Question 1 to 5 Carry One Mark Each

1. Which of the following option is the opposite in meaning to the word below

Sweltering

(a) Cosy (b) Smelly (c) Clammy (d) Freezing

2. It is only by cutivating spirit of renunciation, self sacrifice, contentment and sincere work that can really be happy. The stings of misfortune spare none but they will not Cow such a person which of the following is similar in meaning as the word "Cow" or used in the passage?

(a) Spare (b) Conquer (c) Discard (d) Mould

3. $\frac{1}{\sqrt[3]{25}-\sqrt[3]{5}+1} = A\sqrt[3]{25} + B\sqrt[3]{5} + C$ then A + B + C ?

(a) 0 (b) $\frac{1}{3}$ (c) $\frac{2}{3}$ (d) 1

4. If x = 12 then value of $x^6 - 13x^5 + 13x^4 - 13x^3 + 15x^2 - 13x + 5$?

(a) 12 (b) 17 (c) 281 (d) 182

5. $\left(1-\frac{1}{2^2}\right)\left(1-\frac{1}{3^2}\right)\left(1-\frac{1}{4^2}\right)....\left(1-\frac{1}{85^2}\right)$ equal to :

(a) $\frac{85}{43}$ (b) $\frac{43}{85}$ (c) $\frac{84}{85}$ (d) $\frac{86}{85}$

Question 6 to 10 Carry Two Marks Each

6. Government have traditionally equated economic progress with steel mills and cement factories. While urban centers thrive and city dwellers get rich, hundreds of millions of farmers remain mired in poverty. Another green revolution is the need of the hour and to make if a reality, the global community still has much back breaking farm work to do.

What is the author's main objective in writing the passage

(a) Criticising developed countries for not bolstering economic growth in poor nations

(b) Analysing the disadvantages of the Green Revolution

(c) Persuading experts that a strong economy depends on industrialisation and not agriculture

(d) Making a case for the international society to engineer a second Gereen Revolution

7. In a report, Goldman sachs predicted that if this year too receives weak rains, it could cause agriculture to contract by 2% this fiscal year, making the government's 7% GDP-growth target look "a bit rich".

What is the author trying to canvey through the phrase "making the government's 7% GDP growth target look "a bit such" ?

(a) Indian is unlikely to achieve the targeted growth rate

(b) Allocation of funds to agriculture has raised India's chances of having a high GDP

(c) Agricultural growth has artificially inflated India's GDPand such growth is not real

(d) India is likely to have one of the highest GDP growth rates

8. In an election there are 2 candidates 10% voters did not cast their vote. 300 votes declared invalid and the winner get 60% of the voting list and win by 900 votes then find total number of valid votes :

(a) 2000 (b) 1800 (c) 1500 (d) 1600

9. A, B, C and D purchase a flat in 56 lakhs. The share of B + C + D is 460% of A, the share of A + C + D is $366\frac{2}{3}\%$ of B and C's share is 40% of A + B + D, then find the share of D :

(a) 10 Lakh (b) 12 Lakh (c) 18 Lakh (d) 16 Lakh

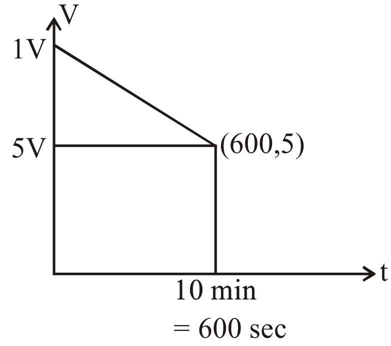
10. The average of 30 students of a class is 14 years 4 months due to admission of 5 new students the average becomes 13 years 9 months, while the age of the younger one in new 5 students is 9 years 11 months. Find the average age of remaining four new students :

(a) 10 years 3 months (b) 10 years 4 months

(c) 10 years 6 months (d) 10 years

Question 1 to 25 Carry One Mark Each

1. The voltage-time characteristics of a voltage source is given below. It is supplies constant current of 2Amp. then



The total energy delivered by the source is

(a) 3 kJ (b) 6 kJ (c) 9 kJ (d) 12 kJ

2. The message signal m(t) whose spectrum is shown in fig. (b) is passed through the system in fig. (a)

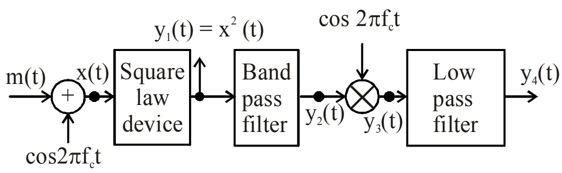


Fig. (a)

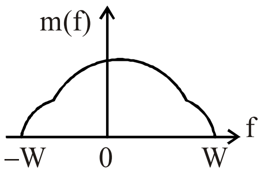
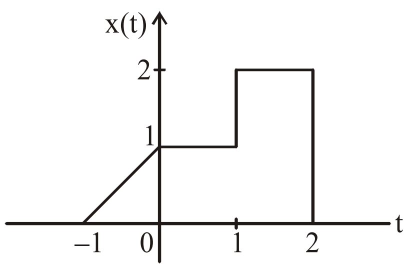


Fig. (b)

The bandpass filter has a bandwidth of 2W centered at f_c and the LPF has a bandwidth of W. The bandwidth of the output signal $y_4(t)$ is

(a) 2W (b) 3W (c) 4W (d) W

3. Signal x(t) shown below can be represented as



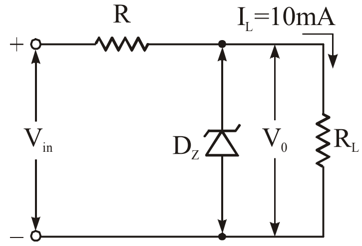
(a) $r(t + 1) - r(t) + u(t - 1) - 2u(t - 2)$ (b) $r(t) - r(t - 1) + u(t - 1) - 2u(t - 2)$

(c) $r(t - 2) - r(t) + u(t + 2) - 2u(t - 2)$ (d) None of these

4. The continuous random variable X is uniformly distributed with mean 1 and variance 3. Then $P(X < 0)$ is

(a) 0.5 (b) $\frac{1}{3}$ (c) $\frac{2}{3}$ (d) $\frac{4}{5}$

5. A zener diode regulator shown in the figure given below is to be designed to meet the following specifications:



I_L = 10 mA, V_0 = 10 V, V_{in} varies from 30V to 50V. The zener diode has V_z = 10V and I_{zk} (knee current) = 1 mA. For satisfactory operation, which one of the following is correct?

(a) $R \leq 1800\ \Omega$ (b) $2000\Omega \leq R \leq 2200\ \Omega$

(c) $3700\Omega \leq R \leq 4000\ \Omega$ (d) $R > 4000\ \Omega$

6. A feedback control system has an open loop transfer function of

$$G(s)H(s) = \frac{ke^{-s}}{s(s^2+2s+1)}$$

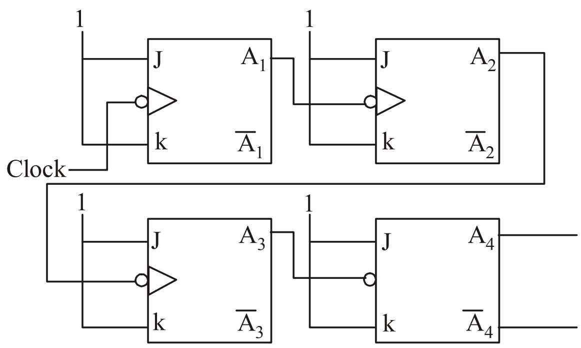
The maximum range of k for the closed loop stability is

(a) $0 < k < \frac{2}{3}$ (b) $\frac{2}{3} < k < 1$ (c) $0 < k < 1$ (d) $\frac{2}{3} < k$

7. In which of the following option the value of stack pointer will not be decremented.

(a) Call 2050 H (b) RST 7 (c) PUSH B (d) POP B

8. Consider a 4 bit ripple counter :



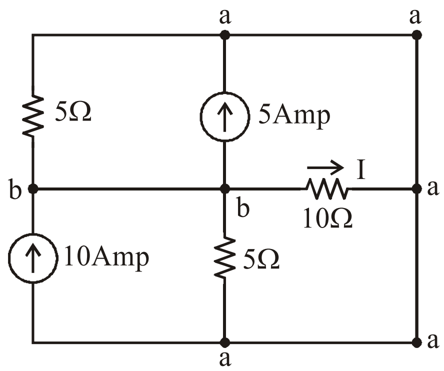
The above counter starts with 0000 state and then clock pulses are applied. After some time the counter reads 0100. This implies number of clock pulse needed as

(a) 4 (b) 20 (c) 36 (d) All of the these

9. If ω_0 is low, the autocorrelation of function $Y(t) = \cos(\omega_0 t)\,\Pi[t/T]$ approximately is, where ^ represent triangle and $\Pi \rightarrow$ rectangle.

