ESE 2024 Prelims Solutions

Electrical Engineering

Set-B

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Electrical Engineering Paper Analysis of ESE 2024 Preliminary Examination

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UPSC ESE Prelims 2024

Electrical Engineering analysis

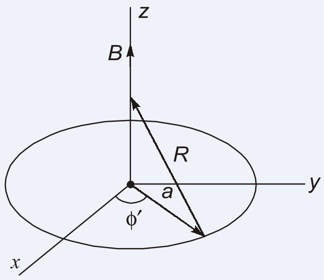
by **MADE EASY faculties**

1. Two perfectly coupled coils each of 1 H self-inductance are connected in parallel so as to aid each other. What is the value of overall inductance?
(a) 0 H (b) 0.5 H
(c) 1 H (d) 2 H

Ans. (b)

End of Solution

2. What is the value of magnetic field on the axis that is perpendicular to the plane containing a circular loop of current shown in the figure using the Biot-Savart law?

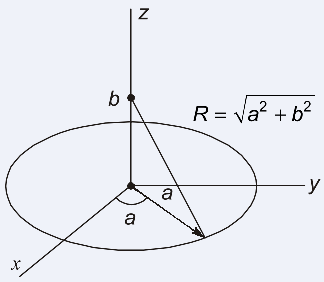


(a) $B(z) = \left[\frac{\mu_0 m}{2\pi R^3}\right]$ (b) $B(z) = \left[\frac{\mu_0 m}{2\pi R^2}\right]$

(c) $B(z) = \left[\frac{\mu_0 m}{2\pi R^4}\right]$ (d) $B(z) = \left[\frac{\mu_0 m}{2\pi R}\right]$

Ans. (a)

The magnetic field due to circular loop on the axis is given by



$$B(z) = \frac{ia^2}{2(a^2 + b^2)^{3/2}}$$

where, a = radius of loop

b = height along z-axis

$$B(z) = \frac{\mu_0 ia^2}{2(a^2 + b^2)^{3/2}}$$

From the figure,

$$\sqrt{a^2 + b^2} = R$$

$\therefore$ $$B(z) = \frac{\mu_0 ia^2}{2(R)^3} = \frac{\mu_0 m}{2\pi R^3}$$

where, m = magnetic dipole moment = ia^2

Hence, $$B(z) = \frac{\mu_0 m}{2\pi R^3}$$

End of Solution

3. What is the transfer function, $G(s) = C(s)/R(s)$, corresponding to the following differential equation?

$$\frac{d^3c}{dt^3} + 4\frac{d^2c}{dt^2} + 6\frac{dc}{dt} + 3c = \frac{d^2r}{dt^2} + 6\frac{dr}{dt} + 4r$$

(a) $G(s) = \dfrac{s^2 + 6s + 4}{s^3 + 4s^2 + 6s + 3}$ (b) $G(s) = \dfrac{s^2 + 5s + 4}{s^3 + 4s^2 + 6s + 3}$

(c) $G(s) = \dfrac{s^2 + 6s + 4}{s^3 + 5s^2 + 6s + 3}$ (d) $G(s) = \dfrac{s^2 + 6s + 4}{s^3 + 4s^2 + 5s + 3}$

Ans. (a)

Given differential equation :

$$\frac{d^3c}{dt^3} + 4\frac{d^2c}{dt^2} + 6\frac{dc}{dt} + 3c = \frac{d^2r}{dt^2} + 6\frac{dr}{dt} + 4r$$

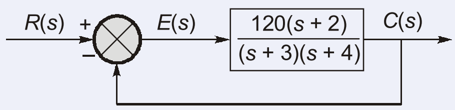
Taking Laplace transform

$[s^3 + 4s^2 + 6s + 3]C(s) = (s^2 + 6s + 4)R(s)$

$$G(s) = \frac{s^2 + 6s + 4}{s^3 + 4s^2 + 6s + 3}$$

End of Solution

4. What are the steady-state errors for the inputs of $3u(t)$, $3tu(t)$ and $3t^2u(t)$ respectively to the system shown in the figure, where the function $u(t)$ is the unit step?



(a) $\frac{3}{21}$, ∞ and ∞ (b) $\frac{1}{6}$, ∞ and $\frac{1}{6}$

(c) ∞, ∞ and $\frac{1}{6}$ (d) $\frac{1}{6}$, ∞ and $\frac{3}{21}$

Ans. (a)

$$G(s)H(s) = \frac{120(s+2)}{(s+3)(s+4)}$$

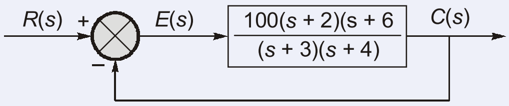
Above system is type-0 system.

$$K_p = \lim_{s\to 0} G(s)H(s) = \frac{120\times 2}{3\times 4} = 20$$

$$e_{ss} = \frac{A}{1+K_p} = \frac{3}{1+20} = \frac{3}{21}$$

End of Solution

5. What are the steady-state errors for the inputs of $4u(t)$, $4tu(t)$ and $4t^2u(t)$ respectively to the system shown in the figure, where the function u(t) is the unit step?



(a) 0, ∞ and ∞

(b) 0, $\frac{1}{25}$ and ∞

(c) ∞, ∞ and $\frac{1}{25}$

(d) $\frac{1}{25}$, ∞ and 0

Ans. (b)

It has to be type-1 system.

For unit step input steady state error will be zero.

