ACE *Pre*-GATE 2017 **Branch: INST**

Q.1 – Q.5 Carry One Mark Each

01. Reaching a place of appointment on Friday. I found that I was two days earlier than the scheduled day. If I had reached on the following Wednesday then how many days late would I have been?
(a) one (b) two (c) three (d) four

01. Ans: (c)

Sol: Friday $\rightarrow$ 2 days earlier
Therefore, scheduled day = Friday + 2 = Sunday
Sunday + 3 = Wednesday
Therefore, I would have been late by 3 days

02. Choose the most appropriate phrase from the options given below to complete the following sentence.
The bus stopped to _____ more passengers.
(a) Take in (b) Take on (c) Take up (d) Take for

02. Ans: (b)

03. Choose the appropriate sentence from the following options.
(a) She has been discharged since
(b) She has since been discharged
(c) She has been since discharged
(d) She since has been discharged

03. Ans: (b)

04. Fill in the blank with an appropriate phrase.

The jet _____ into the air.

(a) Soared (b) Soured

(c) Sourced (d) Sored

04. Ans: (a)

05. Choose the most appropriate word from the options given below to complete the following sentence.

If I had known that you were coming, I _____ you at the airport.

(a) Would meet (b) Would have met

(c) Will have met (d) Had met

05. Ans: (b)

Q.6 – Q.10 Carry two marks each

06. Which of the following can be logically inferred from the given statement.
"No other studied medicine except Helen"
(a) Helen only studied medicine
(b) Only Helen studied medicine
(c) Helen studied only medicine
(d) Helen studied medicine only

06. Ans: (b)

07. The average electricity bill of a household for January to June is ₹ 980, for July to September is ₹ 670, for October to December is ₹ 720. If the family goes on vacation for June and July and no electricity is used, what would be the average electricity bill for that year ?
(a) ₹ 500 (b) ₹ 600
(c) ₹ 700 (d) ₹ 800

07. Ans: (c)

Sol: Average electricity bill from January to June = ₹ 980
$\therefore$ Total electricity bill from January to May = 980×5 = ₹ 4900
(As no electricity is used in June)
Similarly, total electricity bill from August to September (as no electricity is used in July)
$= 670 \times 2$ = ₹ 1340
And total electricity bill from October to December = 720×3 = ₹ 2160
Therefore, total electricity bill from January to December = 4900 + 1340 + 2160 = ₹8400
Thus, average electricity bill for the whole year $= \frac{8400}{12} = ₹700$

08. The following question has four statements of three segments each. Choose the alternative where the third segment in the statement can be deduced using both the preceding two but not just from one of them.
A. Sonia is an actress. Some actresses are pretty. Sonia is pretty.
B. All actors are pretty. Manoj is not an actor. Manoj is not pretty

C. Some men are cops. Some men are brave. Some brave people are cops.

D. All cops are brave. Some men are cops. Some men are brave.

(a) only C (b) only A

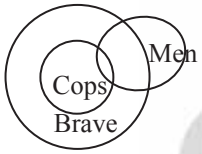
(c) only D (d) B and C

08. Ans: (c)

Sol: Statements:

All cops are brave

Some men are cops



Conclusion:

Some men are brave (True)

Hence, only D follows.

09. A contractor, who got the contract for building the flyover, failed to construct the flyover in the specified time and was supposed to pay ₹ 50,000 for the first day of extra time. This amount increased by ₹ 4,000 each day. If he completes the flyover after one month of stipulated time, he suffers a loss of 10% in the business. What is the amount he received for making the flyover in crores of rupee? (One month = 30 days)

(a) 3.1 (b) 3.24

(c) 3.46 (d) 3.68

09. Ans: (b)

Sol: The sum of money that the contractor was supposed to pay for the period of an month over the stipulated time is

$$= S_n = \frac{n}{2}[2a + (n-1)d]$$

a = 50,000, n = 30, d = 4000

$S_{30} = \frac{30}{2}[2\times 50{,}000 + (30-1)\times 4000] = 15[100{,}000 + 29\times 4000]$

₹ 3240000 = ₹ 32.4 lakhs

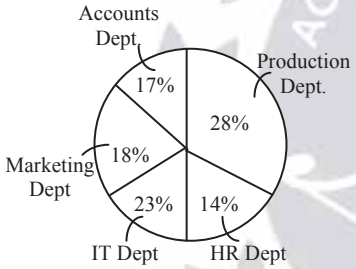
Loss in the business = 10%

$\therefore$ Amount he received for making the flyover = $\frac{3240000}{0.1} = 32400{,}000 =$ ₹ 3.24 crores

10. Study the following pie chart and table carefully to answer the following question that follows:
Percentage break up of employees working in various departments of an organisation and the ratio of men to women in them.

Total number of employees = 1800

Percentage break up of employees:



Ratio of men to women

Department	Men	Women
Production	11	1
HR	1	3
IT	5	4
Marketing	7	5
Accounts	2	7

What is the number of men working in the marketing department?

(a) 132 (b) 174

(c) 126 (d) 189

10. Ans: (d)

Sol: Number of men working in the marketing department $= 1800\times\frac{18}{100}\times\frac{7}{12} = 189$

Q.11 – Q.35 Carry one mark each.

11. The signal x(t) = cos(50πt) + cos(80πt) is sampled at 200Hz. The minimum number of samples required to prevent leakage is _____

Ans: 40

Sol: $\frac{\omega_1}{2\pi} = \frac{50\pi/200}{2\pi} = \frac{1}{8} = \frac{5}{40}$

$\frac{\omega_2}{2\pi} = \frac{80\pi/200}{2\pi} = \frac{1}{5} = \frac{8}{40}$

$\therefore$ The minimum number of samples required to prevent leakage is 40.

12. An n-channel JFET has a gate cut-off voltage of –10V. If –1V is applied at the gate terminal the minimum drain to source voltage required to obtain maximum drain resistance is _____ (V) (Neglect channel length modulation)

Ans: 9

Sol: Drain resistance will be maximum at saturation

Minimum voltage (V_{DS}) for saturation = $V_{GS} - V_P$

Given V_P = Gate cut-off voltage = –10 V

$V_{DS} = V_{GS} - V_P = -1 - (-10) = +9$ V

13. Temperature is measured by a sensor with an output of 0.01 V/^oC. The required ADC word size to measure 0 ^oC to 100 ^oC with 0.01 ^oC resolution is

Ans: 14

Sol: Number of steps of 0.01 ^oC in 100 ^oC = $\frac{100^oC}{0.01^oC}$ = 10000 steps

$2^n = 10000$

n = word size

$n \cong 14$ bits

14. Multimode step index fiber of step index 4.5% with core radius 100/π μm & wavelength of 1 μm. If core refractive index is 1.6 then V-number is

Ans: 96

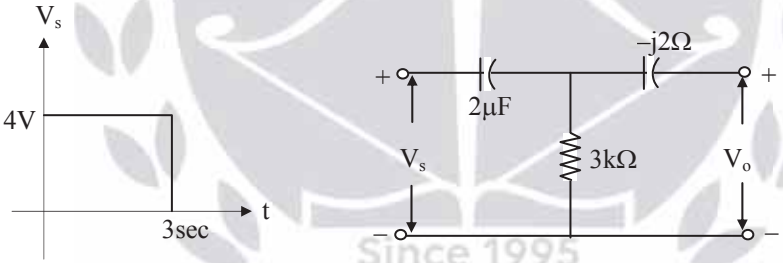
Sol: $V = \frac{2\pi r}{\lambda} n_1 \sqrt{2\Delta} = \frac{2\pi \times \frac{100}{\pi} \times 10^{-6} \times 1.6\sqrt{2 \times 0.045}}{1 \times 10^{-6}} = 96$

15. In 3-ϕ & 4 wire balanced system, the maximum number of wattmeters required to calculate the power is

Ans: 3

Sol: For 3-ϕ & 4 wire system, as neutral is present, we can use maximum 3 wattmeters

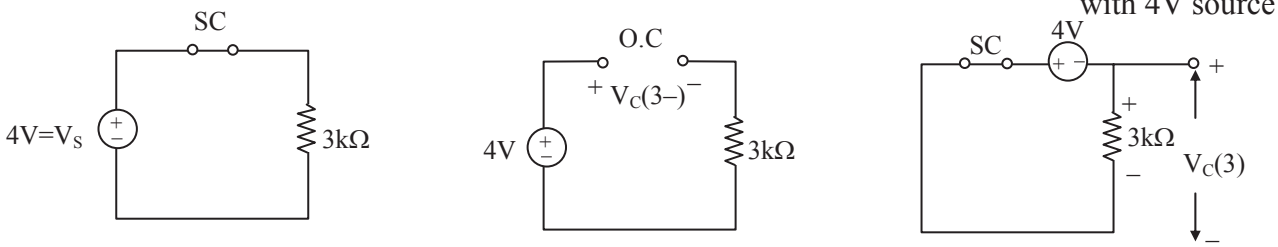
16. A square pulse of 4V amplitude is applied to RC circuit shown in figure. The capacitor is initially uncharged. The output voltage V_o at time t = 3sec is _____ (in Volts).



Ans: –4V

Sol:

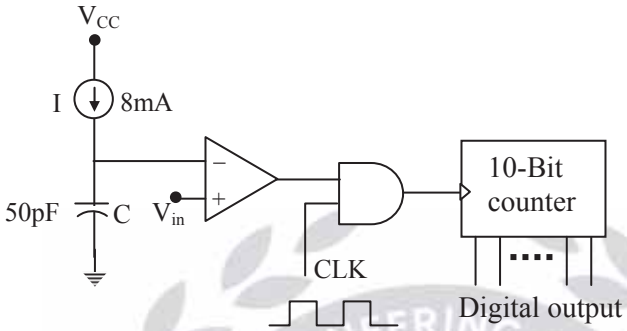
At t = 0: C → Short Circuit At t = (3–): C → Open Circuit At t = 3: C → Short Circuit with 4V source



$V_C(3-) = V_C(3+) = 4V$ $V_C(3) = -4V$

Note: In the circuit –j2Ω capacitor Voltage is zero for all time since there is no current is flowing through that capacitor. Hence it acts as a Short Circuit.