(a) $\frac{1}{2}T\wedge\left[\frac{\tau}{T}\right]\cos(\omega_0\tau)$ (b) $T\wedge\left[\frac{t}{2T}\right]\cos(\omega_0\tau)$ (c) $\cos(\omega_0\tau)$ (d) None of these

10. Consider the circuit shown in below figure the value of current I is



(a) 1 Amp (b) –1 Amp (c) 2 Amp (d) –2 Amp

11. An AM Transmitter Radiates 9 kW with the carrier unmodulated and 10.125 kW when the carrier is sinusoidally modulated. Calculate the net modulation index if another sine wave corresponding to 40% modulation is transmitted simultaneously.

12. Consider the following statements:

1. Indirect addressing is not possible for I/O mapped I/O port addresses

2. Pointers cannot be used to access memory mapped I/O addresses

3. Fewer machine instructions can be used with I/O mapped I/O addressing as compared to memory mapped I/O addressing

4. With an 8085 microprocessor, one can access at the most 512 devices with unique addresses using I/O mapped I/O addressing

Which of these statements are correct?

(a) 1, 2 and 3 (b) 2 and 4 (c) 3 and 4 (d) 1 and 3

13.

```
1000 H  LXI  H, 6A79 H
        MOV  A, B
        LDA  2000 H
        XRA  B
        ANI  00 H
        DAA
        DAD  H
        PCHL
```

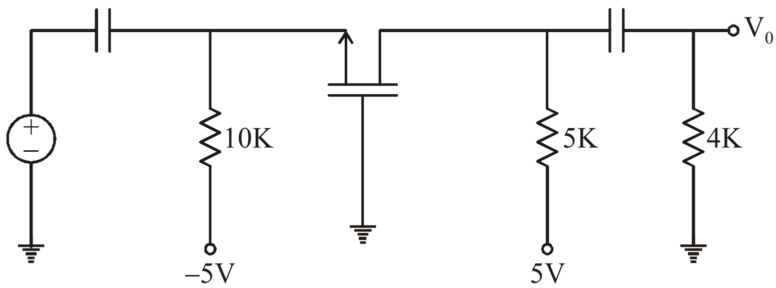
After programme execution value of PC.

(a) 1014 H (b) 100E H (c) 6A79 H (d) D4F2 H

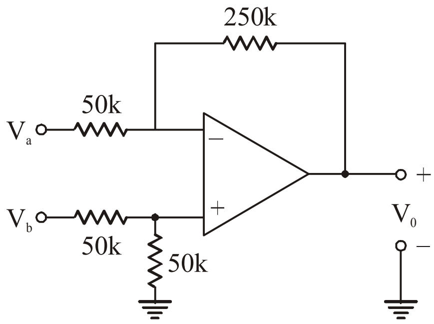
14. Mean value 'c' of Rolle's mean value theorem for f(x) = tanx in the internal [0, π] is

(a) 0 (b) $\frac{\pi}{4}$ (c) $\frac{\pi}{2}$ (d) none

15. Consider the NMOS common gate circuit. The parameter g_m = 2mS & $r_o = \infty$. The voltage gain A_V is

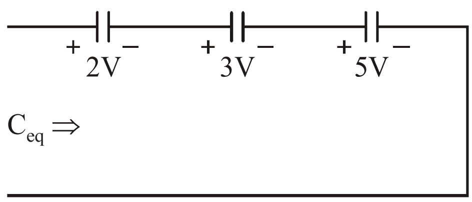


16. What is the output voltage V_0 of the given circuit?



(a) $-5V_a + 2.5V_b$ (b) $-5V_a + 3V_b$ (c) $-2.5V_a + 2.5V_b$ (d) $-2.5V_a + 3V_b$

17. For the circuit shown, what is the equivalent capacitance when each capacitor is having 1 Columb of charge?



(a) 10F (b) 0.1F (c) 1F (d) None

18. A delta modulator is designed to operate on speech signals limited to 2.8 kHz. The sampling rate is 10 times the nyquist rate. Step size is 120 mV. The modulator is tested with a sinusoidal signal of 1.2 kHz. The maximum amplitude of the test signal to avoid slope overload distortion is

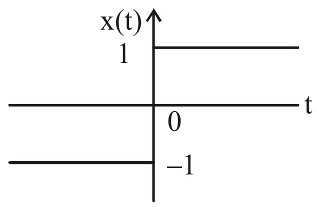
19. The value of integral is $\int_{-\infty}^{\infty} \delta(at-b)\ell n(t+2)$

(a) $\frac{1}{a}\ell n\left(\frac{b}{a}+2\right)$ (b) $\frac{1}{b}\left[\ell n\left(\frac{b}{a}+2\right)\right]$ (c) $\frac{1}{b}\ell n(b+2)$ (d) $\frac{1}{a}\ell n(b+2)$

20. The volume of the solid of revolution generated by revolving the region bounded by y = $\sqrt{x}$ and y = 0 from x = 0 to x = 4 about x-axis is

(a) 2π (b) 4π (c) 8π (d) 16π

21. First derivative of the signal x(t) will be

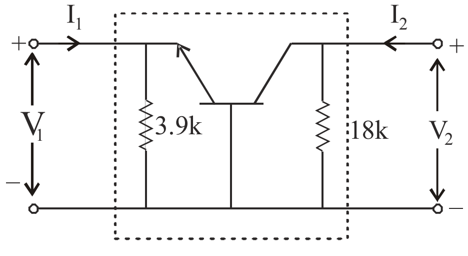


(a) $\delta(t)$ (b) $2\delta(t)$ (c) $u'(t) - 1$ (d) None of these

22. $\int_0^{\infty} t^{1/2}e^{-kt}dt$ =

(a) $\frac{k\sqrt{\pi}}{2}$ (b) $\frac{k^{\frac{1}{2}}\sqrt{\pi}}{3}$ (c) $\frac{1}{2}\sqrt{\pi}k^{\frac{-3}{2}}$ (d) $\frac{1}{2}\sqrt{\pi}\,k^{\frac{-1}{2}}$

23. The common base amplifier is drawn as a two port in figure. The parameter are β = 100, g_m = 3mS, r_0= 800 kΩ. The h parameter h_{21} is



24. State equation of a control system is given by

$$\dot{x} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

The state transition matrix is.

(a) $\begin{bmatrix} 2e^{-t}+e^{-2t} & e^{-t}+e^{-2t} \\ -2e^{-t}+2e^{-2t} & e^{-t}+2e^{-2t} \end{bmatrix}$

(b) $\begin{bmatrix} 2e^{-t}-e^{-2t} & e^{-t}-e^{-2t} \\ -2e^{-t}+2e^{-2t} & -e^{-t}+2e^{-2t} \end{bmatrix}$

(c) $\begin{bmatrix} 2e^{-t}-e^{-2t} & e^{-t}-e^{-2t} \\ -2e^{-t}+2e^{-2t} & 2e^{-t}+e^{-2t} \end{bmatrix}$

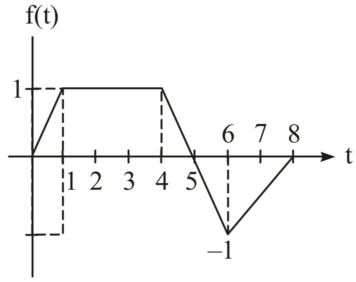
(d) $\begin{bmatrix} e^{-t}-2e^{-2t} & e^{-t}-e^{-2t} \\ e^{-t}+2e^{-2t} & 2e^{-t}+e^{-2t} \end{bmatrix}$

25. $f(z) = u + iv$; $(u,v) \in R$ is analytic function If $u(x, y) = 2x + y^3 - 3x^2y$ and c is arbitary constant then f(z) is

(a) $z+\frac{i}{z}+c$ (b) $3z^2 + c$ (c) $2z + iz^3 + c$ (d) $z^2 + iz + c$

Question 26 to 55 Carry One Mark Each

26. The Laplace transform of the waveform shown in the figure is

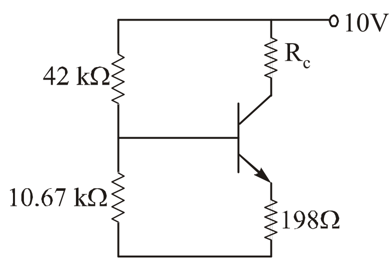


$$\frac{1}{s^2}\left(1 + Ae^{-s} + Be^{-4s} + Ce^{-6s} + De^{-8s}\right)$$

What is the value of D?

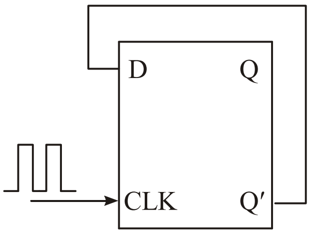
(a) –0.5 (b) –1.5 (c) 0.5 (d) 2.0

27. Consider a transistor circuit the value of $\frac{\partial I_C}{\partial V_{BE}}$ is



(a) –1.5 mA/V (b) –3.5 mA/V (c) –4.0 mA/V (d) –4.5 mA/V

28. The frequency of the clock signal applied to the rising edge triggered D flip-flop shown in the below figure is 10 kHz.