For ramp input

$$e_{ss} = \frac{A}{K_v} = \frac{4}{\lim\limits_{s\to 0} sG(s)H(s)}$$

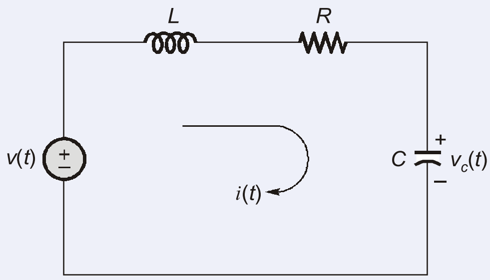
$$= \frac{4}{\dfrac{100\times 2\times 6}{3\times 4}} = \frac{1}{25}$$

For parabolic input,

$$e_{ss} = \infty$$

End of Solution

6. The transfer function of the given circuit shown in the figure by using Laplace transform is



(a) $T(s) = \dfrac{\frac{1}{LC}}{s^2 + \frac{R}{L}s + \frac{1}{LC}}$

(b) $T(s) = \dfrac{\frac{1}{LC}}{s^2 + Rs + \frac{1}{LC}}$

(c) $T(s) = \dfrac{\frac{1}{LC}}{s^2 + \frac{R}{L}s + \frac{1}{L}}$

(d) $T(s) = \dfrac{\frac{1}{LC}}{s^2 + \frac{1}{L}s + \frac{1}{LC}}$

Ans. (a)

$$\text{Transfer function} = \frac{V_c}{V(t)}$$

$$= \frac{\frac{1}{sC}}{R + sL + \frac{1}{sC}}$$

$$= \frac{1}{s^2LC + sRC + 1}$$

$$= \frac{\frac{1}{LC}}{s^2 + s\frac{R}{L} + \frac{1}{LC}}$$

End of Solution

7. What is the status of the closed-loop transfer function

$$T(s) = \frac{10}{s^5 + 2s^4 + 4s^3 + 6s^2 + 2s + 5}$$

using Routh-Hurwitz criterion?

(a) Unstable
(b) Marginally stable
(c) Stable
(d) Neither stable nor unstable

Ans. (a)

s^5	1	4	2
s^4	2	6	5
s^3	1	$-\frac{1}{2}$	
s^2			
s^1			
s^0			

(Unstable)

End of Solution

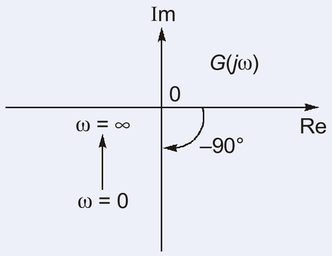
8. What is/are the value(s) of K for which the system is stable for the characteristic equation $s^2 - (K + 2)s + (2K + 1) = 0$?

(a) $-(K + 2) > 0$ and $(2K + 5) > 0$
(b) $K = -2$ and $K = -2.5$
(c) $K < -2$ or $K > -2.5$
(d) $-(K + 2) < 0$ and $(2K + 5) > 0$

Ans. (a)

End of Solution

9. Which one of the following is the correct transfer function obtained from the Nyquist diagram shown in the figure?



(a) $G(s) = 1/s$ (b) $G(s) = K$
(c) $G(s) = 1/s^2$ (d) $G(s) = s$

Ans. (a)

Phase = –90°

Only option (a) satisfy.

End of Solution

10. Which one of the following statements is correct regarding root locus technique?
(a) It can be used to analyze and design the effect of loop gain upon the system's transient response and stability.
(b) It cannot be used to analyze and design the effect of loop gain upon the system's transient response and stability.
(c) It can be used to analyze and design the effect of loop gain upon the system's transient response only.
(d) It can be used to analyze and design the effect of loop gain upon the system's stability only.

Ans. (a)

Root Locus Technique : It can be used to analyze and design the effect of loop gain upon the system's transient response and stability.

End of Solution

11. The transfer function of a single, passive lag-lead network is

(a) $G_c(s) = \left[\dfrac{\left(s+\dfrac{1}{T_1}\right)}{\left(s+\dfrac{\gamma}{T_1}\right)}\right]\left[\dfrac{\left(s+\dfrac{1}{T_2}\right)}{\left(s+\dfrac{1}{\gamma T_2}\right)}\right]$

(b) $G_c(s) = \left[\dfrac{\left(s+\dfrac{1}{T_1}\right)}{\left(s+\dfrac{\gamma}{T_1}\right)}\right]\left[\dfrac{\left(s+\dfrac{1}{T_2}\right)}{\left(s+\dfrac{\gamma}{T_2}\right)}\right]$

(c) $G_c(s) = \left[\dfrac{\left(s+\dfrac{1}{T_1}\right)}{\left(s+\dfrac{1}{\gamma T_1}\right)}\right]\left[\dfrac{\left(s+\dfrac{1}{T_2}\right)}{\left(s+\dfrac{\gamma}{T_2}\right)}\right]$

(d) $G_c(s) = \left[\dfrac{\left(s+\dfrac{1}{T_1}\right)}{\left(s+\dfrac{\gamma}{T_1}\right)}\right]\left[\dfrac{\left(s+\dfrac{\gamma}{T_2}\right)}{\left(s+\dfrac{1}{T_2}\right)}\right]$

Ans. (*)

End of Solution

12. Which one of the following statements is correct regarding state variable approach over transfer function approach?

(a) The state variable can be fed back, it considers the initial conditions and state model of a system is unique.
(b) The state variable can be fed back, it considers the initial conditions and state model of a system is not unique.
(c) The state variable cannot be fed back, it considers the initial conditions and state model of a system is unique.
(d) The state variable can be fed back, it neglects the initial conditions and state model of a system is not unique.

Ans. (b)

The state variable can be fed back it considers the initial conditions and state model of a system is not unique.

End of Solution

13. What is the controllability of the state equation for the given system?

$$\dot{x} = Ax + Bu = \begin{bmatrix} -1 & 1 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & -2 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix} u$$

(a) The system is controllable.
(b) The system is not controllable
(c) It is not possible to find the controllability
(d) It is neither controllable nor stable

Ans. (a)

End of Solution

14. If the initial-state vector, $x(t_0)$, can be found from $u(t)$ and $y(t)$, measured over a finite interval of time from t_0, then the system is

(a) unobservable
(b) observable
(c) Not possible to find the observability
(d) neither unobservable nor observable

Ans. (b)

End of Solution

15. The open-loop transfer function of a unity feedback system is $G(s) = \dfrac{20}{0.21s+1}$. What is the time response subjected to a step input $X(s) = 0.8/s$?