17. A single slope ADC shown below is used to convert an analog input of 16V to digital. Determine the digital output (in decimal) if the clock frequency is 500 MHz. Initial voltage across capacitor is 0V



Ans: 50

Sol:

- Initially $V_c = 0V$; $V_{in} = 16V$

  $\Rightarrow$ comparator output = 1 & clock pulses reach the Counter

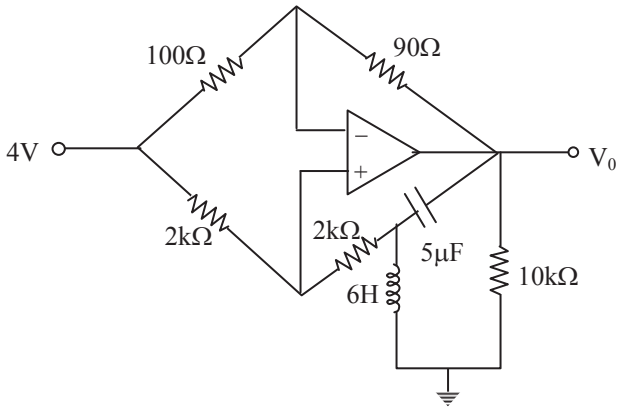
- Time required for the capacitor to charge to 16V is It = CV

$$\Rightarrow t = \frac{CV}{I} = \frac{50\times10^{-12}\times16}{8\times10^{-3}} = 100\text{ns}$$

Clock period $T = \frac{1}{500\times10^{6}} = 2\text{ ns}$

- Digital output $= \frac{100\,\text{ns}}{T} = \frac{100\text{ns}}{2\text{ns}} = (50)_{10}$

18. If the Op-amp is ideal. Find the current (in Amp) across 90Ω resistor.



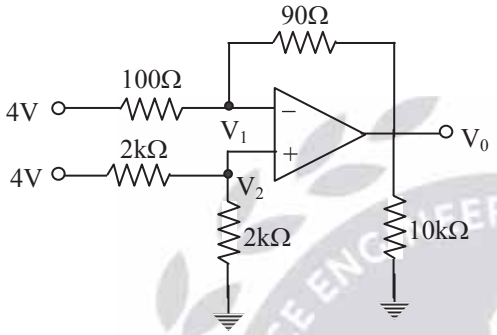
Ans: 0.02 **Range: 0.01 to 0.03**

Sol: Since, DC 4V is given as input, no switch (transient) is provided

$\Rightarrow$ we can proceed under steady state.

C $\rightarrow$ behaves as open & L $\rightarrow$ Acts as short

the circuit is $\rightarrow$



Hence the circuit behaves as a subtractor.

$\therefore$ From superposition,

$$V_0 = \frac{-90}{100}[4] + \left[1 + \frac{90}{100}\right]\left[\frac{4[2k]}{2k+2k}\right] \text{Volts}$$

$= -3.6 + 3.8$

$= 0.2$ V

Hence, from circuit, as $V_2 = \frac{4(2k)}{2k+2k} = V_1$

$\therefore V_1 = 2V$

$\therefore I_{90\Omega} = \frac{V_1 - V_0}{90} = 0.02A$

19. If A, B & C are n × n matrices and | A | = 2, | B | = 3 & | C | = 5 then the value of $|A^2 B C^{-1}|$ = ?

19. Ans: 2.4 **Range: 2 to 3**

Sol: $\left|A^2 B C^{-1}\right| = \frac{|A||A||B|}{|C|} = \frac{2 \times 2 \times 3}{5} = \frac{12}{5} = 2.4$

20. What is the value of $\lim_{x\to\infty}\sqrt{(x^2+x+1)}-x$

20. Ans: 0.5 **Range: 0 to 1**

Sol: $\lim_{x\to\infty}\sqrt{(x^2+x+1)}-x = \lim_{x\to\infty}\left[\sqrt{x^2+x+1}-x\right]\left[\frac{\sqrt{x^2+x+1}+x}{\sqrt{x^2+x+1}+x}\right]$

$$=\frac{1+0}{\sqrt{1+0+0+1}}=\frac{1}{2}=0.5$$

21. An Engineer applies the input r(t) = 2sin(t – 1.55) to a chemical process and measures the output as y(t) = 0.4sin(t – 1.55). What is the gain of the system?

Ans: 0.2 **Range: 0.1 to 0.3**

Sol: Input r(t) = 2sin(t–1.55)

Output y(t) = 0.4sin(t–1.55)

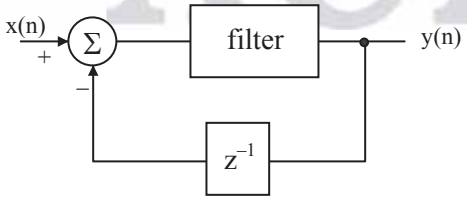
For sinusoidal input, the output is

$y(t) = A\times M \sin(t\pm\theta\pm\phi)$

$A\times M = 0.4$ ($A \rightarrow$ Amplitude of input), A = 2

$2M = 0.4 \Rightarrow M = 0.2$

22. Find the difference equation relating input x(n) and output y(n) for the realization shown in figure. The filter impulse response is $h(n) = 0.5\delta(n) + 0.5\delta(n-1)$.



Option A: y(n) + y(n–1) + y(n–2) = x(n) + x(n–1)

Option B: y(n) + 0.5y(n–1) + 0.5y(n–2) = 0.5x(n) + 0.5x(n–1)

Option C: y(n) – 0.5y(n–1) – 0.5y(n–2) = 0.5x(n) + 0.5x(n–1)

Option D: 1.5y(n) + 0.5y(n–1) = 0.5x(n) + 0.5x(n–1)

Ans: (B)

Sol:

Assume filter transfer function is $H_1(z)$.

$H_1(z) = 0.5 + 0.5z^{-1}$

$$H(z) = \frac{Y(z)}{X(z)} = \frac{H_1(z)}{1+z^{-1}H_1(z)} = \frac{0.5+0.5z^{-1}}{1+z^{-1}(0.5+0.5z^{-1})}$$

$$\frac{Y(z)}{X(z)} = \frac{0.5+0.5z^{-1}}{1+0.5z^{-1}+0.5z^{-2}}$$

$Y(z)[1+0.5z^{-1}+0.5z^{-2}] = 0.5X(z) + 0.5z^{-1}X(z)$

$y(n) + 0.5y(n-1) + 0.5y(n-2) = 0.5x(n) + 0.5x(n-1)$

Distractor Logic:

Option A: If we miss 0.5 in filter impulse response.

Option B: Correct option

Option C: If we feel positive feedback system, wrong interpretation of taking negative coefficients.

Option D: In the feedback multiplier of $h_1(n)$ if we miss z^{-1}

23. An RC low pass filter has the impulse response $h(t) = e^{-t}u(t)$. The response of the system due to the input $x(t) = e^{2t}u(-t)$ is_____

Option A: $\frac{1}{3}e^{2t}u(-t) + \frac{1}{3}e^{-t}u(t)$

Option B: $\frac{-1}{3}e^{2t}u(t) - \frac{1}{3}e^{-t}u(-t)$

Option C: $-\frac{1}{3}e^{2t}u(-t) - \frac{1}{3}e^{-t}u(t)$

Option D: $e^{2t}u(-t) + e^{-t}u(t)$

Ans: (A)

Sol: $H(s) = \frac{1}{s+1}; \sigma > -1$

$X(s) = \frac{-1}{s-2}; \sigma < 2$

Output ROC = $(\sigma > -1) \cap (\sigma < 2) = -1 < \sigma < 2$

$$Y(s) = X(s)H(s) = \frac{-1}{(s-2)(s+1)} = \frac{-1/3}{s-2} + \frac{1/3}{s+1}$$

Based on the output ROC, take inverse Laplace transform

$$y(t) = \frac{1}{3}e^{2t}u(-t) + \frac{1}{3}e^{-t}u(t)$$

Distractor Logic

Option A: Correct Answer

Option B: In the partial fraction if we feel pole '2' is right sided & pole '–1' is left sided

Option C: In the partial fraction expansion if we take negative sign of Y(s) as it is

Option D: In the partial fraction expansion if we miss $\frac{1}{3}$ multipliers

24. The sound from two sound sources are 40 dB and 50 dB. Then the total sound intensity level in dB is

Option A: 50.41

Option B: 52.39

Option C: 0

Option D: 110×10^3

Ans: (A)

Sol: $40 \text{ dB} = 10\log_{10}\left(\frac{I_1}{I_0}\right)$ $\qquad I_1 = 10^4 I_0\left(\frac{W}{m^2}\right)$

$50 \text{ dB} = 10\log_{10}\left(\frac{I_2}{I_0}\right)$ $\qquad I_2 = 10^5 I_0\left(\frac{W}{m^2}\right)$

Total sound intensity $I_T = I_1 + I_2 = (10^4 + 10^5)\ I_0\left(\frac{W}{m^2}\right)$

Total sound intensity level (dB) $= 10\log_{10}\left(\frac{1.1\times10^5 I_0}{I_0}\right) = 50.41$ dB

Distractor Logic

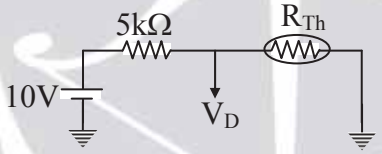
Option A: This is correct option.

Option B: If we taken sound in dB = $20\log_{10}\left(\frac{I_1}{I_0}\right)$ as formula then total sound intensity level in dB = 52.39 dB.

Option C: Total sound intensity level is 0 dB if and only if $I_T = I_0$ but in given a problem $I_T \neq I_0$.

Option D: This option is in magnitude form but as per question we want answer in dB format.