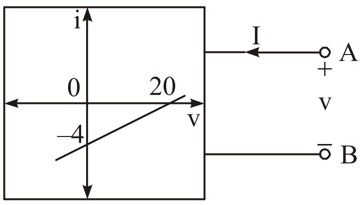
The frequency (in kHz) of the signal available at Q is ______

29. Consider an abrupt silicon P-N junction at a temperature 300K. The ratio of junction capacitance at zero bias $c_j(0)$ and the junction capacitance with 10V reverse bias voltage $C_j(10)$ is

$$\frac{C_j(0)}{C_j(10)} = 3.13$$

Also under reverse bi as, the space charge width into the p-region is 0.2% of the total space charge width. The junction voltage V_j in ______ V

30. The resistance seen from the terminals A and B of the device whose characteristic is shown in the figure below is



______ Ω.

31. What is the PSD of signal y(t) = x(t) – x(t – T), where S_X (f) represent PSD of x(t).

(a) $2S_x(f)[1 - \cos(2\pi fT)]$
(b) $S_x(f)[1 - \cos(2\pi fT)]$
(c) $S_x(f)[1 - \cos(4\pi fT)]$
(d) $2S_x(f)[1 - \cos(4\pi fT)]$

32. Given that continuous time filter transfer function $H(s) = \frac{2s+6}{s^2+6s+8}$ is converted to discrete time filter with transfer function $G(z) = \frac{2z^2-0.5032z}{z^2-0.5032z+.05}$ both filters are same at sampling frequency of f_s is ______ Hz

33. If f(z) = u + iv is an analytic function and
$u + v = (x + y)(2 - 4xy + x^2 + y^2)$, then f(z) is

(a) $z^2 + 2z + k$ (b) $\frac{1}{z} + iz^2 + k$ (c) $2z + iz^3 + k$ (d) $i\left(z^2 + \frac{1}{z^2}\right) + k$

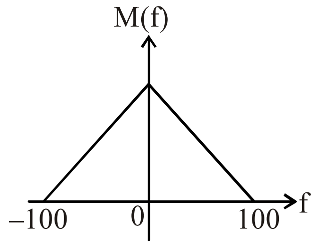
34. The magnetic field intensity of a linearly polarized uniform plane wave propagating in the + y direction in sea water ($\varepsilon_r = 80$, $\mu_r = 1$, $\sigma = 4$) is $H = 0.1 \sin(10^6\pi t - \beta y)\,\hat{a}_x$ A/m at y = 0 (surface of sea water). The distance of the wave travels, before its field strength decreases by 63%, is

(a) 35 cm (b) 25.3 cm (c) 30.7 cm (d) 20 cm

35. A fresnel biprism is placed at 0.06 m from slit illuminated by sodium light of wavelength 4860Å. The width at the fringes obtained on a sreen 0.80 m from the biprism is 0.864 mm. The distance between the coherent sources is

(a) 0.48 mm (b) 0.86 mm (c) 0.91 mm (d) 1.26 mm

36. A DSBSC signal $x(t) = m(t)\cos(2\pi 10^6 t)$ where M(f) is shown in the figure is passed through channel. The output of the channel is observed as
$y(t) = 3\, m(t - 10^{-3}) \sin[2\pi 10^6 t - (\pi/5)]$.
The phase delay and group delay of the channel are respectively



(a) $\tau_p = 1$ ms, $\tau_g = 0.2$ μs (b) $\tau_p = 0.2$ μs, $\tau_g = 2$ ms
(c) $\tau_p = 0.1$ μs, $\tau_g = 1$ ms (d) $\tau_p = 0.1$ μs, $\tau_g = 3$ ms

37. The half range sine series of $f(x) = x(\pi - x)$ in $(0, \pi)$ is ....

(a) $\sum_{n=1}^{\infty} \frac{4}{\pi n^3}\left[1 + (-1)^n\right]\sin nx$ (b) $\sum_{n=1}^{\infty} \frac{4}{\pi n^3}\left[1 - (-1)^n\right]\sin nx$

(c) $\sum_{n=1}^{\infty} \frac{2}{\pi n^3}\left[1 + (-1)^n\right]\sin nx$ (d) $\sum_{n=1}^{\infty} \frac{2}{\pi n^3}\left[1 + (-1)^n\right]\sin nx$

38. Solution of the integration $\int_0^{\infty} \frac{x^2 + 2}{(x^2 + 1)(x^2 + 4)} dx$ is ☐

39. $y' = x(y - x)$, y(2) = 3 then using the Runge - Kutta method of 4th order with step size 0.2. Then y(2.2) is ☐

40. A random variable is known to have a cumulative distribution function

$$F_x(x) = u(x)\left[1 - \frac{x^2}{b}\right]$$

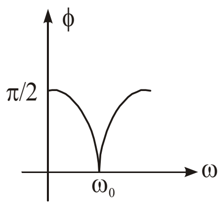
It density function is

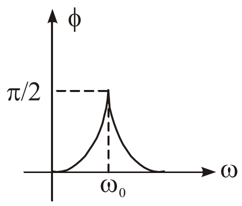
(a) $u(x)\frac{2x}{b}\left(1 - e^{-x^2/b}\right)$ (b) $u(x)\frac{2x}{b}e^{-x^2/b}$

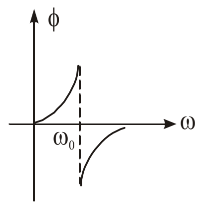
(c) $u(x)\left(1 - \frac{x^2}{b}\right)\delta(x)$ (d) $\left(1 - \frac{x^2}{b}\right)\delta(x) + e^{-x^2/b}$

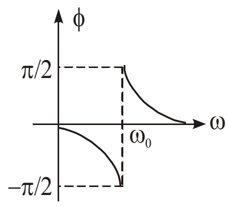
41. What one of the following represents the phase response of the function:

$$H(s) = \frac{s^2 + \omega_0^2}{s^2 + (\omega_0 / Q)s + \omega_0^2}?$$

(a)


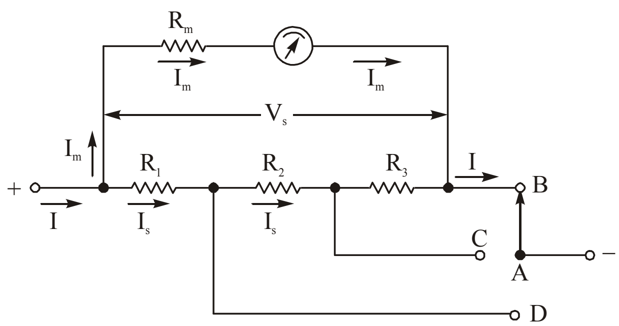
(b)


(c)


(d)


42. A PMMC instrument has a three-resistor Avrton shunt connected across it to make an ammeter. The resistance values are $R_1 = 0.05\ \Omega$, $R_2 = 0.45\ \Omega$, and $R_3 = 4.5\ \Omega$. The meter has $R_m = 1\ k\Omega$ and FSD = 50 μA.

Calculate the three ranges of the ammeter.

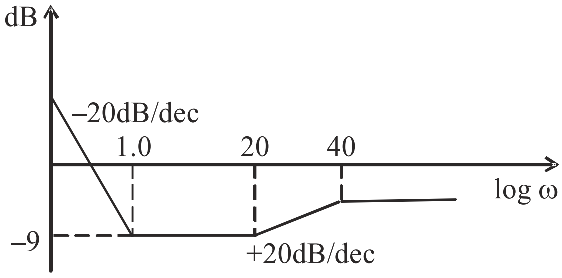


(a) 12.05 mA, 100.05 mA , 1.00005 mA (b) 10.05 mA, 110.05 mA , 1.00005 mA

(c) 10.05 mA, 100.05 mA , 1.00005 mA (d) 10.05 mA, 100.05 mA , 2.00005 mA

43. A dice is thrown twice and the sum of numbers appearing is noted to be 8. Then the probability that number 5 has appeared at least one is [ ]

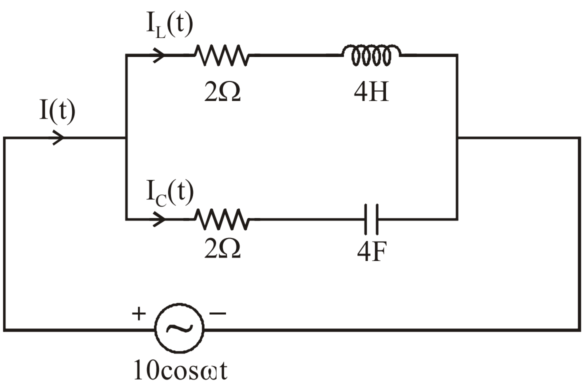
44. The transfer function of the system whose asymptotic approximation is given in figure below, is



(a) $\frac{0.35(1+0.025s)}{(1+s)(1+0.05s)}$ (b) $\frac{0.35(1+s)(1+0.05s)}{s(1+0.025s)}$

(c) $\frac{0.70(1+0.05s)}{(1+s)(1+0.05s)}$ (d) $\frac{0.70(1+s)(1+0.5s)}{(s+1)^2}$

45. Determine the average power dissipated in figure given below



(a) 10 W (b) 15 W (c) 40 W (d) 25 W

46. A p-n junction diode with doping concentration of $N_D = 1\times10^{16}/cm^3$ on n-side. When a forward bias of 0.65 V is applied, then current will flow across the junction due to diffusion & drift, deep inside n-region current flow only due to drifting of electron. The value of electric field inside n-region that maintain the drifting of electron is. (Assume intrinsic carrier concentration)

$D_n = 25\ cm^2/s$ and $D_P = 10cm^2/sec$, $\mu_n = 1350\ cm^2/V\text{-}sec$, $\varepsilon_{si} = 11.7\ \varepsilon_0$, $\varepsilon_0 = 8.854\times10^{-12}$ F/m, reverse saturation current density $J_s = 4.15\times10^{-11}\ A/cm^2$.