(a) $0.76(1 - e^{-t/100})$
(b) $0.76(1 - e^{-t/0.01})$
(c) $0.95(1 - e^{-t/100})$
(d) $0.95(1 - e^{-t/0.01})$

Ans. (b)

Closed loop transfer function $= \dfrac{20}{0.21s+1+20}$

$$= \frac{\frac{20}{21}}{\frac{0.21}{21}s+1}$$

$$T = \frac{1}{100}$$

$$A = \frac{20}{21}\times 0.8 = 0.76$$

Step Response $= A[1 - e^{-t/T}]$

$= 0.76[1 - e^{-t/0.01}]$

End of Solution

16. Consider a random variable X with a uniform p.d.f. on $\left[-\frac{1}{2}, \frac{1}{2}\right]$. Assume that the random variable $Y = X^2$, i.e., $g(r) = r^2$. What is the value of $E(Y)$?

(a) $\dfrac{1}{4}$
(b) $\dfrac{1}{12}$
(c) $\dfrac{1}{16}$
(d) $\dfrac{1}{256}$

Ans. (b)

X taken uniform distribution over $\left[-\frac{1}{2}, \frac{1}{2}\right]$.

$$E[Y] = E[X^2] = \int_{-1/2}^{1/2} x^2 f(x)dx$$

$$= 2\int_0^{1/2} x^2(1)dx = 2\left[\frac{x^3}{3}\right]_0^{1/2}$$

$$= \frac{2}{3}\times\frac{1}{8} = \frac{1}{12}$$

End of Solution

17. What is the relationship between $H(1)$ and $H(2)$ from the N-point DFT of $h(n) = e^{-\frac{n}{5}}$, $0 \le n \le N$? (Take $N = 3$)

(a) $H(1) = H(2)$
(b) $H(1) = H^*(2)$
(c) $H(2) = 2H(1)$
(d) $H(2) + H(1) = 0$

Ans. (b)

$$N = 3$$

$$h(n) = \{1,\ e^{-1/5},\ e^{-2/5}\} \rightleftharpoons H(k)$$

$$H(k) = \sum_{n=0}^{N-1} h(x)\cdot e^{-j\frac{2\pi}{N}kn}$$

$$= \sum_{n=0}^{2} h(n)\cdot e^{-j\frac{2\pi}{N}kn}$$

$$H(1) = \sum_{n=0}^{2} h(n)\cdot e^{-j\frac{2\pi}{3}n}$$

$$= h(0) + h(1)e^{-j\frac{2\pi}{3}} + h(2)e^{-j\frac{4\pi}{3}}$$

$$= 1 + e^{-1/5}e^{-j\frac{2\pi}{3}} + h(2)e^{-j\frac{4\pi}{3}}$$

$$= 1 + e^{-1/5}e^{-j\frac{2\pi}{3}} + e^{-2/5}e^{j\frac{2\pi}{3}} \qquad \left[\because e^{-j\frac{4\pi}{3}} = e^{j\frac{2\pi}{3}}\right]$$

$$H(2) = \sum_{n=0}^{2} h(n).e^{-j\frac{4\pi}{3}n}$$

$$= h(0) + h(1)e^{-j\frac{4\pi}{3}} + h(2)e^{-j\frac{8\pi}{3}}$$

$$= 1 + e^{-1/5}e^{-j\frac{4\pi}{3}} + e^{-2/5}e^{-j\frac{8\pi}{3}}$$

$$= 1 + e^{-1/5}e^{j\frac{2\pi}{3}} + e^{-2/5}e^{-j\frac{2\pi}{3}}$$

Thus, $H(1) = H^*(2)$

End of Solution

18. What is the autocorrelation of the energy signal $x(t) = e^{-t}u(t)$?

(a) $\frac{1}{2}$ for $-\infty < \tau < \infty$
(b) $\frac{3}{4}e^{t-\tau}$ for $-\infty < \tau < \infty$
(c) $\frac{1}{2}e^{-2\tau}$ for $-\infty < \tau < \infty$
(d) $\frac{1}{2}e^{-|\tau|}$ for $-\infty < \tau < \infty$

Ans. (d)

$$r(\tau) = x(\tau) * x(-\tau)$$
$$\downarrow \text{FT}$$
$$R(\omega) = X(\omega).X(-\omega) = \frac{1}{1+j\omega}\cdot\frac{1}{1-j\omega} = \frac{1}{1+\omega^2}$$
$$\downarrow \text{IFT}$$
$$r(\tau) = \frac{1}{2}e^{-|\tau|}$$

End of Solution

19. The response of an LTI system to $u(t)$ is $g(t) = (2e^{-t} - e^{-5t})u(t)$. What is the response, when $x(t) = 1$?

(a) 0
(b) 2
(c) 5
(d) 7

Ans. (a)

$$H(s) = \frac{Y(s)}{X(s)} = \frac{\frac{2}{s+1} - \frac{1}{s+5}}{\frac{1}{s}} = \frac{s(s+9)}{(s+1)(s+5)}$$

For $x(t) = 1$, output will be

$$\text{Output} = H(s)|_{s=0} \times 1 = 0$$

End of Solution

20. What is the value of $x(t)$ for $t > 0$ from the given Laplace transform?

$$X(s) = \frac{s^2 + 3s + 3}{(s+1)(s-2)(s+5)}$$

(a) $\frac{1}{5} + \frac{2}{3}e^{-3t}$
(b) $-\frac{1}{12}e^{-t} + \frac{13}{21}e^{2t}$
(c) $\frac{1}{12}e^{t} + \frac{13}{21}e^{-2t} + \frac{13}{28}e^{5t}$
(d) $-\frac{1}{12}e^{-t} + \frac{13}{21}e^{2t} + \frac{13}{28}e^{-5t}$

Ans. (d)

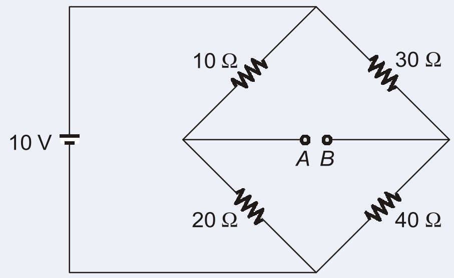
Given :
$$X(s) = \frac{s^2+3s+3}{(sH)(s-2)(s+5)}$$

$$X(s) = \frac{A}{s+1}+\frac{B}{s-2}+\frac{C}{s+5} \qquad \left[A=\frac{-1}{12}; B=\frac{13}{21}; C=\frac{13}{28}\right]$$

$$x(t) = \frac{-1}{12}e^{-t}u(t)+\frac{13}{21}e^{2t}+\frac{13}{28}e^{-5t}$$

End of Solution

21. What is the value of V_{AB} in the network shown in the figure?



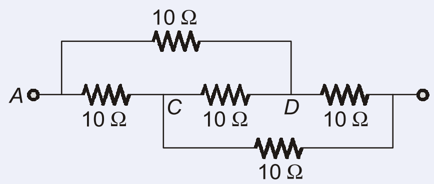
(a) 0.86 V
(b) 0.96 V
(c) 0.66 V
(d) 0.76 V