25. A thermistor sensor is used to monitor room temperature. It has resistance of 5 kΩ at 30 °C with a slope of –10 %/°C. The dissipation constant P_D = 5 mW/°C. It is proposed to use the thermistor in the divider network shown in figure to provide V_o voltage of 5.0 V at 30 °C. The value of thermistor resistance in kΩ due to self heating effects is



Option A: 4.5

Option B: 5.5

Option C: 5

Option D: None of the above

Ans: (A)

Sol: At 30 °C $R_{th} = 5k\Omega$ $V_D = \frac{R_{th}}{R_{th} + 5k\Omega} \times 10V = 5V$

Power dissipated in thermistor $\Rightarrow P = \frac{V^2}{R_{th}} = \frac{(5)^2}{5k} = 5mW$

$$\Delta T = \frac{P}{P_D} = \frac{5mW}{5mW/^oC} = 1^oC$$

$$R_{th} = 5k\Omega + \left[1^oC \times \frac{-10}{100\ ^oC} \times 5k\Omega\right] = 4.5\ k\Omega$$

Distractor Logic

Option A: This is correct option

Option B: This option is correct if we take given slope value positive i.e. +10%/^{o}C

Option C: This option is correct without considering self heating effect

Option D: None of the above

26. An Iron-constantan thermocouple, having linear sensitivity of 20 $\mu V/^oC$, is calibrated at cold junction temperature of 0^oC. This type of thermocouple is used to measure an unknown temperature with the cold junction temperature of 25^oC. Actual hot junction temperature in ^oC if the emf generated is 2.0 mV is

Option A: 125

Option B: 100

Option C: 25

Option D: None of the above

Ans: (A)

Sol: $E_{0\to T} = E_{0\to 25^oC} + E_{25^oC\to T}$

$E_{25^oC\to T} = 2.0$ mV $\qquad E_{0^oC\to 25^oC} = 20\times10^{-6}\times25 = 0.5$ mV

$E_{0\to T} = 0.5\text{mV} + 2.0\text{ mV} = 2.5$ mV

Actual hot junction temperature $= \dfrac{2.5\times10^{-3}\ \text{V}}{20\times10^{-6}\ \text{V}/^o\text{C}} = 125\ ^o\text{C}$

Distractor Logic:

Option A: This is correct option

Option B: This option is correct if we take $E_{0^oC\to T} = E_{25^oC\to T} = 2.0$ mV

Option C: This option is correct if we take $E_{0^oC\to T} = E_{0^oC\to 25^oC} = 0.5$ mV

Option D: None of the above

27. Which of the following could not be the auto correlation function of a random process ?

Option A: $R(\tau) = \begin{cases} 1-|\tau|; & |\tau|<1 \\ 0; & |\tau|>1 \end{cases}$

Option B: $R(\tau) = 5\sin 3\tau$

Option C: $R(\tau) = \begin{cases} \cos\tau; & |\tau| \le \pi/2 \\ 0; & |\tau| > \pi/2 \end{cases}$

Option D: $R(\tau) = \dfrac{\sin\tau}{\tau}$

Ans: (B)

Sol: Auto correlation function is always even function, maximum value occurs at $\tau = 0$.

option (B) violating these two conditions

Distractor Logic:

Option A: ACF satisfies $R_x(-\tau) = R_x(\tau)$

$$|R_x(\tau)| \le R_x(0)$$

$$R(\tau) = \begin{cases} 1-|\tau|; & |\tau| < 1 \\ 0; & |\tau| > 1 \end{cases}$$ satisfies both properties

So option A wrong

Option B: $R_x(-\tau) \neq R_x(\tau)$, $5\sin(3\tau)$ violates even condition

So option (B) Correct Answer

Option C: $\cos(\tau)$, $|\tau| \le \pi/2$ satisfies all properties

So option C is wrong

Option D: $\frac{\sin\tau}{\tau}$ satisfies all properties

So option D is wrongs

28. A network is composed of two sub-networks N_1 & N_2 as shown in figure

If the sub network N_1 contains only linear, bilateral, time invariant elements then it can be replaced by its Thevenin's equivalent even if the sub-network N_2 contains

Option A: A two-terminal element which is non linear

Option B: A non-linear inductance mutually coupled to an element in N_1

Option C: An element which is linear, but mutually coupled to same element in N_1

Option D: A dependent source the value of which depends upon the voltage (OR) current in any element of N_1

Ans: (A)

Sol: Network N_1 is passive network as per given data. Then network N_2 should be active element which should be independent. i.e., independent either voltage (OR) current source

Distractor Logic

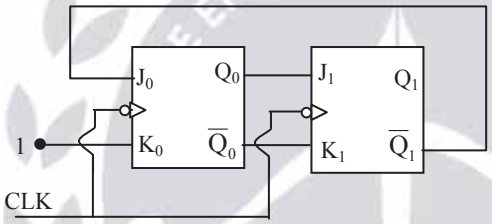
Option A: Correct option

Option B: Nonlinear inductance is not possible

Option C: If N_2 is linear element we can't replace the network by its Thevenin's equivalent

Option D: If N_2 contains dependent source then control variable should be in network N_2 only

29. Find the value of the following counter after 730 clock pulses. Initially $Q_0 = Q_1 = 0$.



Option A: $Q_0\, Q_1 = 00$

Option B: $Q_0\, Q_1 = 01$

Option C: $Q_0\, Q_1 = 10$

Option D: $Q_0\, Q_1 = 11$

Ans: (C)

Sol:

It is a 2 bit synchronous counter. Given $J_0 = \overline{Q}_1$; $K_0 = 1$; $J_1 = Q_0$; $K_1 = \overline{Q}_0$

	Present state		Flip Flop Inputs				Next state		
	Q_0	Q_1	J_0	K_0	J_1	K_1	Q_0	Q_1	
⓪	0	0	1	1	0	1	1	0	②
②	1	0	1	1	1	0	0	1	①
①	0	1	0	1	0	1	0	0	⓪

counting sequence is 00, 10, 01, 00,…….. it is a Mod-3 counter.

Counter value after 730 clock pulses is same value of the counter after 1 pulse i.e., $Q_0Q_1 = 10$

Distractor Logic

Option A: It might be mistaken as 2–bit Johnson counter which is a 4:1 counter. Thus value after 730 pulses is same as initial value i.e., $Q_0\ Q_1 = 00$

Option B: The counting sequence of the counter may be mistaken as 00, 01, 10, 00, …… Then its solution is taken as 01

Option C: Correct option

Option D: Mistakenly chosen as 11

30. In 8085 Microprocessor the Accumulator has a 2's complement number '11110100'. Determine the function of executing the following sequence of instructions RLC, RRC and RAR.

Assume 'carry' flag is cleared initially.

Option A : It finds 1's complement representation of the given 2's complement number

Option B : It converts the given 2's complement number to corresponding sign magnitude representation

Option C: It divides the given 2's complement number by 2

Option D: It multiplies the given 2's complement number by 2

Ans: (C)

Sol: Given Accumulator value = -12_{10}

		ACC								**cy**
		1	1	1	1	0	1	0	0	0
RLC	⇒	1	1	1	0	1	0	0	1	1
RRC	⇒	1	1	1	1	0	1	0	0	1
RAR	⇒	1	1	1	1	1	0	1	0	0

Accumulator value is 11111010 = $\boxed{-6_{10}}$

Distractor Logic

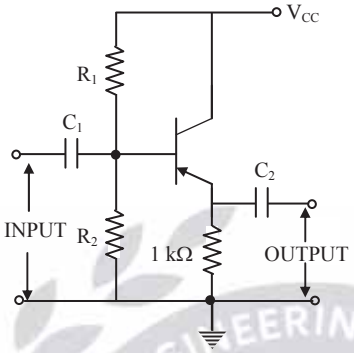
Option A: It may be mistaken as 1's complement form of given number

Option B: It may be mistaken as sign magnitude form of given number

Option C: Correct option

Option D: It may be mistaken as multiplication of 2's complement number

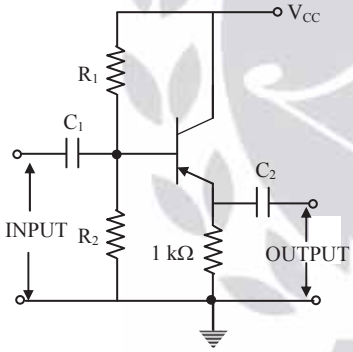
31. In the amplifier circuit shown in figure, the transistor parameters with usual notations are $g_m = 0.015$ S, $r_{b'e} = 1\,k\Omega$, $r_{bb'} = 90\,\Omega$, $C_{b'e} = 20$ pF and $C_{b'c} = 3$ pF. Neglecting the loading effect of biasing resistors, R_1 & R_2, the mid-frequency voltage gain of the amplifier is _____.



(A) – 13.76 (B) 0.9411 (C) 0.936 (D) 1

Ans: (C)

Sol:



Consider the parameters of BJT

$r_{b'e} = 1k\Omega$, $r_{bb'} = 90\Omega$ & $g_m = 0.015$ S,

Step(1) : $h_{ie} = r_{b'e} + r_{bb'} = 1090\,\Omega$

$$\text{Consider, } r_{b'e} = \frac{h_{fe}}{g_m} \Rightarrow h_{fe} = r_{b'e} \times g_m = 1k\Omega \times 0.015 = 15$$

Step(2): The given circuit is emitter follower (CC Amplifier)

$\therefore$ The mid-frequency voltage gain in a CC amplifier,

$$A_V = \frac{(1+h_{fe})R_E}{h_{ie} + (1+h_{fe})R_E} = \frac{16 \times 1k\Omega}{1.09k\Omega + 16 \times 1k\Omega} = \frac{16\,k\Omega}{17.09\,k\Omega}$$

$A_V = 0.936$

Distractor Logic

Option: A:

If the given circuit is assumed as CE Amplifier, with a load resistance of R_L=1k ; then,

Step (1): $h_{ie} = r_{b'e} + r_{bb'} = 1090\,\Omega$

$$\text{Consider, } r_{b'e} = \frac{h_{fe}}{g_m} \Rightarrow h_{fe} = r_{b'e} \times g_m = 1k\Omega \times 0.015\,\text{℧} = 15$$

Step (2): $A_V = -\dfrac{h_{fe}R_L}{h_{ie}} = -\dfrac{15\times 1k}{1.09k} = -13.76$

Option: B

CC Amplifier: if we consider $h_{ie} = r_{b'e}$ [neglecting $r_{bb'}$ (base spreading resistance)]

$$A_V = \frac{(1+h_{fe})R_E}{h_{ie}+(1+h_{fe})R_E} = \frac{16\times 1k\Omega}{1k\Omega + 16\times 1k\Omega} = \frac{16k\Omega}{17k\Omega} = 0.9411$$

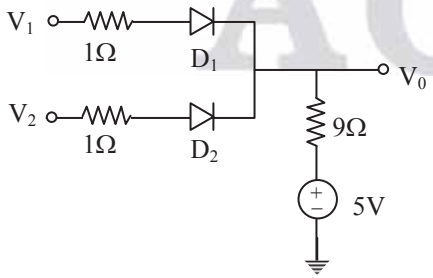
Option: C

CC Amplifier; $A_V = 0.936$

Option: D

The voltage gain in a CC amplifier ideally is '1'

32. Assume both the diodes to be precise, if $V_1 = -5V$ & $V_2 = 10V$, find V_0 ?



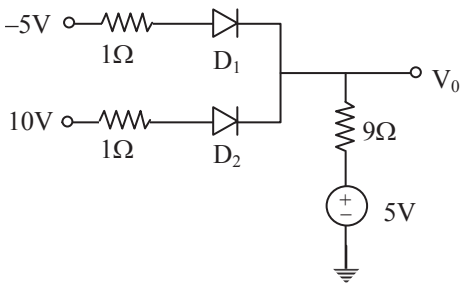
Option A: –4V

Option B: 8.87 V

Option C: 9.5 V

Option D: –4.63 V

Ans: (C)



Sol: Assume D_1 OFF & D_2 ON,

$$\therefore V_0 = \frac{\left(\frac{10}{1}\right)+\left(\frac{5}{9}\right)}{\left(\frac{1}{1}\right)+\left(\frac{1}{9}\right)} = 9.5V$$

Now, check Assumption:

$$i_{D_2} = \frac{10-9.5}{1} = 0.5A > 0,$$

$\therefore D_2 \rightarrow ON \rightarrow True.$

$V_{D_1} = V_1 - V_0 = -5 - 9.5 = -14.5V < 0$

$\therefore D_1 \rightarrow OFF$ is True

Distractor Logic:

Option A: –4 V → This is possible only when $D_1 \rightarrow$ short & $D_2 \rightarrow$ open

But from given biasing, this result is impossible

Option B: 8.87 V → is possible for $D_1 \rightarrow$ OFF & $D_2 \rightarrow$ ON, but if diodes are practical.