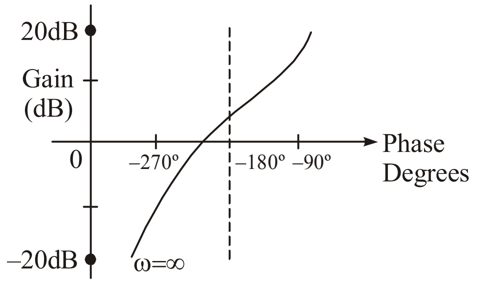
[ ] V/cm

47. If a vector $\vec{r}$ is defined as $\vec{r} = x\hat{a}_x + y\hat{a}_y + z\hat{a}_z$. The divergence of vector $\vec{A} = |\vec{r}|^n \vec{r}$ is

(a) $(n + 1)r^{n-1}$ (b) $3nr^{n-1}$ (c) $(n + 3)r^n$ (d) $(3n + 1)r^n$

48. The gain-phase plot of a linear control system is shown in the below figure.

What are the gain-margin (GM) and the phase-margin (PM) of the system?



(a) GM > 0 dB and PM > 0 degree (b) GM > 0 dB and PM < 0 degree

(c) GM < 0 dB and PM > 0 degree (d) GM < 0 dB and PM < 0 degree

49. A LTI continuous - time system has the frequency response H(ω). It is known that the input, x(t) = 1 + 4 cos (3πt) + 8 sin (5πt – 90°) produces the response.

y(t) = 2 – 2 sin (3πt). Then H(ω) at ω = 5π is

(a) 2 (b) 0 (c) $0.5\ e^{j\pi/2}$ (d) 8

50. Consider a MOS structure with the following specifications: circular cross section of diameter 0.5mm, SiO_2 layer of thickness 80 nanometers, permittivity of SiO_2 is 4 and $\varepsilon_0 = 8.854 * 10^{-14}$ F/cm.

If the dielectric strength of SiO_2 film is 10^7 V/cm, the breakdown voltage of the MOS capacitor is

[ ] Volts.

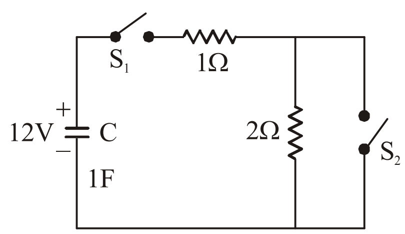
51. A random variable X has probability density function f(x) as given as

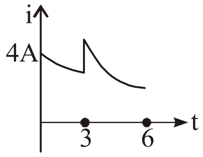
$$f(x) = \begin{cases} a + bx + cx^2 & 0 < x < 1 \\ 0 & \text{otherwise} \end{cases}$$

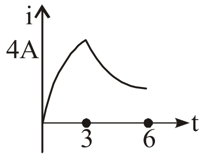
If the expected value $E(X) = \frac{1}{2}$ and $E(X^2) = \frac{2}{3}$ P(X < 0.5) is

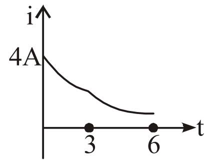
[ ]

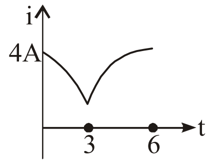
52. The capacitor in the circuit as shown below is initially charged to 12V with S_1 and S_2 open S_1 is closed at t = 0 while S_2 is closed at t = 3 sec. The waveform of the capacitor is represented by



(a) 

(b) 

(c) 

(d) 

53. u = x – y + z, v = x + y – z and w = $x^2 + xz - xy$ then Jacobian of (u, v, w) with respect to (x, y, z) is [ ]

54. A (x, y, z) = $\sum(1, 2, 4, 6)$
B(x, y, z) = $\sum(0, 1, 6, 7)$
C(x, y, z) = $\sum(2, 6)$
D(x, y, z) = $\sum(0, 1, 2, 3, 5, 7)$
The boolean function is implemented using ROM. The memory contents at address 4 of the ROM is
(a) 1000 (b) 0001 (c) 0111 (c) 1110

55. A unity feedback control system whose open-loop transfer function is $G(s) = \frac{25}{s(s+6)}$. The rise time and settling time for tolerance 2% respectively
(a) 0.55 sec, 1.33 sec (b) 1 sec, 1.33 sec (c) 0.55 sec, 2.66 sec (d) 1 sec, 2.66 sec

❑❑❑

ANSWERS KEY

1. *Ans. (d)*

2. *Ans. (d)*

3. *Ans. (b)*

$$\frac{1(5^{1/3}+1)}{[(5^{1/3})^2 - 5^{1/3}\times 1 + 1^2]\times(5^{1/3}+1)}$$

$\therefore$ $a^3 + b^3 = (a + b)(a^2 - ab + b^2)$

$$\frac{\sqrt[3]{5}+1}{(5^{1/3})^3+1^3} = \frac{\sqrt[3]{5}+1}{6}$$

$$A = 0$$

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

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

$$A + B + C = \frac{1}{3}$$

4. *Ans. ()*

$x^6 - 12x^5 - x^5 + 12x^4 - x^4 - 12x^3 - x^3 + 12x^2 + 2x^2 - 12x + x^2$

$= 12^6 - 12^6 - 12^5 + 12^5 - 12^4 - 12^4 - 12^3 + 12^3 + 12^2 - 12^2 + 2x^2 + 5 - x$

$= 2(12)^2 + 5 - 12$

$= 281$

5. *Ans. (b)*

$$\left(\frac{2^2-1}{2^2}\right)\left(\frac{3^2-1}{3^2}\right)....\left(\frac{85^2-1}{85^2}\right) = \frac{1\times 3}{2\times 2}\times\frac{2\times 4}{3\times 3}\times\frac{4\times 6}{4\times 4}....\frac{84\times 86}{85\times 85}$$

$$= \frac{1}{2}\times\frac{86}{85} = \frac{43}{85}$$

6. *Ans. (d)*

7. *Ans. (a)*

8. ***Ans. (c)***

$$\text{Voting list} = 100x$$
$$\text{Voting} = 90x$$
$$\text{Valid} = (90x - 300)$$
$$W = 60x$$
$$L = 30x - 300$$
$$\text{Winner} - \text{Loser} = 900$$
$$60x - (30x - 300) = 900$$
$$x = 20$$
$$\text{Valid votes} = 1500$$

9. ***Ans. (c)***

$$460\% = \frac{23}{5} \quad 366\frac{2}{3}\% = \frac{11}{3}$$

56

B + C + D	:	A
23		5
28	→	56
1	→	2
A		= 10 Lakh

56

A + C + D	:	B
11		3
14	→	56
1	→	4
B		= 12 Lakh

$$40\% = \frac{2}{5}$$

56

A + B + D	:	C
5		2
7	→	56
1	→	8
C		= 16 Lakh
D		= 18 Lakh

10. ***Ans. (b)***

$$\text{Total age of 35 students} = 35\ (13 \times 12 + 9)$$
$$= 5775 \text{ months}$$
$$\text{Total age of 30 students} = 30\ (14 \times 12 + 4)$$
$$= 5160 \text{ months}$$
$$\text{Age of younger student} = 108 + 11 = 119$$

Average age of remaining 4 is

$$5775 - 5279 = \frac{496}{4}$$

$$= 10 \text{ years } 4 \text{ months}$$

Answer 1 to 25 Carry One Mark Each

1. Ans. ***(c)***

$$I = 2 \text{ Amp}$$

$$Y = mX + C$$

$$V = -\frac{t}{120} + 10$$

$$W = \int_0^{600} V.\, I dt$$

$$W = \int_0^{600} \left(\frac{-t}{120} + 10\right) \cdot 2dt = \int_0^{600} \left[\frac{-t}{60} + 20\right] dt = \left[-\frac{t^2}{120} + 20t\right]_0^{600}$$

$$= \left[\frac{-(600)^2}{120} + 20 \times 600\right] = 9000\text{J or } 9\text{kJ}$$

2. ***Ans. (d)***

$$x(t) = m(t) + \cos 2\pi f_c t$$

$$y_1(t) = x^2(t) = (m(t) + \cos 2\pi f_c t)^2$$

$$= [m^2(t) + 2\, m(t) \cos 2\pi f_c t + \cos^2 2\pi f_c t]$$

$$y_2(t) = 2m(t) \cos 2\pi f_c t$$

$$y_3(t) = [2\, m(t) \cos (2\pi f_c t)] (\cos 2\pi f_c t)$$

$$= m(t)\, [1 + \cos 4\pi f_c t]$$

$$y_4(t) = m(t)$$

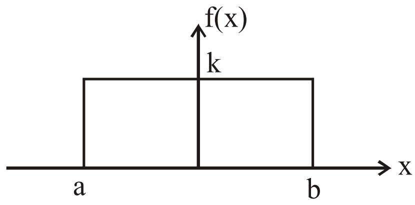
$$\Rightarrow \quad Y_4(f) = M(f)$$

Thus BW of $y_4(t)$ will be same as m(t) i.e. W.