Ans. (b)

$$V_{AB} = V_A - V_B$$
$$= 10\times\frac{20}{30} - 10\times\frac{40}{70}$$
$$V_{AB} = \frac{20}{3}-\frac{40}{7}$$
$$V_{AB} = 0.96 \text{ V}$$

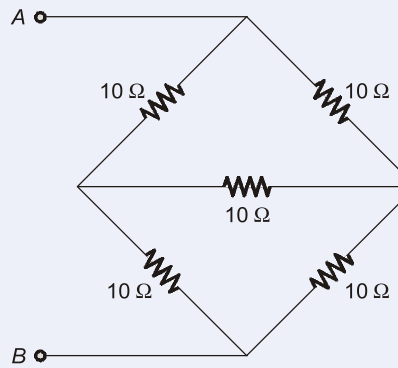
End of Solution

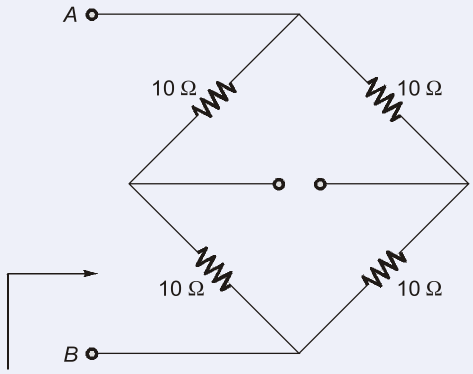
22. Five resistances of 10 Ω each are connected between terminals *A* and *B* as shown in the figure. What is the total resistance between terminals *A* and *B*?



(a) 5 Ω
(b) 10 Ω
(c) 15 Ω
(d) 20 Ω

Ans. (b)

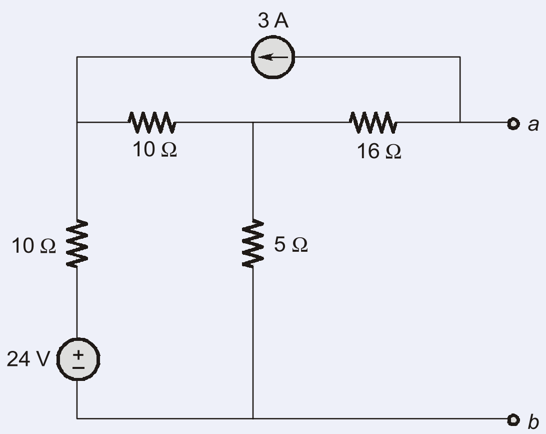




$R_{AB} = (20 \parallel 20) = 10\ \Omega$

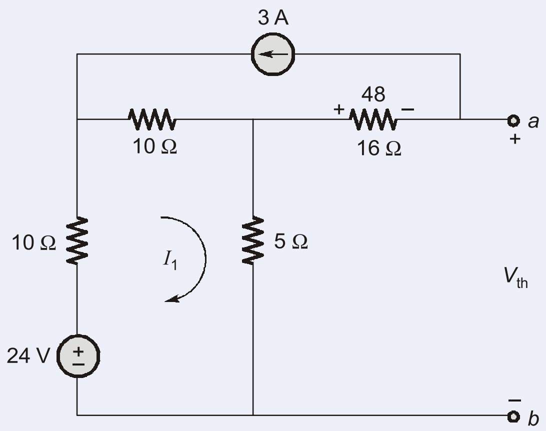
End of Solution

23. The Thevenin equivalent circuit voltage and resistance for the given circuit between terminals *a* and *b* respectively



(a) 49.2 V, 10 Ω
(b) –49.2 V, 15 Ω
(c) –49.2 V, 20 Ω
(d) 49.2 V, 20 Ω

Ans. (c)



Applying KVL in loop 1

$$24 = 25I_1 + 30$$

$$I_1 = \frac{24-30}{25} = -\frac{6}{25}$$

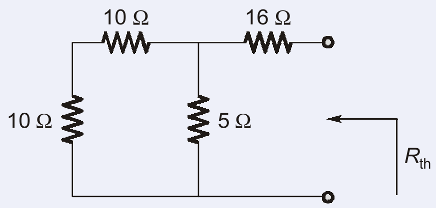
$$V_{th} = 5(I_1) - 48$$

$$= 5 \times \frac{-6}{25} - 48$$

$$= \frac{-6}{5} - 48$$

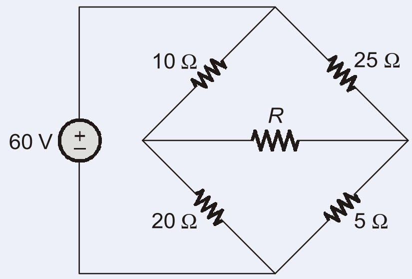
$$V_{th} = -49.2 \text{ V}$$

$$R_{th} = [(10 + 10) \parallel 5] + 16 = 20\ \Omega$$



End of Solution

24. What is the maximum power that can be delivered to the variable resistor R in the circuit?



(a) 15.77 W
(b) 18.77 W
(c) 19.77 W
(d) 20.77 W

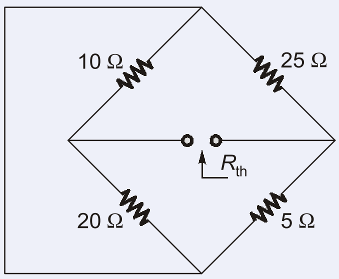
Ans. (d)

Condition for maximum power transfer is

$$R_L = R_{th}$$

For R_{th} calculation :