But given diodes are precise ⇒ They are ideal

Option C: True

Option D: –4.63 V → This is possible only when $D_1 \rightarrow$short, $D_2 \rightarrow$open & diodes are practical

33. The general solution of $\frac{dy^4}{dx^4} - 6\frac{dy^3}{dx^3} + 12\frac{dy^2}{dx^2} - 8\frac{dy}{dx} = 0$ is

(A) $y = C_1 + (C_2 + C_3 x + C_4 x^2) e^{2x}$

(B) $y = (C_1 + C_2 x + C_3 x^2) e^{2x}$

(C) $y = (C_1 + C_2 x + C_3 x^2 + C_4 x^3) e^{2x}$

(D) $y = C_1 + C_2 x + C_3 x^2 + C_4 e^{2x}$

33. Ans: (A)

Sol: The given equation is $(D^4 - 6D^3 + 12D^2 - 8D) y = 0$

$D(D^3 - 6D^2 + 12D - 8) y = 0$

$D(D-2)^3 = 0$

$\therefore D = 0, 2, 2, 2$

$\therefore$ The required solution is (A)

34. $L\{e^{-2t}[1-u(t-1)]\} = ?$

(A) $\frac{1-e^{(s+2)}}{(s+2)}$ (B) $\frac{1+e^{(s+2)}}{(s+2)}$

(C) $\frac{1-e^{-(s+2)}}{(s+2)}$ (D) $\frac{1+e^{-(s+2)}}{(s+2)}$

34. Ans: (C)

Sol: $L\{e^{-2t}[1-u(t-1)]\} = L\{e^{-2t}g(t)\}$ (Where $g(t) = [1-u(t-1)]$)

$$= G(s+2) \quad \left(G(s) = L\{g(t)\} = \frac{1}{s} - \frac{e^{-s}}{s}\right)$$

$$= \frac{1-e^{-(s+2)}}{(s+2)}$$

35. The closed loop transfer function of a unity feedback system is $\frac{C(s)}{R(s)} = \left(\frac{30}{s^2+5s+36}\right)$. The steady state error due to a unit step input is

Option A: $\frac{36}{66}$

Option B: $\frac{1}{6}$

Option C: $\frac{36}{30}$

Option D: None

Ans: (B)

Sol: Given CLTF $\frac{C(s)}{R(s)} = \frac{30}{s^2+5s+36}$

Get OLTF $G(s) = \frac{30}{s^2+5s+6}$, $H(s) = 1$

Steady state error for unit step input $e_{ss} = \frac{1}{1+k} = \frac{1}{1+\frac{30}{6}}$

$$e_{ss} = \frac{6}{36} = \frac{1}{6}$$

Distractor Logic:

Option A: If the given transfer function is considered as a OLTF then $e_{ss} = \frac{A}{1+k}$

$$e_{ss} = \frac{1}{1+\frac{30}{36}} = \frac{36}{66}$$

Option B: Correct Option

Option C: If the given transfer function is considered as OLTF and taken $e_{ss} = \frac{A}{k} = \frac{1}{\left(\frac{30}{36}\right)} = \frac{36}{30}$

Option D: If considered OLTF is unstable then e_{ss} is none (or) ∞

Q.36 – Q.65 carry two marks each.

36. Consider the filter $H(z)=\dfrac{z+2}{z+0.5}$. The input to this filter is x(n) = cos(nπ). The phase delay of this system is _____ secs

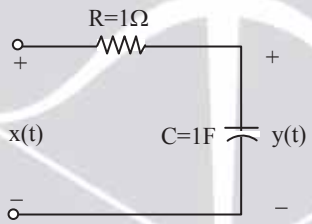
Ans: 1

Sol: $\omega_0=\pi(z=e^{j\omega_0}=-1)\Rightarrow H(e^{j\omega_0})=H(e^{j\pi})=H(-1)=\dfrac{-1+2}{-1+0.5}=-2=2e^{-j\pi}$

$x(n)=\cos(n\pi)\Rightarrow y(n)=2\cos(n\pi-\pi)$

$t_p(\omega)=-\dfrac{\theta(\omega)}{\omega}=-\dfrac{(-\pi)}{\pi}=1\text{sec}$

37. Signal $x(t)=|10\sin t|$ Volts is applied to the circuit shown in figure. The Fourier series coefficient of the output has a dc value of _____



Ans: 6.366 **Range: 6 to 7**

Sol: $x(t)=|10\sin t|$ is a Full-wave rectifier

$\omega_0=2\text{rad}/\text{sec}$,

The Exponential Fourier Series coefficients of Full Wave rectified wave form is

$C_0=\dfrac{20}{\pi}\quad C_n=\dfrac{20}{\pi(1-4n^2)}$

$H(\omega)=\dfrac{1}{1+j\omega}$

$\Rightarrow H(n\omega_0)=\dfrac{1}{1+jn\omega_0}=\dfrac{1}{1+j2n}$

$H(n\omega_0)\big|_{n=0}=1$

$\therefore$ dc component of output is $= C_0H(0)=\dfrac{20}{\pi}=6.366$

38. When three transparent glass sheets of thickness 0.1 mm, 0.2 mm & 0.3 mm respectively are inserted in the interfering beam path in a Bi-prism experiment. The path difference due to insertion of three glass sheets in μm is (Refractive index of glass sheet is 1.5)

Ans: 300

Sol: $P.D = \mu(t_1 + t_2 + t_3) - (t_1 + t_2 + t_3)$

$= (\mu - 1)(t_1 + t_2 + t_3)$

$= (1.5 - 1)(0.1 + 0.2 + 0.3) \times 10^{-3}$

$= 0.5 \times 0.6 \times 10^{-3}$

$= 30 \times 10^{-5}$

$P.D = 300\ \mu m$

39. A dual slope integrating DVM is used to measure a voltage signal $V(t) = (100+100\sin 100\pi t)V$, in its (0-200)V range of operation and $3\frac{1}{2}$ digit display. The accuracy specification of this DVM is 0.5% of reading + 1 digit. The % error in reading of DVM is

Ans: 0.6% **Range: 0.3% to 0.8%**

Sol: DVM measures average value of input voltage signal.

$\therefore$ DVM reading = 100 V

1 digit = 1 count

= 1 step

= r (resolution)

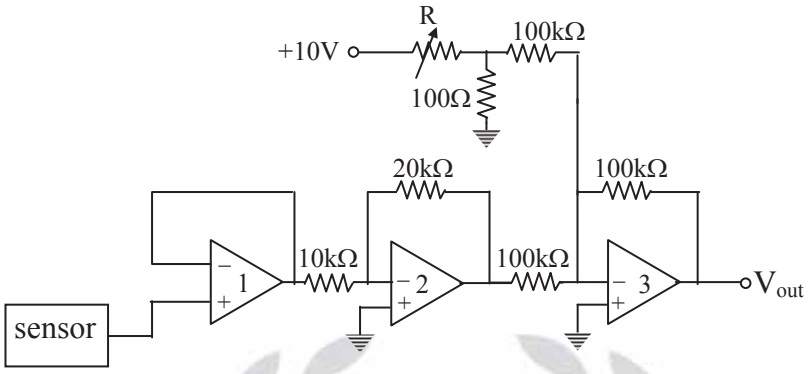
Resolution of DVM in 200V range is $\frac{200}{2 \times 10^3} = 0.1$ V

$\text{Error} = \frac{0.5}{100} \times 100 + 0.1$

$= 0.6$ V

% error in reading of 100V = $\frac{0.6}{100} \times 100\% = 0.6\%$

40.



A sensor outputs a voltage ranging from –1 V to –6 V for interface to an analog to digital converter. The signal conditioning circuit output needs to be 0 V to 10 V. For given data the value of R in Ω is

Ans: 400

Sol: Sensor Output Signal Conditioning Circuit Output

–1V 0V

–6V 10V

$V_{out} = mV_{in} + V_x$

$0 = m(-1) + V_x$ ---- (1)

$10 = m(-6) + V_x$

$10 = -5m$

$m = -2 \quad V_x = 2$

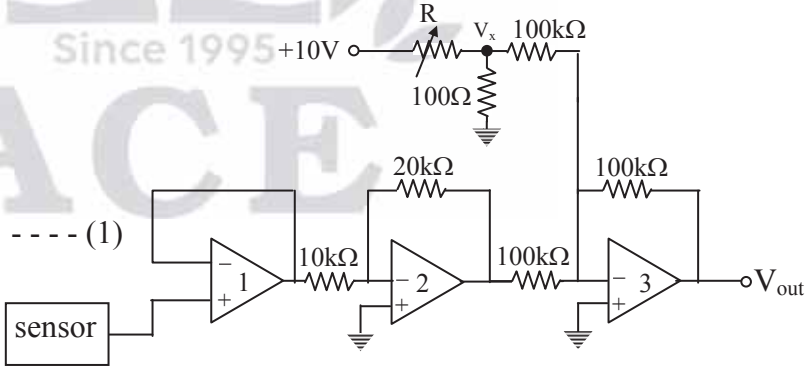
$$V_x = 10 \times \frac{100k\Omega \,||\, 100\Omega}{(100k\Omega \,||\, 100\Omega) + R} \quad \text{- - - - (1)}$$