3. ***Ans. (a)***

4. ***Ans. (b)***

According to question, PDF of Random is variable



$$f(x) = \begin{cases} k \; ; a \le x \le b \\ 0 \; ; \text{otherwise} \end{cases}$$

Also, $\frac{a+b}{2} = 1$ and $\frac{(b-a)^2}{12} = 3$

$\Rightarrow$ $a + b = 2$ …(1)

& $b - a = 6$ …(2)

Hence $b = 4, \quad a = -2$

$\because$ $\int_{-\infty}^{\infty} f(x)dx = 1$

$\Rightarrow$ $\int_{a}^{b} kdx = 1$

$\Rightarrow$ $k = \frac{1}{b-a} = \frac{1}{6}$

$$P(x < 0) = \int_{-\infty}^{0} f(x)dx = \int_{-2}^{0} \frac{1}{6}dx$$

$$= \frac{2}{6} = \frac{1}{3}$$

5. ***Ans. (a)***

$$\frac{V_{in} - V_z}{R} = I_z + I_L$$

$$\frac{V_{in_{min}} - V_z}{R} = I_{zk} + I_L,\ I_{zk} = \text{knee current}$$

$$R \le \frac{V_{in_{min}} - V_z}{I_{zk} + I_L} \Rightarrow R \le \frac{30-10}{(1mA + 10mA)}$$

$$R \le 1818\Omega$$

6. ***Ans. (a)***

For low frequency

$$e^{-s} = (1 - s)$$

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

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

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

$$s^3 + 2s^2 + s + k - ks = 0$$

$$s^3 + 2s^2 + s\ (1 - k) + k = 0$$

s^3	1	$1-k$
s^2	2	k
s^1	$\frac{2(1-k)-k}{2}$	
s^0	k	

For stability k > 0 and

$$2\ (1 - k) - k > 0$$

$$2 - 3\ k > 0 \text{ or } k < \frac{2}{3}$$

Hence, the restriction on k is

$$0 < k < \frac{2}{3}$$

7. ***Ans. (d)***

8. ***Ans. (d)***

0	0	0	0	
0	0	0	1	← After 1st clock pulse
0	0	1	0	
0	0	1	1	
0	1	0	0	← After 4th clock pulse
⋮				
1	1	1	1	← After 15th clock pulse
0	0	0	0	← After 16th clock pulse
⋮				
0	1	0	0	← After 20th clock pulse

0100 counter output will be

at 4^{th}, $(16 + 4)^{th}$, $(2 \times 16 + 4)^{th}$ ..... clock

In general at (16n + 4)th clock pulse

Counter output will be 0100.

9. ***Ans. (a)***

$R_y(\tau)$

$$= \int_{-\infty}^{\infty} \Pi\left(\frac{t}{T}\right).\Pi\left(\frac{t-\tau}{T}\right)\cos(\omega_0 t).\cos[\omega_0(t-\tau)]dt$$

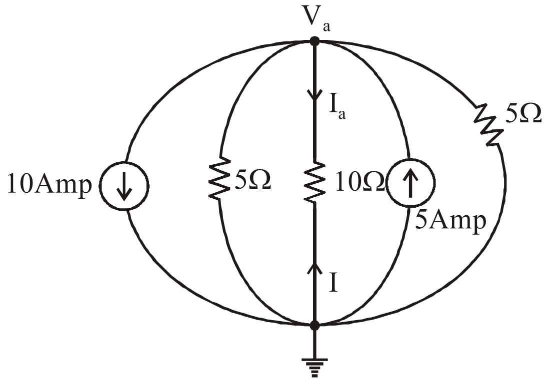
$$= \frac{\cos\omega_0\tau}{2}\int_{-\infty}^{\infty} \Pi\left(\frac{t}{T}\right)\Pi\left(\frac{t-\tau}{T}\right)dt + \frac{1}{2}\int_{-\infty}^{\infty} \Pi\left(\frac{t}{T}\right)\Pi\left(\frac{t-\tau}{T}\right)\cos(2\omega_0 t-\tau)dt$$

$$= \left(\frac{\cos\omega_0\tau}{2}\right)\wedge\left[\frac{t}{T}\right] + \frac{1}{4\omega_0}$$

$$\left[\sin(\omega_0 T - \omega_0\tau) - \sin\omega_0\tau\right]$$

$$\equiv \frac{1}{2}\cos(\omega_0\tau)\wedge\left[\frac{t}{T}\right]$$

10. ***Ans. (a)***



$$+\cancel{10}+\frac{V_a}{5}+\frac{V_a}{10}-\cancel{5}+\frac{V_a}{5} = 0$$

$$V_a\left[\frac{1}{5}+\frac{1}{10}+\frac{1}{5}\right] = -5$$

$$V_a\left[\frac{2+1+2}{10}\right] = -5$$

$$V_a = -10$$

$$I_a = \frac{-10}{10} = -1$$

$\because$ $I_a = -I$

$$\mathbf{I = 1\ Amp}$$

11. ***Ans. (0.60 to 0.69)***

$$P_c = 9\text{kW},\ P_t = 10.125\ \text{kW};$$

$$P_t = P_c\left(1+\frac{\mu^2}{2}\right)$$

$$\mu_1 = \sqrt{2\left(\frac{P_t}{P_c}-1\right)} = 0.5$$

$\therefore$ $\mu_1 = 0.5,\ \mu_2 = 0.4$

$\therefore$ $\mu_t^2 = \mu_1^2 + \mu_2^2$

$\therefore$ $\mu_t = \sqrt{\mu_1^2+\mu_2^2} = 0.64$

12. ***Ans. (d)***

Pointer (HL pair) can be used to access memory mapped I/O. with I/O mapped I/O, address is of 8 bit so we can address maximum

$= 2^8$ I/O devices

$= 256$ I/O devices

13. ***Ans. (d)***

14. ***Ans. (d)***

$$f(x) = \tan x; \quad [0, \pi]$$

Since f(x) is not continuous in [0, π],

Hence mean value theorem can not be applied

15. ***Ans. (4 to 5)***

$$V_0 = -g_m V_{gs}(R_D \| R_2)$$

$$V_1 = -V_{gs}$$

$$A_V = \frac{V_0}{V_1} = 4.44$$

16. ***Ans. (b)***

Output- due to voltage at inverting terminal keeping voltage at non-inverting terminal zero is.

$$V_{01} = V_a \times \left(-\frac{R_f}{R}\right) = V_a\left(-\frac{250}{50}\right)$$

$$V_{01} = -5\ V_a$$

Output voltage due voltage at non-inverting terminal keeping voltage at inverting terminal zero.

$$V_{02} = V_b \times \frac{50}{(50+50)} \times \left(1+\frac{R_f}{R}\right)$$

$$= V_b \times \frac{1}{2}\left(1+\frac{250}{50}\right)$$

$$V_{02} = 3V_b$$

So, according to superposition theorem, net output voltage

$$V_0 = V_{01} + V_{02}$$

$$V_0 = -5V_a + 3V_b$$

17. ***Ans. (b)***

$$C = \frac{Q}{V}$$

$\because$ $$C_1 = \frac{1}{2}F,\ C_2 = \frac{Q_2}{V_2} = \frac{1}{3}F$$

$$C_3 = \frac{Q}{V_3} = \frac{1}{5}F$$

As C_1, C_2 & C_3 are corrected in series.

$$Ceq = \frac{C_1C_2C_3}{C_1C_2 + C_2C_3 + C_3C_1} = \frac{\frac{1}{30}}{\frac{1}{3}} = 0.1F$$