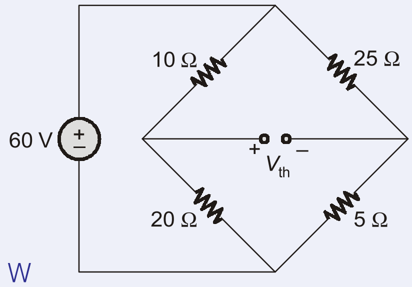
$$R_{th} = (10 \parallel 20) + (25 \parallel 5)$$



$$R_{th} = \frac{10 \times 20}{30} + \frac{25 \times 5}{30}$$

$$R_{th} = \frac{325}{30}$$

For V_{th} calculation :



$$V_{th} = 60 \times \frac{20}{30} - 60 \times \frac{5}{30}$$

$$V_{th} = 30 \text{ V}$$

$$P_{max} = \frac{V_{th}^2}{4R_{th}} = \frac{30 \times 30}{4 \times \frac{325}{30}} = 20.7 \text{ W}$$

End of Solution

25. Consider the following statements regarding the initial conditions for inductor and capacitor :

1. If there is no current flowing through the inductor at $t = 0^-$, the inductor will act as an open circuit at $t = 0^+$.
2. If there is no voltage across the capacitor at $t = 0^-$, the capacitor will act as an open circuit at $t = 0^+$.
3. If a current of value I_0 flows through the inductor at $t = 0^-$, the inductor can be regarded as a current source of I_0 ampere at $t = 0^+$.

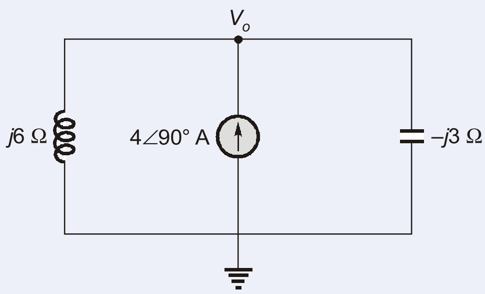
Which of the above statements is/are correct?

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

Ans. (c)

End of Solution

26. What is the value of voltage V_o shown in the circuit?



(a) –8 V
(b) 8 V
(c) 24 V
(d) –24 V

Ans. (c)

Applying KCL

$$\frac{V_o}{j6} + \frac{V_o}{-j3} = 4\angle 90^\circ$$

$$V_o\left[\frac{1}{j6}+\frac{1}{-j3}\right] = j4$$

$$V_o = 24 \text{ V}$$

End of Solution

27. The value of the power consumed by the balanced star-connected load in terms of the balanced delta-connected load is

(a) $P_Y = \left[\frac{P_\Delta}{\sqrt{3}}\right]$

(b) $P_Y = \left[\sqrt{3}P_\Delta\right]$

(c) $P_Y = \left[\frac{P_\Delta}{3}\right]$

(d) $P_Y = [3P_\Delta]$

Ans. (c)

End of Solution

28. The Z parameters of a two-port network are $Z_{11} = 20\ \Omega$, $Z_{22} = 30\ \Omega$, $Z_{12} = Z_{21} = 10\ \Omega$. The corresponding values of $ABCD$ parameters are

(a) $\begin{bmatrix} 2 & 0.1 \\ 50 & 3 \end{bmatrix}$

(b) $\begin{bmatrix} 3 & 50 \\ 0.1 & 2 \end{bmatrix}$

(c) $\begin{bmatrix} 2 & 40 \\ 0.1 & 3 \end{bmatrix}$

(d) $\begin{bmatrix} 2 & 50 \\ 0.1 & 3 \end{bmatrix}$

Ans. (d)

$$V_1 = 20I_1 + 10I_2 \quad ...(1)$$
$$V_2 = 10I_1 + 30I_2 \quad ...(2)$$

ABCD parameters :

$$V_1 = AV_2 - BI_2$$
$$I_1 = CV_2 - DI_2$$

From equation (2)

$$I_1 = \frac{V_2}{10} - \frac{30}{10}I_2 \quad ...(3)$$

Substitute equation (3) in equation (1)

$$V_1 = 20\left(\frac{V_2}{10} - 3I_2\right) + 10I_2$$

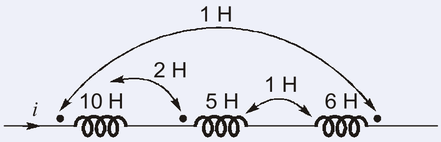
$$V_1 = 2V_2 - 50I_2 \quad ...(4)$$

From eqn. (3) and eqn. (4)

Values of ABCD parameters are $\begin{bmatrix} 2 & 50 \\ 0.1 & 3 \end{bmatrix}$

End of Solution

29. What is the value of equivalent inductance of the network shown in the figure?



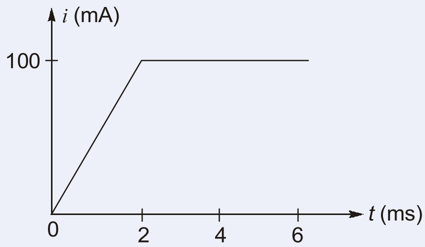
(a) 19 H
(b) 21 H
(c) 23 H
(d) 25 H

Ans. (b)

$$L_{eq} = L_1 + L_2 + L_3 + 2M_{12} - 2M_{23} - 2M_{13}$$
$$L_{eq} = 10 + 5 + 6 + 2(2) - 2(1) - 2(1)$$
$$L_{eq} = 21H$$

End of Solution

30. An initially uncharged 1 mF capacitor has the current shown in the figure. What is the voltage across it at $t = 2$ ms?



(a) 50 mV
(b) 100 mV
(c) 200 mV
(d) 250 mV

Ans. (b)

$$i(t) = \frac{100\times10^{-3}t}{2\times10^{-3}}$$
$$i(t) = 50t;\ 0 < t \le 2$$
$$V_c(t) = \frac{1}{C}\int_0^{2\times10^{-3}} i(t)dt$$
$$V_c = \frac{1}{1\times10^{-3}}\int_0^{2\times10^{-3}} 50t\,dt$$

V_c at 2 msec is 100 mV.