$100\ k\Omega \,||\, 100\ \Omega \cong 100\ \Omega$

Equation (1) becomes

$$V_x = 10 \times \frac{100}{100 + R}$$

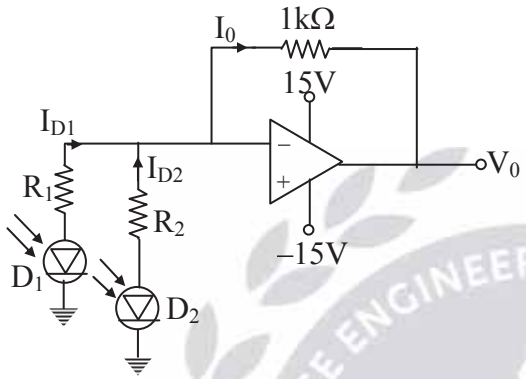
$R = 400\ \Omega$



41. Photodiodes D_1 & D_2 have active area of 10^{-2} cm^2 & 10^{-1} cm^2 respectively. D_1 & D_2 both have same sensitivity of 1 A/W. When the light of intensity 10 mW/cm^2 falls on the photodiode then the power dissipation in resistor 1 kΩ in mW is

Ans: 1.21 **Range: 1.10 to 1.30**

Sol:



$$I_0 = I_{D_1} + I_{D_2}$$

$$I_{D_1} = 10\frac{\text{mW}}{\text{cm}^2} \times 10^{-2}\ \text{cm}^2 \times 1\frac{\text{A}}{\text{W}} = 0.1\ \text{mA}$$

$$I_{D_2} = 10\frac{\text{mW}}{\text{cm}^2} \times 10^{-1}\ \text{cm}^2 \times 1\frac{\text{A}}{\text{W}} = 1\ \text{mA}$$

$$I_0 = 1.1\ \text{mA}$$

$$P = I_0^2 \times 1000 = 1.21\ \text{mW}$$

42. A single phase house service energy meter of 230V, 10A. The meter constant of meter is $180\left(\frac{\text{rev}}{\text{kWhr}}\right)$. The meter takes 55sec for making 90 revolutions of the disc when connected to a 36 kW unity power factor load. The error in the reading of the meter in % is

Ans: –9.09 **Range: –8 to –10**

Sol: Energy recorded (measured value)

$$= \frac{90(\text{rev})}{180(\text{rev}/\text{kWhr})} = 0.5(\text{kWhr})$$

Energy consumed (true value)

$$= \frac{36\,\text{kW} \times 55\,\text{sec}}{3600} = 0.55(\text{kWhr})$$

$$\text{Error} = \frac{E_{measured} - E_{true}}{E_{true}} \times 100$$

$$= \frac{0.5\,\text{kWhr} - 0.55\,\text{kWhr}}{0.55\,\text{kWhr}} \times 100$$

$$= -9.09\%$$

43. Ten different signals are to be Time Division Multiplexed and transmitted using PCM. Four of these signals have a maximum frequency of 10kHz, two of them have maximum frequency of 15kHz, two other signals have a maximum frequency of 5kHz and remaining signals have a maximum frequency of 20kHz. The value of bit rate (in Mbps), if signals sampled at Nyquist rate and samples are represented using 10 bits is _____

Ans: 2.4 **Range: 2.3 to 2.5**

Sol: $r_{b,TDM} = n\, f_{s,TDM}$

$n = 10$

$f_{s,TDM} = 4f_{s_1} + 2f_{s_2} + 2f_{s_3} + 2f_{s_4}$

$W_1 = 10k\ ,\ f_{s_1} = 20k$

$W_2 = 15k\ ,\ f_{s_2} = 30k$

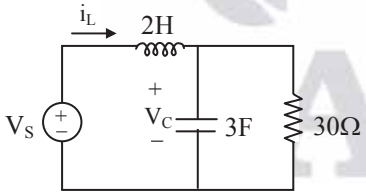
$W_3 = 5k\ ,\ f_{s_3} = 10k$

$W_4 = 20k\ ,\ f_{s_4} = 40k$

$f_{s,TDM} = 4\times 20k + 2\times 30k + 2\times 10k + 2\times 40k = 240\text{ k samples/sec}$

$r_{b,TDM} = 10\times 240\,\text{k samples per sec} = 2400\text{ kbps} = 2.4\text{ Mbps}$

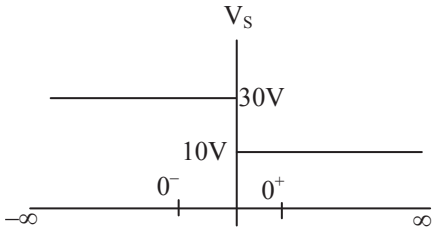
44. Consider the following network



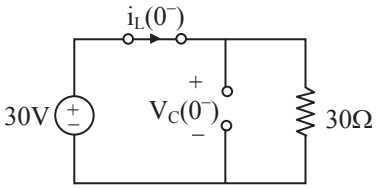
If $V_s = 10 + 20\,u(-t)$, then the value of $\frac{di_L(t)}{dt}$ at $t = 0^+$ in A/s is _____

Ans: –10

Sol:



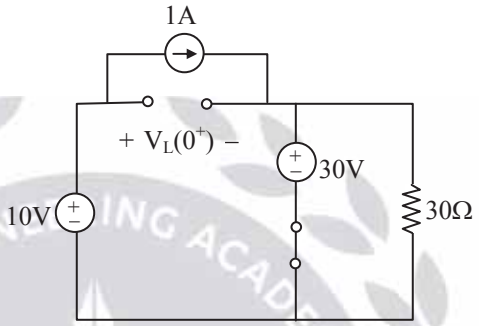
(i) At $t = 0^-$: Steady state



$$i_L(0^-) = \frac{30}{30} = 1A = i_L(0^+)$$

$$V_C(0^-) = 30V = V_C(0^+)$$

(ii) At $t = 0^+$



At $t = 0^+$: Transient state

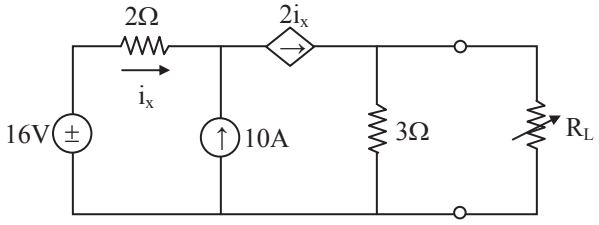
By KVL $\Rightarrow 10 - V_L(0^+) - 30 = 0$

$$\Rightarrow V_L(t)\big|_{t=0^+} = -20$$

$$\Rightarrow \frac{L di_L(t)}{dt}\bigg|_{t=0^+} = -20$$

$$\Rightarrow \frac{di_L(t)}{dt}\bigg|_{t=0^+} = \frac{-20}{L} = \frac{-20}{2} = -10A/s$$

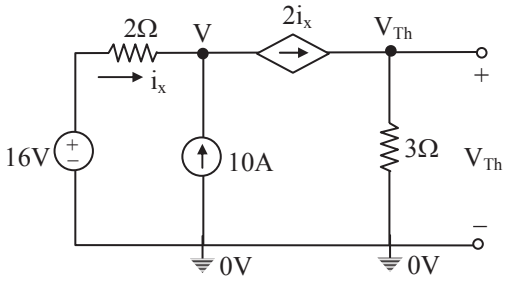
45. Consider the following network



The value of maximum power transferred to load 'R_L' (in watts) is _____

Ans: 300

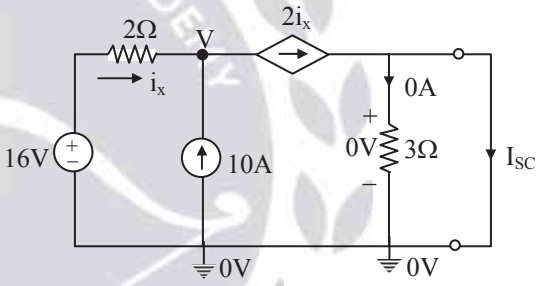
Sol: Evaluation of V_{Th}:



Nodal $\Rightarrow -i_x - 10 + 2i_x = 0 \Rightarrow i_x = 10A$

Nodal $\Rightarrow -2i_x + \dfrac{V_{Th}}{3} = 0 \Rightarrow V_{Th} = 6i_x = 60V$

Evaluation of I_{SC}:

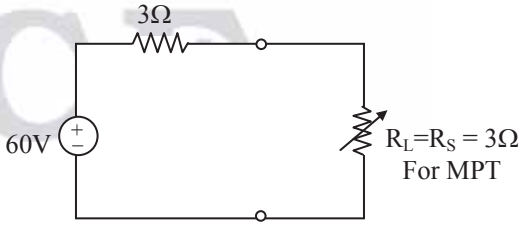


Nodal $\Rightarrow -i_x - 10 + 2i_x = 0 \Rightarrow i_x = 10\ A$

So, $I_{SC} = 2i_x = 20A$

$$\Rightarrow R_{Th} = \frac{V_{Th}}{I_{SC}} = \frac{60}{20} = 3\Omega$$

$$\Rightarrow P_{max} = \frac{V_{Th}^2}{4 \times R_{Th}} = \frac{60^2}{4 \times 3} = 300W$$

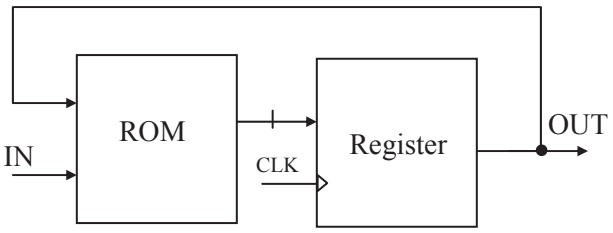


46. The maximum frequency of operation (in MHz) for the sequential circuit shown below is _____ (MHz)

The Propagation delays are as follows

$t_{ROM} = 7.5$ ns; $t_{Reg} = 2.5$ ns

$t_{Setup} = 2.5$ ns; $t_{Hold} = 2.5$ ns



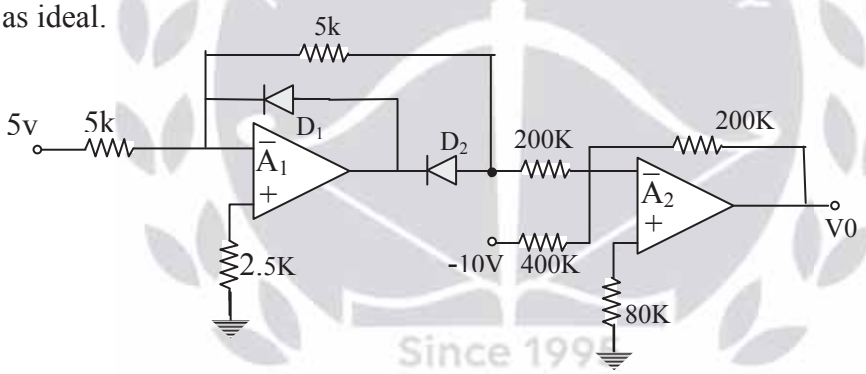
Ans: 80

Sol: The frequency of operation of the given sequential circuit is

$$f \le \frac{1}{t_{Rom} + t_{Reg} + t_{Setup}} \Rightarrow f \le \frac{1}{(7.5 + 2.5 + 2.5) \times 10^{-9}}$$