18. ***Ans. (0.85 to 0.90)***

$$W = 2.8 \text{ kHz}$$

$$NR = 2.8 \times 2 = 5.6 \text{ kHz}$$

$$\Delta = \text{step size} = 120 \text{ mW}$$

$$f_s = SR = 10\ (NR) = 56 \text{ Ksamples/sec}$$

$$f_m = \text{message frequency of sinusoidal signal} = 1.2 \text{ kHz}$$

To avoid slope overload

$$\frac{\Delta}{T_s} > \frac{d}{dt}m(t)\Big|_{max} \qquad (\because T_s = 1/f_s)$$

$$m(t) = A \sin 2\pi\ f_m t$$

$$\frac{\Delta}{T_s} \geq A2\pi f_m;$$

$$\Delta f_s > A2\pi f_m; \qquad \left(\because f_s = \frac{1}{T_s}\right)$$

$$A_{max} = \frac{\Delta f_s}{2\pi f_m} \qquad ...(1)$$

Substituting values in (1) we get

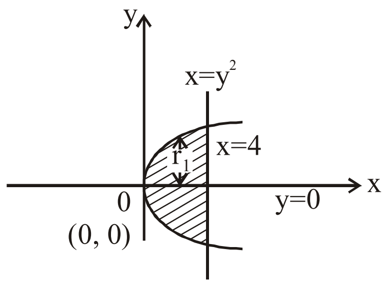
$$A_{max} = 0.891 \text{ V}$$

19. ***Ans. (a)***

$$\int_{-\infty}^{\infty}\delta(at-b)\ell n(t+2) = \int_{-\infty}^{\infty}\frac{1}{a}\delta(t-b/a)\ell n(t+2)$$

$$= \frac{1}{a}\ell n\left(\frac{b}{a}+2\right)$$

20. ***Ans. (c)***



$$\text{Volume} = \int_{x=0}^{4}\pi r_1^2 dx = \int_{x=0}^{4}\pi(\sqrt{x})^2 dx$$

$$= \int_{x=0}^{4}\pi x dx = \left(\frac{\pi x^2}{2}\right)_{x=0}^{4} = 8\pi$$

21. ***Ans. (b)***

$$x(t) = 2u(t) - 1$$
$$x'(t) = 2\delta(t) - 0 = 2\delta(t)$$

22. ***Ans. (c)***

$$I = \int_0^{\infty} t^{1/2}e^{-kt}dt$$

$= \text{Laplace transform of } t^{1/2} \text{ when } S=k$

$$= L\left\{t^{1/2}\right\}_{S=k}$$

$$= \left(\frac{\left\lceil\frac{1}{2}+1\right.}{S^{\frac{1}{2}+1}}\right)_{S=k} = \frac{\left\lceil\frac{3}{2}\right.}{k^{\frac{3}{2}}} = \frac{1}{2}\sqrt{\pi}\,k^{-\frac{3}{2}}$$

23. ***Ans. (0.85 to 0.95)***

$$r_\pi = \frac{\beta}{g_m} = \frac{100}{3m} = 33.3\ k\Omega$$

$$h_{21} = \left.\frac{I_2}{I_1}\right|_{V_2=0}$$

$$I_2 = \frac{V_\pi}{r_0} + g_m V_\pi$$

$$I_1 = \frac{-V_\pi}{3.9k} - \frac{V_\pi}{r_\pi} - \frac{V_\pi}{r_0} - 9mV_\pi$$

$$h_{21} = -\frac{9m}{\frac{1}{3.9\,k} + \frac{1}{r_\pi} + 9m}$$

$$h_{21} = 0.91$$

24. ***Ans. (b)***

$$A = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$$

State transition matrix

$$\phi(t) = e^{At} = L^{-1}\left[(sI - A)^{-1}\right]$$

$$(sI - A) = \begin{bmatrix} s & 0 \\ 0 & s \end{bmatrix} - \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} = \begin{bmatrix} s & -1 \\ 2 & s+3 \end{bmatrix}$$

$$(sI - A)^{-1} = \frac{1}{(s+1)(s+2)}\begin{bmatrix} s+3 & 1 \\ -2 & s \end{bmatrix}$$

$$= \begin{bmatrix} \frac{s+3}{(s+1)(s+2)} & \frac{1}{(s+1)(s+2)} \\ \frac{-2}{(s+1)(s+2)} & \frac{s}{(s+1)(s+2)} \end{bmatrix}$$

$$\phi(t) = L^{-1}\ [(sI - A)^{-1}]$$

$$= \begin{bmatrix} 2e^{-t} - e^{-2t} & e^{-t} - e^{-2t} \\ -2e^{-t} + 2e^{-2t} & -e^{-t} + 2e^{-2t} \end{bmatrix}$$

25. ***Ans. (c)***

$$u = 2x + y^3 - 3x^2y$$

$$\frac{\partial u}{\partial x} = 2 - 6xy, \quad \frac{\partial u}{\partial y} = 3y^2 - 3x^2$$

$$f(z) = \int \frac{\partial u}{\partial x}(z,o)dz - i\frac{\partial u}{\partial y}(z,o)dz + c$$

$$= \int 2dz + i\int 3z^2 dz + c = 2z + iz^3 + c$$

Answer 26 to 55 Carry Two Marks Each

26. ***Ans.(a)***

$$x(t) = r(t) - r(t-1) - r(t-4) + 0.5r(t-6) - 0.5r(t-8)$$

$$X(s) = \frac{1}{s^2}(1 - e^{-s} - e^{-4s} + 0.5e^{-6s} - 0.5e^{-8s})$$

So, $D = -0.5$

27. ***Ans. (b)***

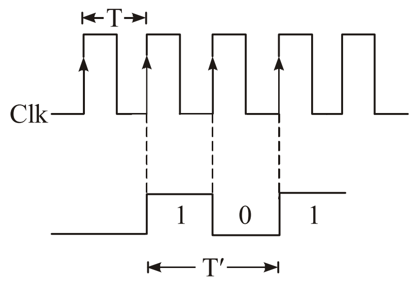
28. ***Ans. (5kHz)***

$\because$ $Q(n+1) = D$

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

toggle mode of operation.

So, output frequency is divided by 2 in toggle mode of operation as



$$T' = 2T$$

$\therefore$ $$\frac{1}{T'} = \frac{1}{2T} = \frac{f}{2} = \frac{10}{2} = 5kHz$$

29. ***Ans. (1.00 to 1.50)V***

We have

$$\frac{C_j(0)}{C_j(10)} = 3.13$$

$$\therefore \quad C_j = \frac{C_j(0)}{\sqrt{1+\left(\frac{V_{RB}}{V_0}\right)}}$$

$$C_j\ (10) = \frac{C_j(0)}{\sqrt{1+\frac{10}{V_0}}}$$

$$\frac{C_j(10)}{C_j(0)} = \frac{1}{\sqrt{1+\frac{10}{V_0}}}$$

$$\frac{1}{3.13} = \frac{1}{\sqrt{1+\frac{10}{V_0}}}$$

$$V_0 = 1.14V$$

30. **23.** ***Ans. (5Ω)***

v-i characteristic is $i = \frac{1}{5}v - 4$

$$\therefore \quad R_{AB} = \frac{dv}{di} = 5\Omega$$

31. ***Ans.*** **(a)**

$$R_y(\tau) = E[y(\tau)\ y(t+\tau)]$$

$$R_y(\tau) = E[(x(\tau) - x(\tau - T))\ (x(t+\tau) - x(t+\tau - T)]$$

$$= 2R_x(\tau) - R_x(\tau + T) - R_x(\tau - T)$$

$$F\ \{R_y(\tau)\} = S_y(f) = 2S_x(f) - S_x(f)[e^{\,j2\pi fT} + e^{-j2\pi fT}]$$

$$= 2S_x(f)[1 - \cos 2\pi fT]$$

32. ***Ans. (2)***

$$H(s) = \frac{2s+6}{s^2+6s+8}$$

$$\Rightarrow \quad H(s) = \frac{1}{s+2}+\frac{1}{s+4}$$

$$h(t) = e^{-2t}\ u(t)\ +\ e^{-4t}\ u(t)$$

$$\downarrow t = nT_s$$

$$h[nT_s] = e^{-2nT_s}u[n]-e^{-4nT_s}u[n]$$

$$H(z) = \frac{1}{1-\frac{1}{e^{2T_s}}z^{-1}}+\frac{1}{1-e^{-4T_s}z^{-1}}$$

$$= \frac{2z^2-e^{-4T_s}z-e^{-2T_s}z}{z^2-ze^{-2T_s}-ze^{-4T_s}+e^{-6T_s}}$$

$$e^{-6T_s} = 0.05$$

$$\Rightarrow \quad T_s = \frac{1}{2} \Rightarrow f_s = 2\text{Hz}$$

33. ***Ans. (c)***

$$u + v = (x + y)(2 - 4xy + x^2 + y^2)$$

$$u + v = 2x–4x^2y+x^2 + xy^2 + 2y–4xy^2+x^2y+y^3$$

$$u + v = x^3 + y^3 - 3x^2y - 3xy^2 + 2x + 2y$$

$$u_x + v_x = 3x^2 - 6xy - 3y^2 + 2 \quad \ldots(1)$$

$$u_y + v_y = 3y^2 - 3x^2 - 6xy + 2 \quad \ldots(2)$$

For analytic function $u_x = v_y\ \&\ u_y = -v_x$

$\Rightarrow$ $$u_x - u_y = 3x^2 - 3y^2 - 6xy + 2 \quad \ldots(3)$$

& $$u_y + u_x = 3y^2 - 3x^2 - 6xy + 2 \quad \ldots(4)$$

From (3) & (4)

$$2u_x = -12xy + 4$$

or $$u_x = -6xy + 2 \quad \ldots(5)$$

& $$2u_y = 6y^2 - 6x^2$$

or $$u_y = 3y^2 - 3x^2 \quad \ldots(6)$$

$$f(z) = \int u_x(z,0)dz - i\int u_y(z,0) + k$$

$$= \int 2dz + i\int 3z^2 dz + k$$

$$= 2z + iz^3 + k$$

34. ***Ans.* (*a*)**

Given field strength decreased by 63%

So present field strength is 37%

$$e^{-\alpha z} = 0.37$$

But
$$\alpha = \sqrt{\frac{\omega\mu\sigma}{2}} = \sqrt{\frac{10^6\pi\times4\pi\times10^{-7}\times4}{2}} = \sqrt{8}$$

$$\Rightarrow \quad e^{-\sqrt{8}z} = 0.37$$

$$\Rightarrow \quad \ell n\, e^{-\sqrt{8}z} = \ell n(0.37)$$

$$\Rightarrow \quad z = \frac{-\ln(0.37)}{\sqrt{8}}$$

$$\Rightarrow \quad z = 0.35 \text{ m}$$

$\therefore$ The distance the wave can travel in the medium, z = 35 cm.