End of Solution

31. What is the percentage resolution of a 4-bit R-2R ladder DAC, which has a reference voltage of 4.5 V?

(a) 6.25%
(b) 6.67%
(c) 7.25%
(d) 7.67%

Ans. (b)

$$\text{Percentage resolution} = \frac{1}{2^n - 1} \times 100 = \frac{1}{15} \times 100$$
$$= 6.67\%$$

End of Solution

32. Consider the following statements regarding successive approximation ADC :
1. The output data can be taken out of the converter either in series or in parallel.
2. The circuit is less complex compared to ramp ADC.
3. As the conversion time is not dependent on the analog input, so it is comparatively faster.

Which of the above statements is/are correct?
(a) 1 and 2
(b) 2 only
(c) 3 only
(d) 1 and 3

Ans. (c)

End of Solution

33. What are the key properties of an op-amp which plays an important role in designing op-amp operated active filters?
(a) High output impedance, low input impedance and the possibility of having signal amplification to the desired level.
(b) High input impedance, low output impedance and the possibility of having signal amplification to the desired level.
(c) High output impedance, low input impedance and the possibility of having signal amplification to the higher level only.
(d) High input impedance, low output impedance and the possibility of having signal amplification to the lower level only

Ans. (b)
For op-amp operated active filter it requires
1. High input impedance
2. Low output impedance
3. Signal amplification to desired level

End of Solution

34. Which one of the following stores all data written to and read from memory?
(a) Instruction register
(b) Memory buffer register
(c) Memory address register
(d) Status register

Ans. (b)
MBR/MDR → Memory Buffer / Data Register

End of Solution

35. What does 'STA address' stand for in 8085 microprocessor?
(a) Copy the data byte at the memory location specified by the 16-bit address into the accumulator.
(b) Copy the data from the source to the destination location specified by the 16-bit address.
(c) Copy the data from the destination to the source location specified by the 16-bit address.
(d) Copy the data from the accumulator to the memory location specified by the 16-bit address.

Ans. (d)
STA 16-bit address → Store the content of accumulator at 16-bit address.

End of Solution

36. An AM commercial broadcast receiver is operating in a frequency band of 535 kHz to 1605 kHz with an input filter factor of 54. What are the bandwidths at the low and high ends of RF spectrum respectively?
(a) 100 kHz and 29.63 kHz
(b) 10 kHz and 2.96 kHz
(c) 10 kHz and 29.63 kHz
(d) 100 kHz and 2.96 kHz

Ans. (c)
B.W. at the low end of RF spectrum,

$$BW = \frac{fr}{Q} = \frac{535\text{ kHz}}{54} = 9.9\text{ kHz} \simeq 10\text{ kHZ}$$

B.W. at the high end of RF spectrum

$$= \frac{1605\text{ kHz}}{54} = 29.7\text{ kHz}$$

End of Solution

37. Consider the following statements regarding digital communication :
1. Digital signals can be coded to yield extremely low error rates and low fidelity.
2. Digital signals are easier to encrypt for security and privacy.
3. Digital signal storage is expensive.

Which of the above statements is/are correct?
(a) 1 and 2
(b) 2 only
(c) 3 only
(d) 1 and 3

Ans. (a)

End of Solution

38. Consider the following statements regarding Time-Division Multiplexing (TDM) :
1. TDM is readily implemented with high-density VLSI circuitry.
2. TDM synchronization is less demanding than that of suppressed-carrier FDM.
3. TDM crosstalk immunity does not depend on the transmission bandwidth.

Which of the above statements is/are correct?

(a) 1 and 2
(b) 2 only
(c) 1 only
(d) 1 and 3

Ans. (c)

End of Solution

39. What is net baseband bandwidth in Frequency-Division Multiplexing?

(a) It is the sum of the modulated message bandwidths and the guard bands
(b) It is the product of the modulated message bandwidths and the guard bands
(c) It is the value obtained by subtracting modulated message bandwidths from the guard bands
(d) It is the product of the modulating message bandwidths and the modulated message

Ans. (a)

End of Solution

40. During serial transmission, a group of 512 sequential 12-bit data words is transmitted in 0.016 s. What is the speed of transmission?

(a) 384 kbps
(b) 384 bps
(c) 6.84 kbps
(d) 6.84 bps

Ans. (a)

$$512 \times 12 = 6144 \text{ bits transmitted in } 0.016 \text{ seconds}$$

Number of bits transmitted in 1 sec

$$= \frac{1}{0.016} \times 6144 = 384000$$

End of Solution

41. What is the property of an isotropic material that must be satisfied?

(a) It has the same electric properties for the various directions of appliance of the electric field
(b) It has the different electric properties for the various directions of appliance of the electric field
(c) It has the different electric properties for the same direction of appliance of the electric field
(d) It has the same electric properties for the opposite directions of appliance of the electric field

Ans. (a)

Isotrope materials exhibit same electric properties in all directions of applied electric field.

End of Solution

42. What is the order of resistivity of conductive material?

(a) 10^{-6} Ω-m to 10^{-8} Ω-m
(b) 10^{6} Ω-m to 10^{8} Ω-m
(c) 10^{-10} Ω-m to 10^{8} Ω-m
(d) 10^{-9} Ω-m to 10^{12} Ω-m

Ans. (a)

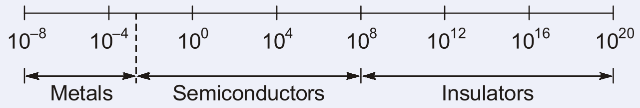


Fig. : Resistivity scale for materials found in nature

End of Solution

43. What are the properties of good insulating material?

(a) Low dielectric strength, volume resistivity of high value and very low dissipation factor
(b) Low dielectric strength, volume resistivity of low value and very low dissipation factor
(c) Low dielectric strength, volume resistivity of low value and high dissipation factor
(d) High dielectric strength, volume resistivity of high value and very low dissipation factor

Ans. (d)

- High dielectric strength
- Volume resistivity of high value
- Very low dissipation factor

End of Solution

44. What is the value of the Curie temperature of iron?

(a) About 1043 K
(b) About 1555 K
(c) About 1422 K
(d) About 1322 K

Ans. (a)

