = K_1 = 1$, $J_2 = K_2 = Q_1$ (B) $J_1 = K_1 = 0$, $J_2 = K_2 = \bar{Q}_1$ (C) $J_1 = K_1 = Q_1$, $J_2 = K_2 = 0$ (D) $J_1 = K_1 = Q_1$, $J_2 = K_2 = Q_1$

Key: (A)

Exp:

Present State		Next State		Flip flop Input			
Q_1	Q_2	Q_1^+	Q_2^+	J_1	K_1	J_2	K_2
0	0	1	0	1	X	0	X
1	0	0	1	X	1	1	X
0	1	1	1	1	X	X	0
1	1	0	0	X	1	X	1

From the column of $J_1 K_1 J_2 K_2$

We can say $J_1 = 1$

$K_1 = 1$

And $T_2 = Q_1$

$K_2 = Q_1$