35. ***Ans.* (*a*)**

36. ***Ans.* (*c*)**

$$X(f) = \frac{1}{2}[M(f - f_c)+M(f + f_c)]$$

Where
$$f_c = 1\text{MHz}$$
$$y(t) = 3m\ (t - 10^{-3})\ \sin\ (2\pi10^6t-(\pi/5))$$
$$\tau_g = 1 \text{ msec}$$
$$\tau_p = \frac{-\theta(\omega)}{\omega}$$
$$= \frac{-(-\pi/5)}{2\pi\times10^6} = 0.1\ \mu \text{ sec}$$

37. ***Ans.* (*b*)**

Half range sine series is

$$f(x) = \sum_{n=1}^{\infty} b_n \sin nx$$

where

$$b_a = \frac{2}{\pi}\int_0^{\pi} x(\pi - x)\sin nx dx = \frac{4}{\pi n^3}\left[1-(-1)^n\right]\sin nx$$

38. ***Ans. (1 to 1.5)***

$$I = \int_0^{\infty} \frac{x^2+2}{(x^2+1)(x^2+4)}dx = \frac{1}{2}\int_{-\infty}^{\infty} \frac{x^2+2}{(x^2+1)(x^2+4)}dx$$

$$f(z) = \frac{z^2+2}{(z^2+1)(z^2+4)} = \frac{z^2+2}{(z+i)(z-i)(z+2i)(z-2i)}$$

$$I = \frac{2\pi i}{2}[\text{Res}[f(z)]_{z=i} + \text{Res}[f(z)]_{z=2i}] \quad \ldots(1)$$

Now,

$$\text{Res}[f(z)]_{z=i} = \lim_{z\to i}[(z-i)f(z)]$$

$$= \lim_{z\to i}\frac{z^2+2}{(z+i)(z^2+4)}$$

$$= \frac{1}{2i(3)} = \frac{1}{6i} = \frac{-i}{6}$$

$$\text{Res}[f(z)]_{z=2i} = \lim_{z\to 2i}[(z-2i)f(z)]$$

$$= \lim_{z\to 2i}\left[\frac{z^2+2}{(z^2+1)(z+2i)}\right]$$

$$= \frac{-2}{(-3(4i)} = \frac{1}{6i} = \frac{-i}{6}$$

$\Rightarrow$

$$I = \pi i\left(\frac{-i}{6} - \frac{i}{6}\right) = \pi i \times \frac{-2i}{6}$$

$$= \frac{\pi}{3} = 1.047$$

39. *Ans. (3.46 to 3.48)*

$$\frac{dy}{dx} = x(y - x) = xy - x^2$$

$$x_0 = 2, \quad y_0 = 3, \quad h = 0.2$$

$$f(x, y) = x(y - x) = xy - x^2$$

$$k_1 = hf(x_0, y_0) = 0.4$$

$$k_2 = hf\left(x_0 + \frac{h}{2}, y_0 + \frac{k_1}{2}\right) = 0.462$$

$$k_3 = hf\left(x_0 + \frac{h}{2}, y_0 + \frac{k_2}{2}\right) = 0.475$$

$$k_4 = hf(x_0 + h_1, y_0 + k_3) = 0.561$$

$$k = \frac{1}{6}(k_1 + 2k_2 + 2k_3 + k_4) = 0.4725$$

$$y_{n+1} = y_n + k$$

$$y_1 = y(x_0 + h) = y(2.2) = y_0 + k = 3.4725$$

40. *Ans. (None)*

$$F_x(x) = u(x)\left(1 - \frac{x^2}{b}\right)$$

$$\text{Its density function} = \frac{d}{dx}F_x(s) = \frac{d}{dx}\left[u(x)\left(1 - \frac{x^2}{b}\right)\right]$$

$$= \left[\frac{d}{dx}u(x)\right]\left(1 - \frac{x^2}{b}\right) + u(x)\frac{d}{dx}\left(1 - \frac{x^2}{b}\right)$$

$$= \delta(x)\left[1 - \frac{x^2}{b}\right] + u(x)\left(-\frac{2x}{b}\right)$$

$$= \delta(x) - \frac{2x}{b}u(x)$$

None of the given options are correct.

41. ***Ans.(d)***

Phase response

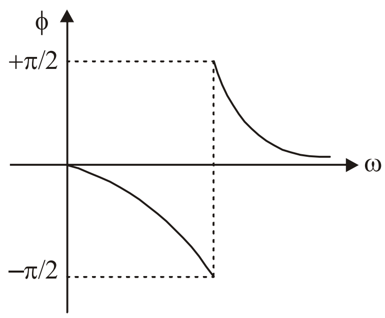
$$H(s) = \frac{s^2 + \omega_0^2}{s^2 + (\omega_0 / Q)s + \omega_0^2}$$

$$H(j\omega) = \frac{-\omega^2 + \omega_0^2}{-\omega^2 + j\frac{\omega\omega_0}{Q} + \omega_0^2}$$

$$\phi = \angle H(j\omega) = -\tan^{-1}\frac{\omega\omega_0 / Q}{\omega_0^2 - \omega^2}$$

At $\omega = \omega_0,\ \angle H(j\omega) = -\tan^{-1}\infty = -90°$

The plot of ϕ is shown figure



42. ***Ans.* (*c*)**

Switch at contact B :

$$V_s = I_m R_m$$
$$= 50\mu A \times 1k\Omega = 50mV$$

$$I_s = \frac{V_s}{R_1 + R_2 + R_3}$$

$$= \frac{50mV}{0.05\Omega + 0.45\Omega + 4.5\Omega} = 10mA$$

$$I = I_m + I_s = 50\mu A + 10mA$$
$$= 10.05\ mA$$

Ammeter range $\cong$ 10mA.

Switch at contact C : $V_s = I_m(R_m + R_3)$

$$= 50\mu A(1k\Omega + 4.5\Omega)$$

$$\cong 50 \text{ mV}$$

$$I_s = \frac{V_s}{R_1 + R_2}$$

$$= \frac{50\text{mV}}{0.05\Omega + 0.45\Omega}$$

$$= 100 \text{ mA}$$

$$I = 50\mu A + 100 mA$$

$$= 100.05 \text{ mA}$$

Ammeter range $\cong$ 100 mA.

Switch at contact D : $V_s = I_m(R_m + R_3 + R_2)$

$$= 50\mu A(1k\Omega + 4.5\Omega + 0.45\Omega)$$

$$\cong 50 \text{ mV}$$

$$I_s = \frac{V_s}{R_1} = \frac{50\text{mV}}{0.05\Omega}$$

$$= 1 \text{ A}$$

$$I = 50\mu A + 1A$$

$$= 1.00005 \text{ A}$$

Ammeter range $\cong$ 1A.

43. ***Ans. (0.4)***

Sample space = S = {(1, 1), (1, 2)……(6, 6)}

Let E_1 = event that sum of number appearing is 8

E_1 = {(2, 6), (3, 5), (4, 4), (5, 3), (6, 2)}

Required probability = $\frac{2}{5}$ = 0.4

44. ***Ans. (b)***

$$\frac{0.35(1+s)(1+0.05s)}{s(1+0.025s)}$$

First line has a slope of –20 dB/dec and it is not passing through ω = 1 rad/sec. Therefore it indicate term k/s

$$20 \log k = -9$$

$$k = 0.35$$

The term is $\frac{0.35}{s}$

At ω = 1 rad/sec, slope changes to a dB/dec indicating a term (1 + s)

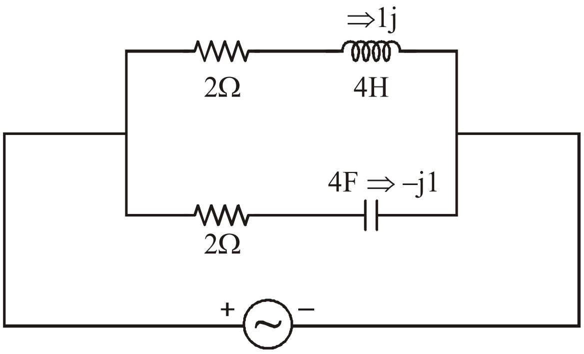
At ω = 20 rad/sec, slope changes to + 20 dB/dec indicating a term $\left(1+\frac{s}{20}\right)$