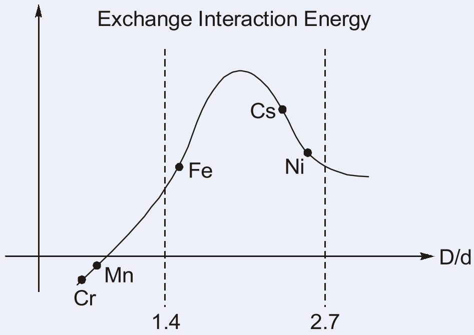
Material	Curie Temperature (K)
Fe	1043
Co	1404
Ni	631
Cd	289

End of Solution

45. Which one of the following is the correct relationship among the Curie temperatures of Fe, Ni and Co?

(a) (*D*/*d*)(Ni) Curie < (*D*/*d*) (Fe) Curie < (*D*/*d*) (Co) Curie
(b) (*D*/*d*)(Ni) Curie < (*D*/*d*) (Co) Curie < (*D*/*d*) (Fe) Curie
(c) (*D*/*d*)(Co) Curie < (*D*/*d*) (Ni) Curie < (*D*/*d*) (Fe) Curie
(d) (*D*/*d*)(Fe) Curie < (*D*/*d*) (Ni) Curie < (*D*/*d*) (Co) Curie

Ans. (*)



End of Solution

46. What is the value of $\int_0^{2+i} (\bar{z})^2 dz$, along the line $y = \frac{x}{2}$?

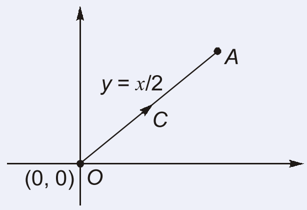
(a) $\frac{5}{3}(2-i)$

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

(c) $\frac{4}{3}(2+i)$

(d) $2 - i$

Ans. (a)



$$Z = x + iy \Rightarrow dz = dx + idy$$

Along OA : $y = \frac{x}{2} \Rightarrow dy = \frac{dx}{2}$

So, $dz = dx + i\left(\frac{dx}{2}\right) = \left(1+\frac{i}{2}\right)dx \qquad (0 \le x \le 2)$

$$I = \int_0^{2+i} (\bar{z})^2 dz = \int_0^{2+i} (x-iy)^2 dz = \int_C (x^2 - y^2 - 2ixy)dz$$

$$= \int_{OA}\left[x^2 - \frac{x^2}{4} - 2ix\left(\frac{x}{2}\right)\right]\left(1+\frac{i}{2}\right)dx$$

$$= \left(1+\frac{i}{2}\right)\int_{x=0}^{2}\left(\frac{3}{4}x^2 - ix^2\right)dx$$

$$= \left(1+\frac{i}{2}\right)\left(\frac{3}{4}-i\right)\left(\frac{x^3}{3}\right)_0^2$$

$$= \left(\frac{3}{4} - i + \frac{3}{8}i - \frac{i^2}{2}\right)\left(\frac{8}{3}\right) = \left[\frac{5}{4} - \frac{5}{8}i\right]\left(\frac{8}{3}\right)$$

$$= \frac{10}{3} - \frac{5}{3}i = \frac{5}{3}[2 - i]$$

Hence, the correct option is (a)

End of Solution

47. The following is the frequency distribution of a random sample of weekly earnings of 509 employees :

Weekly earning	No. of employees
10	3
12	6
14	10
16	15
18	24
20	42
22	75
24	90
26	79
28	55
30	36
32	26
34	19
36	13
38	9
40	7

What is the average weekly earning?

(a) 26.16
(b) 24.87
(c) 28.61
(d) 20.74

Ans. (*)

Weeakly Earnings	No. of Employees (N)	X
10	3	30
12	6	72
14	10	140
16	15	240
18	24	432
20	42	840
22	75	1650
24	90	2160
26	79	2054
28	55	1540
30	36	1080
32	26	832
34	19	646
36	13	468
38	9	342
40	7	280
	$N = 509$	$\Sigma X = 12806$

So, Average earning $= \frac{\Sigma X}{N} = \frac{12806}{509} = 25.15$

End of Solution

48. The numbers examined, the mean weight and the standard deviation in each group of examination by three medical examiners are given below. What is the standard deviation of the entire data when grouped together?

Med. Exam	Nos. examined	Mean wt. (lb)	SD (lb)
A	50	113	6
B	60	120	7
C	90	115	8

(a) 8.183 lb
(b) 7.746 lb
(c) 7.152 lb
(d) 6.981 lb

Ans. (b)

$$\bar{X}_C = 116$$

$$d_1 = X_1 - \bar{X}_C = 113 - 116 = -3$$

$$d_2 = X_2 - \bar{X}_C = 120 - 116 = 4$$

$$d_3 = X_3 - \bar{X}_C = 115 - 116 = -1$$

$$\text{Combined } \sigma_C = \sqrt{\frac{N_1\sigma_1^2 + N_2\sigma_2^2 + N_3\sigma_3^2 + N_1d_1^2 + N_2d_2^2 + N_3d_3^2}{N_1 + N_2 + N_3}}$$

$$= \sqrt{\frac{(50\times36)+(60\times49)+(90\times64)+(50\times9)+(60\times16)+(90\times1)}{200}}$$

$$= 7.746$$

End of Solution

49. The solution for

$$\frac{d^4x}{dt^4} + 4x = 0$$

is

(a) $x = e^{-t}(c_1 \cos 2t + c_2 \sin 2t) + e^{t}(c_3 \cos 2t + c_4 \sin 2t)$
(b) $x = e^{-t}(c_1 \cos 4t + c_2 \sin 4t) + e^{t}(c_3 \cos 4t + c_4 \sin 4t)$
(c) $x = e^{-t}(c_1 \cos t + c_2 \sin t) + e^{t}(c_3 \cos t + c_4 \sin t)$
(d) $x = e^{-2t}(c_1 \cos t + c_2 \sin t) + e^{4t}(c_3 \cos t + c_4 \sin t)$