$$f_{max} = \frac{1 \times 10^9}{12.5} = 80\text{MHz}$$

47. Find the output voltage V_0 (in Volts) of op-amp circuit shown in figure assuming op-amp & diodes as ideal.

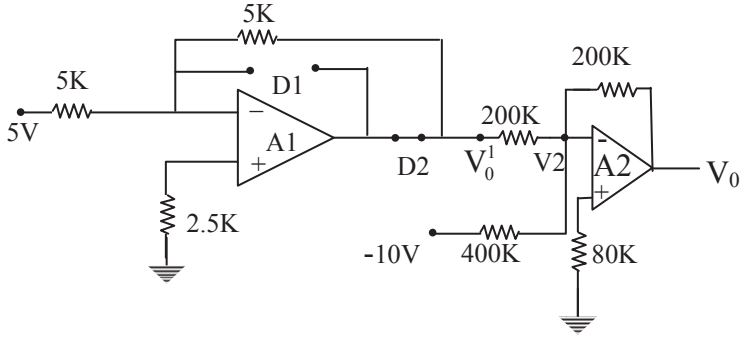


Ans: 10

Sol: Step (1) For the given input of 5v, D1 is off & D2 is ON

$$V_0^1 = \frac{-5k}{5k} \times 5v = -5v$$

Step (2) KCL at the inverting input, V_2 of op-amp2(A_2)



Op-amp 2 (A2)

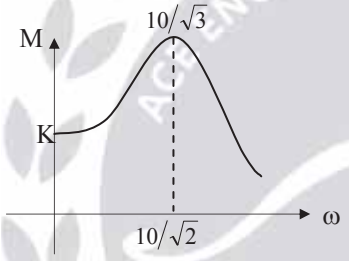
$$\frac{V_0^1}{200k} - \frac{10v}{400k} + \frac{V_0}{200k} = 0$$

$$V_0 = 200k\left[\frac{5V}{200k} + \frac{10V}{400k}\right] = 5\text{ V} + 5\text{ V}$$

$$\therefore V_0 = 10\text{ V}$$

48. Frequency response of a second order system is given below. The value of K is ____

$$G(s) = \frac{K \times 100}{s^2 + 10s + 100}$$



Ans: 5

Sol: $G(s) = \frac{K \times 100}{s^2 + 10s + 100}$

$s^2 + 10s + 100 \Rightarrow s^2 + 2s\xi\omega_n + \omega_n^2$

$\omega_n = 10$

$\xi = 1/2$

$$M = \frac{K}{2\xi\sqrt{1-\xi^2}} = \frac{10}{\sqrt{3}} = \frac{K}{2(0.5)\sqrt{1-(0.5)^2}} = \frac{10}{\sqrt{3}}$$

$K = 5$

49. $y = e^{-x}\left(C_1 \cos\sqrt{3}\,x + C_2 \sin\sqrt{3}\,x\right) + C_3 e^{2x}$ is the general solution of

(A) $(D^3 + 4)\,y = 0$ (B) $(D^3 - 8)\,y = 0$

(C) $(D^3 + 8)\,y = 0$ (D) $(D^3 - 2D^2 + D - 2)\,y = 0$

49. Ans: (B)

Sol: The roots of AE are $\left(-1 \pm \sqrt{3}\,i\right)$ & 2

$\therefore$ The required equation is

$(D-2)(D^2 + 2D + 4)\,y = 0$

i.e., $(D^3 - 8)\,y = 0$

50. Find the value of $\int_C \frac{z\cos z}{\left(z - \frac{\pi}{2}\right)^2} dz$, where 'C' is $|z - 1| = 1$

(A) $i\pi$ (B) $-i\pi$ (C) $i\pi^2$ (D) $-i\pi^2$

50. Ans: (D)

Sol: $z = \frac{\pi}{2} = \frac{3.14}{2} = 1.57$ is a pole of order '2' lies inside 'C'

$$\therefore \int_C \frac{z\cos z}{\left(z - \frac{\pi}{2}\right)^2} dz = 2\pi i\, f^1\left(\frac{\pi}{2}\right) \quad \text{(where } f(z) = z\cos z\text{)}$$

$$= 2\pi i\left(\frac{-\pi}{2}\right)$$

$$= -\pi^2 i$$

51. $(a\alpha + b)x + ay + bz = 0$

$(b\alpha + c)x + by + cz = 0$

$(a\alpha + b)y + (b\alpha + c)z = 0$ have non-trivial solutions if

(i) a, b, c are in A. P

(ii) a, b, c are in G. P

(iii) a, b, c are in H. P

(iv) 'α' is a root of $(ax^2 + 2bx + c) = 0$

(A) both (i) & (iv) (B) both (ii) & (iv)

(C) both (iii) & (iv) (D) only (iv)

51. Ans: (B)

Sol: $\begin{vmatrix} (a\alpha + b) & a & b \\ (b\alpha + c) & b & c \\ 0 & (a\alpha + b) & (b\alpha + c) \end{vmatrix} = 0$

$R_3 \to R_3 - (\alpha R_1 + R_2)$

$$\Rightarrow \begin{vmatrix} a\alpha + b & a & b \\ b\alpha + c & b & c \\ -a\alpha^2 - 2b\alpha - c & 0 & 0 \end{vmatrix} = 0$$

i.e., $-(a\alpha^2 + 2b\alpha + c)(ac - b^2) = 0$

$\therefore$ 'α' is a root of $(ax^2 + 2bx + c) = 0$

or a, b, c are in G. P

52. Which one of the following statement is NOT TRUE about eigen signal?

Option A: Every signal is an eigen signal to the system described by $h(t) = A\delta(t)$

Option B: The signal $x(t) = e^{j\beta t}$ is an eigen signal of an LTI system given by $h(t) = e^{-\alpha t}u(t)$

Option C: The signal $x(t) = \cos\beta t$ is an eigen signal of an LTI system given by $\dot{y}(t) + \alpha y(t) = x(t)$

Option D: The signal $x(t) = \text{Sinc}(\alpha t)$ is an eigen signal of LTI system having $h(t) = \text{Sinc}(\beta t)$; $\beta \geq \alpha$

Ans: (C)

Sol: If $x(t) = \cos(\beta t)$ & $\dot{y}(t) + \alpha y(t) = x(t)$ then

$y(t) = A\cos(\beta t) + B\sin(\beta t)$

$= C\cos(\beta t + \theta)$

Distractor Logic:

Option A: $x(t)*A\delta(t) = Ax(t)$ but you may feel $A\delta(t)$

Option B: we may think of 'α' & 'β' nature

Option C: Correct option

Option D: Wrong option

$\text{Sinc}(t)*\text{Sinc}(t) = \text{Sinc}(t)$

$\text{Sinc}(t)*\text{Sinc}(2t) = \frac{1}{2}\text{Sinc}(t)$ but you may think $\text{Sinc}(2t)$

53. An electrodynamometer wattmeter measures a power in single phase 50Hz AC circuit. Load voltage 230V and current 10A at lagging p.f of 0.5. The Wattmeter pressure coil resistance is 10kΩ and inductance is 100mH, then % error will be

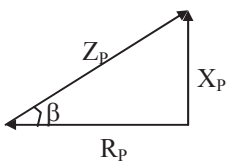
(A) zero (B) –1.68% (C) 0.54% (D) 0.156%

Ans: (C)

Sol: $\tan\beta = \frac{X_P}{R_P}$

$= \frac{2\pi \times 50 \times 100 \times 10^{-3}}{10 \times 10^3}$

$\beta = 0.179$



% error = + (tanϕ tanβ)×100

= 1.732 ×0.00312 ×100

= 0.54 %

Distractor Logic:

Option: (A)

There is no effect of pressure coil resistance on wattemeter reading

Option: (B)

if it is energy meter

$$\% \text{ error} = \frac{\sin(10-30)-0.5}{0.5}\times 100$$

= –1.68%

Option: (C) Correct Answer

Option: (D)

% error = + (cosϕ tanβ)×100

= 0.5 ×0.00312 ×100

= 0.156%

54. The four arms of a Wheatstone bridge are as follows: Arm AB =100 Ω,BC = 10Ω, CD = 4Ω and DA = 50Ω.The galvanometer has a resistance of 20Ω and is connected across BD. A source of 10V DC is connected across AC, then the current through the galvanometer is

(A) zero (B) 13.3mA (C) 5.18mA (D) 39mA

Ans: (C)

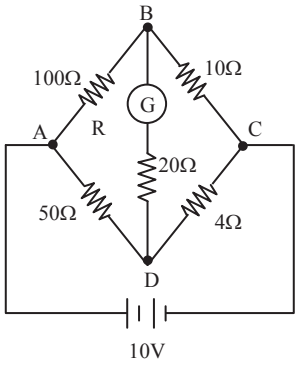
Sol:

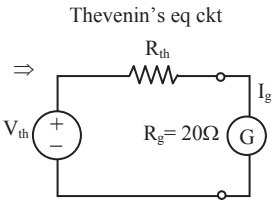
$V_{th} = V_B - V_D$

$$= \left(10 \times \frac{10}{10+100} - 10 \times \frac{4}{4+50}\right)$$

$$= 0.9091 - 0.7407$$

$$= 0.17V$$





$$R_{th} = \frac{100 \times 10}{100+10} + \frac{50 \times 4}{50+4}$$

$$= 9.09091 + 3.7037$$

$$= 12.7946\Omega$$

$$I_g = \frac{V_{th}}{R_{th} + 20} = \frac{0.17}{12.7946 + 20} = 5.18mA$$

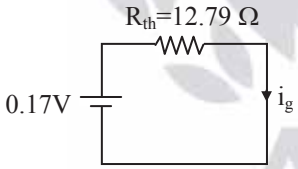
Distractor Logic

Option: (A)

if bridge is balanced, $i_g = 0$

Option: (B)

if galvanometer resistance is neglected



$$i_g = \frac{0.17}{12.179} = 0.01329 \text{ A} = 13.3 \text{ mA}$$

Option: (C) Correct Answer

Option: (D)

if AB & AD branches are interchanged

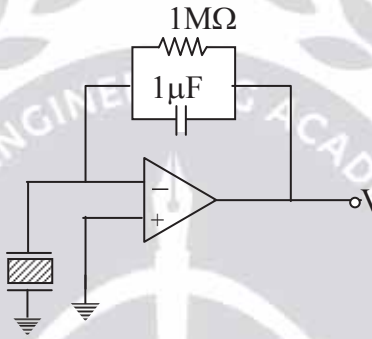
$$V_{th} = \frac{10 \times 10}{10+50} - \frac{10 \times 4}{4+100} = 1.28 \text{ Volts}$$

$$R_{th} = \frac{10\times 50}{10+50} + \frac{4\times 100}{104} = 12.18\ \Omega$$

$$i_g = \frac{1.28}{20+12.18} = 0.03977\ A$$

$$= 39\ mA$$

55. Piezoelectric transducer shown in figure has charge sensitivity of 2 pC/N. If a force of sin(t) N is applied to piezoelectric transducer the output amplitude magnitude of the charge amplifier in μV is