At ω = 40 rad/sec, slope changes to a dB/dec indicating a term $1/\left(1+\frac{s}{40}\right)$

Combining all the terms, we get

$$G(s) = \frac{0.35(1+s)(1+0.05s)}{s(1+0.025s)}$$

45. ***Ans. (c)***



Here $R^2 = 4$

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

∴ $R^2 \neq \frac{L}{C}$

$$\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{4\times 4}} = \frac{1}{4}\text{rad/sec}$$

$$y_0 = \frac{2R}{R^2+\frac{L}{C}} = \frac{2\times 2}{(2)^2+\frac{4}{4}} = \frac{4}{5} = 0.8$$

$$z_0 = 1.25$$

$$I(t) = \frac{10\cos\frac{t}{4}}{1.25} = 8\cos\frac{t}{4}$$

$$I_L(t) = \frac{(2-j1)}{2+\cancel{j}+2-\cancel{j}}I(t)$$

$$I_L(t) = \frac{2-j1}{4}I(t)$$

$$I_L(t) = \frac{\sqrt{5}}{4}\angle -26.56\, I(t)$$

$$I_L(t) = \frac{\sqrt{5}}{\cancel{4}}\angle -26.56 \cdot {}^{2}\cancel{8}\cos\left(\frac{t}{4}\right)$$

$$I_L(t) = 2\sqrt{5}\cos\left(\frac{t}{4}-26.56\right)$$

Similarly

$$I_C(t) = 2\sqrt{5}\cos\left(\frac{t}{4}+26.56\right)$$

$$P_{total} = \left(\frac{2\sqrt{5}}{\sqrt{2}}\right)^2\cdot 2+\left(\frac{2\sqrt{5}}{\sqrt{2}}\right)^2\cdot 2$$

$$= \left(\sqrt{2}\times\sqrt{5}\right)^2\cdot 2+\left(\sqrt{2}\sqrt{5}\right)^2\cdot 2$$

$$= 10\times 2+10\times 2$$

$$\mathbf{P_{total} = 40\ W}$$

46. ***Ans. (1 to 3)***

we have

$$J = J_S\left\{\exp\left(V/V_T\right)-1\right\}$$

$$J = 4.15\times10^{-11}\left\{\exp\left(0.65/26\right)-1\right\}$$

$J = 2.98$ A/cm2

Deep in to n-region current density is

$J = \sigma_\varepsilon = n_\varepsilon \mu_n \varepsilon$ (only drift).

$2.98 = 10^{16} \times 1.6 \times 10^{-19}\times1350\times\varepsilon$

$\varepsilon = 1.52$ V/cm.

47. ***Ans. (c)***

$$|r| = \sqrt{x^2+y^2+z^2}$$

$$\vec{A} = |r|^n x\hat{a}_x + |r|^n y a_y + |r|^n z\hat{a}_z$$

$$\nabla\cdot\vec{A} = \frac{\partial}{\partial x}(|r|^n x)+\frac{\partial}{\partial y}(|r|^n y)+\frac{\partial}{\partial z}(|r|^n z)$$

$$= |r|^n + x.\frac{n}{2}.\frac{|r|^n}{|r|^2}.2x + |r|^n + y.\frac{n}{2}\frac{|r|^n}{|r|^2}.2y + |r|^n + z.\frac{n}{2}.\frac{|r|^n}{|r|^2}.2z$$

$$= 3|r|^n + nx^2\frac{|r|^n}{|r|^2} + ny^2\frac{|r|^n}{|r|^2} + nz^2\frac{|r|^n}{|r|^2}$$

$$= |r|^n\left[3+\frac{n(x^2+y^2+z^2)}{|r|^2}\right]$$

$$= (n+3)\,|r|^n$$

48. ***Ans. (d)***

Since gain (dB) > 0 at ω_{pc},

Therefore GM < 0

PM $= 180 + \angle GH|_{\omega gc}$

Since, $\angle GH|_{\omega gc} < -180°$

Therefore, PM < 0 degree

49. ***Ans. (b)***

$$Y(\omega) = H(\omega)X(\omega)$$

The system is not passing the input frequency, $\omega = 5\pi$ to the output as the output is not containing $\omega = 5\pi$ sinusoid.

$\therefore$ System function, $H(\omega)$ at $\omega = 5\pi$ should be zero.

50. ***Ans. (80)***

Dielectric strength of $SiO_2 = 10^7$ V/cm

Thickness of SiO_2 layer is $= 80 \times 10^{-9}$ m

$= 80 \times 10^{-7}$ cm

Break down voltage $V_{BD} = E_{tox}$

$= 10^7 \times 80 \times 10^{-7}$

$V_{BD} = 80V$

51. ***Ans.* (0.5)**

$$\int_0^1 f(x)\cdot dx = 1 \qquad \text{(Total probability = 1)}$$

$$\Rightarrow \int_0^1 \left(a + bx + cx^2\right)dx = 1$$

$$\left. ax + \frac{bx^2}{2} + \frac{cx^3}{3}\right|_0^1 = 1$$

$$\Rightarrow a + \frac{b}{2} + \frac{c}{3} = 1$$

$$\Rightarrow 6a + 3b + 2c = 6 \qquad ...(1)$$

$$E(X) = \frac{1}{2}$$

$$\int_0^1 xf(x)dx = \frac{1}{2}$$

$$\Rightarrow \int_0^1 x\left(a + bx + bx^2\right)dx = \frac{1}{2}$$

$$\Rightarrow \left. \frac{ax^2}{2} + \frac{bx^3}{3} + \frac{cx^4}{4}\right|_0^1 = \frac{1}{2}$$

$$\Rightarrow \frac{a}{2} + \frac{b}{3} + \frac{c}{4} = \frac{1}{2}$$

$$\Rightarrow 6a + 4b + 3c = 6 \qquad ...(2)$$

$$E(X^2) = \frac{2}{3}$$

$$\int_0^1 x^2 \cdot (a + bx + cx^2) dx = \frac{2}{3}$$

$$\Rightarrow \quad \frac{a}{3} + \frac{b}{4} + \frac{c}{5} = \frac{2}{3}$$

$$\Rightarrow \quad 20a + 15b + 12c = 40 \qquad ...(3)$$

Solving (1), (2) and (3)

$$a = 11;\ b = -60,\ c = 60$$

$$P(X < .5)$$

$$\Rightarrow \quad \int_0^{.5} f(x) \cdot dx = \int_0^{.5} (11 - 60x + 60x^2) dx$$

$$11x\Big|_0^{.5} - \frac{60}{2}x^2\Big|_0^{.5} + \frac{60}{3}x^3\Big|_0^{.5}$$

$$\Rightarrow \quad \frac{11}{2} - 30 \times \frac{1}{4} + 20 \times \frac{1}{8}$$

$$\Rightarrow \quad \frac{11}{2} - \frac{15}{2} + \frac{5}{2} = \frac{11}{2} - \frac{10}{2} = \frac{1}{2}$$

$= 0.5$

52. ***Ans. (a)***

At t = 3, since 2Ω is shorted, I_c jumps to a new value and then decreases with reduced time constant.

53. ***Ans. (0)***

$$u = x - y + z,\quad v = x + y - z,\quad w = x^2 + xz - xy$$

where, J = acobian of (u, v, w) w.r.t. (x, y z)

$$J = \frac{\partial(u,v,w)}{\partial(x,y,z)} = \begin{vmatrix} \frac{\partial u}{\partial x} & \frac{\partial u}{\partial y} & \frac{\partial u}{\partial z} \\ \frac{\partial v}{\partial x} & \frac{\partial v}{\partial y} & \frac{\partial v}{\partial z} \\ \frac{\partial w}{\partial x} & \frac{\partial w}{\partial y} & \frac{\partial w}{\partial z} \end{vmatrix}$$

$$= \begin{vmatrix} 1 & -1 & 1 \\ 1 & 1 & -1 \\ (2x + z - y) & -x & x \end{vmatrix}$$

$$J = 1(x-x)+1(x+2x+z-y)+1(-x-2x-z+y) = 0$$

54. ***Ans. (a)***

55. ***Ans. (a)***

$$\frac{C(s)}{R(s)} = \frac{G(s)}{1+G(s)H(s)}$$

$$H(s) = 1$$

& $$G(s) = \frac{25}{s(s+6)}$$

$$\frac{C(s)}{R(s)} = \frac{25}{s^2 + 6s + 2s}$$

$$\omega_n^2 = 25$$

or $$\omega_n = 5 \text{ rad/sec}$$

$$2\xi\omega_n = 6$$

or $$\xi = \frac{6}{2\times 5} = 0.6$$

$$\xi = 0.6$$

$$\omega_d = \omega_n\sqrt{1-\xi^2}$$

$$= 5\sqrt{1-0.36}$$

$$= 4 \text{ rad/sec}$$

Rise time $$t_r = \frac{\pi-\beta}{\omega_d}$$

$$= \frac{3.14-0.92}{4}$$

$$= 0.55 \text{ sec}$$

Settling time (2%)

$$t_s = \frac{4}{0.6\times 5} = 1.33$$

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