Option A: $\sqrt{2}$

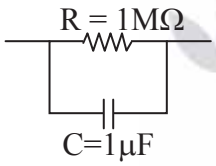
Option B: $\frac{1}{\sqrt{2}}$

Option C: 2

Option D: 0

Ans: (A)

Sol:



$$i = \frac{dq}{dt} = \frac{d}{dt}(dF) = \frac{d}{dt}(2\times 10^{-12}\times \sin t) = 2\cos t\ (pA)$$

$$Z = R \parallel \frac{1}{j\omega C} = \frac{R}{1+j\omega RC} = \frac{10^6}{1+j}$$

$$|Z| = \frac{10^6}{\sqrt{2}}$$

$$V_0 = -i\times Z = -2\times\frac{10^6}{\sqrt{2}}\times 10^{-12}\cos t = -\sqrt{2}\cos t\ \mu V$$

$$|V_0| = \sqrt{2}\ \mu V$$

Distractor Logic

Option A: This is the correct option

Option B: This option as answer if we take charge sensitivity = 1 pC/N

Option C: This option as answer if we take impedance Z = R = 1000 Ω

Option D: This option as answer if we apply a force of constant amplitude

56. Pre-envelope of $\cos(2\pi f_c t)$ is _____.

Option A: 1

Option B: $e^{j2\pi f_c t}$

Option C: $e^{-j2\pi f_c t}$

Option D: $1/2$

Ans: (B)

Sol: Pre-envelope, $x_+(t) = x(t) + j\hat{x}(t) = \cos(2\pi f_c t) + j\sin(2\pi f_c t)$

$= e^{j2\pi f_c t}$

Distractor Logic

Option A: Envelope of $\cos(2\pi f_c t)$ is 1. [If student think pre envelope and envelope are same]

So option A wrong

Option B: Correct answer

Option C: $x_+(t) = x(t) - j\hat{x}(t)$ [wrong expression]

$= \cos(2\pi f_c t) - j\sin(2\pi f_c t)$

$= e^{-j2\pi f_c t}$

So option C wrong

Option D: If student thinks

$$\text{Pre envelope} = \frac{1}{2}\text{ Envelope}$$

So option D wrong

57. A signal is given by, s(t) = 20cos(100πt) + 17cos(500πt). How many bits of quantization are required so that the signal to quantization noise ratio is greater than 50dB ?

Option A: 8

Option B: 7

Option C: 9

Option D: 10

Ans: (C)

Sol: s(t) = 20cos(100πt) + 17cos(500πt)

$$\text{Signal Power} = \frac{20^2}{2} + \frac{17^2}{2} = 344.5$$

$10\log SQNR \geq 50$ dB

$SQNR \geq 10^5$

$SQNR \geq 100000$

$$\frac{344.5}{QNP} \geq 100000$$

$$QNP \leq \frac{344.5}{100000}$$

$$QNP \leq 3.445 \times 10^{-3}$$

$$QNP = \frac{\Delta^2}{12} = \left(\frac{DR}{L}\right)^2 \times \frac{1}{12}$$

Dynamic range = $V_{max} - V_{max} = 37 - (-37) = 74$

$$\left(\frac{74}{L}\right)^2 \times \frac{1}{12} \leq 3.445 \times 10^{-3}$$

$$\frac{1}{L^2} \leq \frac{3.445 \times 10^{-3} \times 12}{74 \times 74}$$

$$\frac{1}{L^2} \leq 7.55 \times 10^{-6}$$

$L^2 \geq 132450.331$

$L \geq 363.93$

$n \geq \log_2 363.93$

$n \geq 8.51 \Rightarrow n \geq 9$

Distractor Logic

Option A: $s(t) = 20\cos(100\pi t) + 17\cos(500\pi t)$

$$\text{Signal Power} = \frac{20^2}{2} = 200 \quad [\because \text{maximum amplitude signal consider})$$

$10 \log \text{SQNR} \geq 50$

$\text{SQNR} \geq 10^5$

$$\frac{200}{\text{QNP}} \geq 100000$$

$$\frac{\text{QNP}}{200} \leq \frac{1}{100000}$$

$$\text{QNP} \leq \frac{200}{100000} \leq \frac{1}{500} \Rightarrow \frac{\Delta^2}{12} \leq \frac{1}{500}$$

$$\Rightarrow \Delta^2 = 0.024 \Rightarrow \left(\frac{\text{DR}}{\text{L}}\right)^2 \leq 0.024 \Rightarrow \left(\frac{40}{\text{L}}\right)^2 \leq 0.024 \Rightarrow \left(\frac{\text{L}}{40}\right)^2 \leq 41.67$$

$L^2 \geq 66672$

$L \geq 258.21, n = 8$

So option A wrong

Option B:

$s(t) = 20\cos(100\pi t) + 17\cos(500\pi t)$

$$\text{Signal Power} = \frac{20^2}{2} + \frac{17^2}{2} = 344.5$$

$\text{SQNR} \geq 10^5$

$$\frac{344.5}{\text{QNP}} \geq 100000$$

$\text{QNP} \leq 0.003445$

$$\frac{\Delta^2}{12} \leq 0.003445$$

$\Delta^2 \leq 0.04134$

$$\left(\frac{DR}{L}\right)^2 \le 0.04134$$

$$\left(\frac{34}{L}\right)^2 \le 0.04134 \ (\because \text{dynamic range wrong})$$

$$L^2 \ge 34^2 \times \frac{1}{0.04134}$$

$$L^2 \ge 27963.23174$$

$$L \ge 167.22$$

$$n \ge 7.38$$

So option B wrong

Option C: Correct answer

Option D: If dynamic range is 40, n = 10

So option D wrong

58. For an RL series circuit R = 5Ω and X_L = 5Ω, the applied voltage $V(t) = 2\cos 3t + 4\sqrt{2}\cos(3t + 45^o) + 12\sin 3t$ Volts. Then find the RMS value of the resultant current in the circuit.

Option A: $\frac{3}{\sqrt{5}}$A

Option B: 1A

Option C: $\sqrt{2}$ A

Option D: None

Ans: (B)

Sol: $V(t) = 2\cos 3t + 4\sqrt{2}\cos(3t + 45^o) + 12\sin 3t$

$$= 2\cos 3t + 4\sqrt{2}\left(\cos 3t\frac{1}{\sqrt{2}} - \sin 3t\frac{1}{\sqrt{2}}\right) + 12\sin 3t$$

$$= 6\cos 3t + 8\sin 3t$$

$$V_{RMS} = \sqrt{\frac{1}{2}\left(6^2 + 8^2\right)} = \sqrt{50} = 5\sqrt{2} \text{ Volts}$$

$$\left|I_{RMS}\right| = \left|\frac{V_{RMS}}{Z}\right| = \frac{5\sqrt{2}}{\sqrt{R^2 + X_L^2}} = \frac{5\sqrt{2}}{\sqrt{5^2 + 5^2}} = 1\text{Amps}$$

Distractor Logic:

Option A: $V_{RMS} = \sqrt{\frac{1}{2}\left(2^2 + (4\sqrt{2})^2 + 12^2\right)} = \sqrt{90} = 3\sqrt{10}$ Volts

$$\left|I_{RMS}\right| = \left|\frac{V_{RMS}}{Z}\right| = \frac{3\sqrt{10}}{\sqrt{50}} = \frac{3}{\sqrt{5}} \text{Amps}$$

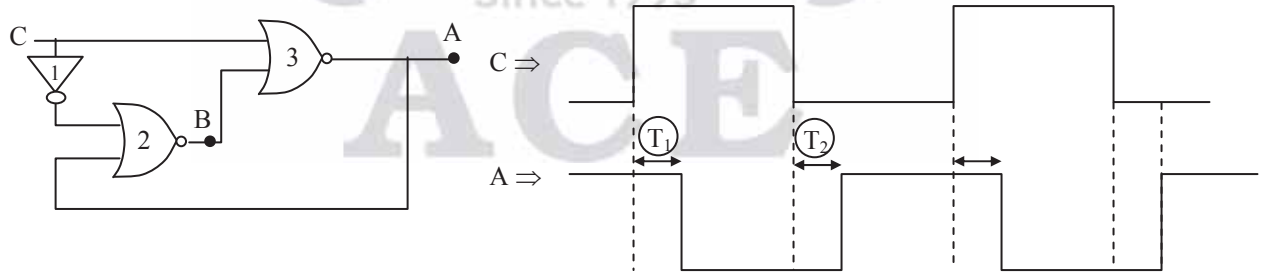
Option B: $I_{RMS} = 1A$

Option C: $V = 6\cos 3t + 8\sin 3t = 10\sin(3t + 36.86^o) = 10\angle 36.86^o$

$$I = \frac{V}{Z} = \frac{10}{\sqrt{5^2 + 5^2}} = \frac{10}{\sqrt{50}} = \sqrt{2}\text{Amps}$$

Option D: None

59. In the following circuit 'C' input is driven by a square wave with 50% Duty cycle. Each gate has a propagation delay of 1ns. Determine the values of T_1 and T_2, respectively for the output waveform is as shown below.



Option A: 3ns, 3ns

Option B: 1ns, 3ns

Option C: 1ns, 2ns

Option D: 2ns, 3ns

Ans: (B)

Sol: When C = 1, A becomes 0 after 1ns.

When C = 0, B becomes 0 after 2ns and A is 1 after 3ns

Distractor Logic

Option A: There is a possibility of adding propagation delays of all logic gates

Option B: Correct option

Option C: It is possible to take Gate-3 delay when C = 1 and propagation delays of Gate② and Gate③ when C = 0

Option D: Possible to take Gate②, ③ delays when C = 1 and Gate ①, ② and ③ delays when C = 0

60. In a 12-bit bipolar ADC, the digital output is in 2's complement form.Find the digital output for an analog input of –4V in 4 Hex digits. The input voltage range is –4V to +4V

Option A: $FFFF_H$

Option B: 8000_H

Option C: $F800_H$

Option D: $FF00_H$

Ans: (C)

Sol: For –4V, the 12-bit digital output is 1000 0000 0000 = 800_H.

Then digital output in 4 Hex digits is = $F800_H$

Distractor Logic

Option A:

It is possible to select max negative output as

1111 1111 1111 which is $FFFF_H$ in 4 Hex digits

Option B:

Max negative value using 12-bits is 1000 0000 0000_2.

i.e., 800_H. In 4 Hex digits it may be mistaken as 8000_H

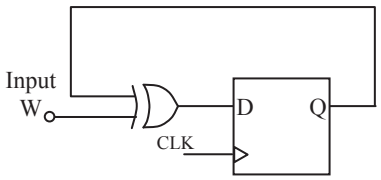
Option C:

Correct option

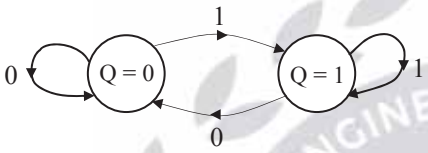
Option D:

Mistakenly it is taken as $F00_H$, which is in 4 Hex digits as $FF00_H$

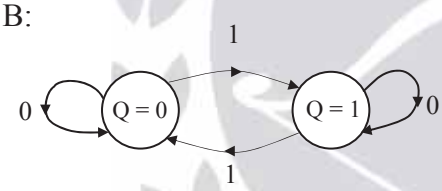
61. The state diagram for the sequential circuit shown below is



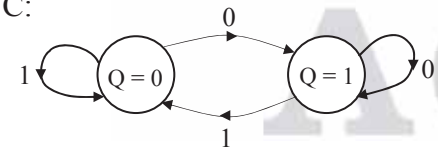
Option A:



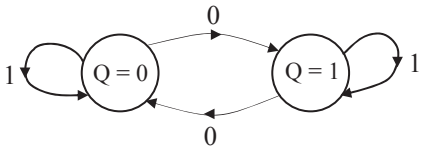
Option B:



Option C:



Option D:



Ans: (B)

Sol:

$Q(t+1) = D$ and output $P = Q(t)$

Where $D = Q \oplus W$

i.e., $Q(t+1) = Q(t) \oplus W$

If $W = 0 \Rightarrow Q(t+1) = Q(t)$

If $W = 1 \Rightarrow Q(t+1) = \overline{Q(t)}$

Distractor Logic

Option A:

The output branches from each state are not assessed properly

Option B:

Correct option

Option C:

The output branches are not assessed properly

Option D:

The output branches from each state are not assessed properly

62. In the circuit shown in figure , a silicon transistor with $V_{BE} = 0.7V$, $\beta = 100$ is used. Then find the collector current I_C.

(A) 9.2 mA (B) 2.1 mA (C) 1.86 mA (D) 0

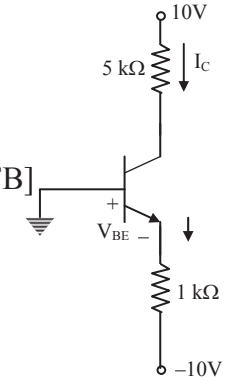
Ans: (B)

Step (1): KVL for BE loop of BJT

$0 - 0.7V - I_E\ 1K + 10V = 0$ …….. (1)

$\Rightarrow I_E = \dfrac{9.3V}{1K} = 9.3mA$ …….. (2) [i.e J_E is FB]

$\Rightarrow I_C = \left(\dfrac{\beta}{1+\beta}\right) I_E = 9.2mA$ ….. (3)



Step (2): KVL for C-loop

$10V - I_C \times 5K - V_C = 0$ …… (4)

$V_C = 10V - 9.2mA \times 5K = -36V$ ……. (5)

$\Rightarrow V_{CB} = V_C - V_B = -36V - 0 = -36V$ …… (6)

NOTE: $\because V_{CB}$ is –Ve, collector junctions is F.B

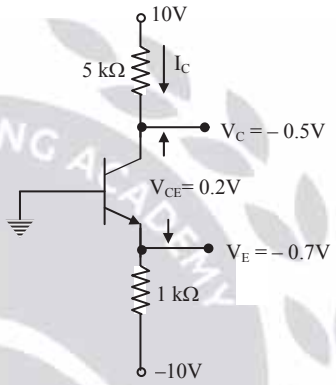
$\therefore$ BJT is operated in saturation region

Step (3): $\because$ BJT is in saturation, $V_{CE_{sat}} = 0.2V$

$\Rightarrow V_C = V_{CE_{sat}} + V_E = -0.5V$ ……. (1)

KVL for collector –loop:

$$I_C = \frac{10V - (-0.5V)}{5K} = 2.1mA \text{ …. (2)}$$



Distractor Logic

Option: A

If the device(BJT) is in forward active region, KVL for BE loop of BJT

$0 - 0.7V - I_E\ 1K + 10V = 0$

$$I_E = \frac{9.3V}{1K} = 9.3mA$$

$$\therefore I_c = \left(\frac{\beta}{1+\beta}\right) I_E = \frac{100}{101} \times 9.3mA$$

$I_c = 9.2mA$

Option: B

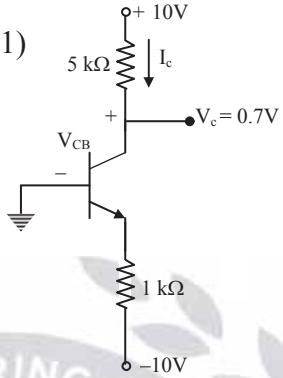
$I_c = 2.1mA$ …… (1) ($\because$ Device is actually biased in saturation region)

Option: C

If the device is in inverse (or reverse) active region,

(i.e) E-B junction is R.B & C.B junction is F.B

Assuming $V_{CB} = 0.7V \Rightarrow V_c = 0.7V$ …… (1)



[$\because V_{CB} = V_C - V_B = V_C$]

KVL for collector loop of BJT

$10V - I_c\,5K - 0.7V = 0$ …… (1)

$I_c = \frac{9.3V}{5K} = 1.86mA$ …… (2)

Option: D

If the device is in cutoff region

$I_B = 0 \Rightarrow I_C = 0$ …… (1)

63. A bag contains (n + 1) coins. It is known that one of these coins shows heads on both sides where as the other coins are fair. One coin is selected at random and tossed. If the probability that the toss results in heads is $\frac{7}{12}$, then the value of 'n' is _____.

(A) 4 (B) 5 (C) 6 (D) 7

63. Ans: (B)

Sol: Let A = Event of selecting two headed coin

B = Event of selecting a fair coin

E = Event of coming head on selected coin

Given that $P(A)\,P(E/A) + P(B)\,.\,P(E/B) = \frac{7}{12}$

i.e., $\frac{1}{(n+1)}.1 + \frac{n}{(n+1)}.\frac{1}{2} = \frac{7}{12}$

$12 + 6n = 7n + 7$

$\therefore n = 5$

64. The characteristic equation of a feedback control system is given by $s^2 + s(k-1) + k = 0$. Where $k > 0$.The break points on RLD are

Option A: –0.414, 2.414

Option B: 0.414, 2.414

Option C: 0.414, –2.414

Option D: –0.414, –2.414

Ans: (C)

Sol: Break point $\Rightarrow \frac{dk}{ds} = 0$

Given, CE: $s^2 + sk - s + k = 0$

CE $\rightarrow (s^2 - s) + k(s+1) = 0$

$$k = -\frac{(s^2 - s)}{(s+1)}$$

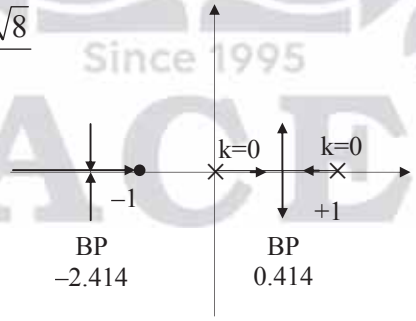
$$\frac{dk}{ds} = -\left[\frac{(2s-1)(s+1) - (s^2 - s)}{(s+1)^2}\right] = 0$$

$\Rightarrow 2s^2 - s + 2s - 1 - s^2 + s = 0$

$\Rightarrow s^2 + 2s - 1 = 0$

$$s = \frac{-2 \pm \sqrt{4 - 4(1)(-1)}}{2} = \frac{-2 \pm \sqrt{8}}{2}$$

s = 0.414 and –2.414



$$\Rightarrow G(s)H(s) = \frac{k(s+1)}{s(s-1)} \Rightarrow$$

Distractor Logic

Option A: Given points are not on RLD.

Option B: One BP is valid and another is invalid.

Option C: Correct Option.

Option D: One BP is valid and another is invalid.

65. The state model of the system is given as

$$\dot{X}=\begin{bmatrix}0 & 1\\ -2 & -9\end{bmatrix}X+\begin{bmatrix}0\\ 1\end{bmatrix}U \ \& \ y=[1 \quad 0]x$$

Then find the poles of the system.

Option A: s = –0.22, –8.77

Option B: s = 0.216, –9.216

Option C: s = 0.22, 8.77

Option D: s = –0.216, 9.21

Ans: (A)

Sol: From the magnitude equation

$$[sI-A]=\begin{bmatrix}s & -1\\ 2 & s+9\end{bmatrix}$$

$$\text{Adj}[sI-A]=\begin{bmatrix}s+9 & 1\\ -2 & s\end{bmatrix}$$

$$TF=\frac{C\,\text{Adj}[sI-A]B}{|sI-A|}+\cancel{D}^{0}$$

$$TF=\frac{[1 \quad 0]\begin{bmatrix}s+9 & 1\\ -2 & s\end{bmatrix}\begin{bmatrix}0\\ 1\end{bmatrix}}{s(s+9)+2}=\frac{[1 \quad 0]\begin{bmatrix}1\\ s\end{bmatrix}}{s^2+9s+2}=\frac{1}{s^2+9s+2}$$

CE $s^2+9s+2=0$

s = –0.22, –5.77

Distractor Logic

Option A: Correct option

Option B: This option is constructed with wrong calculation of determinant as $|sI-A|=s^2+9s-2=0$

Option C: While calculating determinant, the subtraction of last row and column element is wrong, then the equation is $|sI-A|=s^2-9s+2=0$

Option D: This option is constructed with wrong calculation of determinant as $|sI-A|=s^2-9s-2=0$