Ans. (c)

$$(D^4 + 4)x = 0$$

A.E. is $m^4 + 4 = 0 \Rightarrow (m^2)^2 - (2i)^2 = 0$

$$(m^2 - 2i)(m^2 + 2i) = 0$$

$$m^2 = 2i \text{ and } m^2 = -2i$$

$$m = \pm\sqrt{2}(i)^{1/2} \text{ and } m = \pm\sqrt{2}(-i)^{1/2}$$

$$= \pm\sqrt{2}\left[e^{\frac{\pi}{2}i}\right]^{1/2} \text{ and } m = \pm\sqrt{2}\left[e^{\frac{-\pi}{2}i}\right]^{1/2}$$

$$= \pm\sqrt{2}\left[\cos\frac{\pi}{4} + i\sin\frac{\pi}{4}\right] \text{ and } m = \pm\sqrt{2}\left[\cos\frac{-\pi}{4} + i\sin\frac{-\pi}{4}\right]$$

$$= \pm(1 + i) \text{ and } m = \pm\sqrt{2}\left(\frac{1}{\sqrt{2}} - i\frac{1}{\sqrt{2}}\right)$$

$$= \pm(1 - i) = 1 - i \text{ and } -1 + i$$

Hence, roots are $m = 1 \pm i\ (\alpha \pm i\beta)$ and $-1 \pm i\ (\gamma \pm i\delta)$

Given solution is $x = CF + PI$

$$x = e^{1.t}[C_1 \cos t + C_2 \sin t] + e^{-1.t}[C_3 \cos t + C_4 \sin t] + 0$$

End of Solution

50. What is the deflection $u(x, y, t)$ of the square membrane with $a = b$ and $c = 1$ if the initial velocity is and the initial $f(x, y) = A \sin \pi x \sin 2\pi y$?

(a) $A \sin \pi x \sin 2\pi y$

(b) $A \sin \pi x \sin 2\pi y \sin\left(\sqrt{3}\pi t\right)$

(c) $A \sin \pi x \sin 2\pi y \tan\left(\sqrt{6}\pi t\right)$

(d) $A \sin \pi x \sin 2\pi y \cos\left(\sqrt{5}\pi t\right)$

Ans. (d)

Two dimensional wave equation is given as

$$\frac{\partial^2 u}{\partial t^2} = \left(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2}\right) C^2$$

where deflection is $u = f(x, y, t)$

But we will solve it by options.

Taking option (d), $u = A \sin \pi x \,.\, \sin 2\pi y.\ \cos(\sqrt{5}\pi t)$

At t = 0, initial deflection

$$u = A \sin \pi x \,.\, \sin 2\pi y$$

which is given in question. Hence, option (d) is the right answer.

End of Solution

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51. If $u = x \log xy$, where $x^3 + y^3 + 3xy = 1$, what is du/dx?

(a) $du/dx = \log xy - x(x^2 + y)/y(y^2 + x)$

(b) $du/dx = 0.5 + \log xy - x(x^2 + 2y)/y(y^2 + x)$

(c) $du/dx = 2 + \log xy - x(x^2 + y)/y(y^2 + 2x)$

(d) $du/dx = 1 + \log xy - x(x^2 + 2y)/y(y^2 + x)$

Ans. (d)

$$u = x \log xy$$

then, $$u_x = x\left(\frac{1}{xy} \cdot y\right) + \log xy$$

$$u_y = x\left(\frac{1}{xy} \cdot x\right) = \frac{x}{y}$$

and $x^3 + y^3 + 3xy = 1 \Rightarrow \dfrac{dy}{dx} = -\left(\dfrac{x^2 + y}{y^2 + x}\right)$

Now $u \to (x, y) \to x$

So, by total derivative concept

$$du = \left(\frac{\partial u}{\partial x}\right) dx + \left(\frac{\partial u}{\partial y}\right) dy$$

or
$$\frac{du}{dx} = \left(\frac{\partial u}{\partial x}\right) + \left(\frac{\partial u}{\partial y}\right)\frac{dy}{dx}$$

$$= 1 + \log(xy) + \left(\frac{x}{y}\right) \cdot \left[-\left(\frac{x^2 + y}{y^2 + x}\right)\right]$$

End of Solution

52. What is the particular integral of $(D^3 + 1)y = \cos(2x - 1)$?

(a) $\frac{1}{25}[\cos(2x-1) - 5\sin(2x-1)]$

(b) $\frac{1}{55}[\cos(2x-1) - 6\cos(2x-1)]$

(c) $\frac{1}{65}[\cos(2x-1) - 8\sin(2x-1)]$

(d) $\frac{1}{75}[\sin(2x-1) - 4\sin(2x-1)]$

Ans. (c)

$$(D^3 + 1)y = \cos(2x - 1)$$

$$\text{P.I.} = \frac{1}{f(D)} \cdot Q = \frac{1}{D^3 + 1}\cos(2x-1)$$

$$= \frac{1}{D(-4)+1}\cos(2x-1) = \frac{1}{1-4D}\cos(2x-1)$$

$$= \frac{1+4D}{1^2 - 16D^2}(\cos(2x-1)) = \frac{1+4D}{1-16(-4)}\cos(2x-1)$$

$$= \frac{1+4D}{65}\cos(2x-1)$$

$$= \frac{1}{65}[\cos(2x-1) - 8\sin(2x-1)]$$

End of Solution

53. Let X be a Poisson variate such that $P[X = 2] = 9P[X = 4] + 90P[X = 6]$. Then $E[X]$ is equal to

(a) 1

(b) e^2

(c) log 2

(d) $\frac{1}{2}$

Ans. (a)

$$P(X = 2) = 9P(X = 4) + 90P(X = 6)$$

$$\frac{e^{-\lambda} \cdot \lambda^2}{2!} = 9\frac{e^{-\lambda}\lambda^4}{4!} + 90\frac{e^{-\lambda} \cdot \lambda^6}{6!}$$

$$\lambda^2 = \frac{9\lambda^4}{12} + \frac{90\lambda^6}{360} = \frac{3\lambda^4}{4} + \frac{\lambda^6}{4}$$

$$\lambda^6 + 3\lambda^4 - 4\lambda^2 = 0 \quad \text{or} \quad \lambda^2(\lambda^4 - 3\lambda^2 - 4) = 0$$
$$\lambda^2[(\lambda^2 - 4)(\lambda^2 + 1) = 0 \quad \Rightarrow \quad \lambda = 0, \pm 2, \pm 1$$

For Poisson, λ = variance so neglect –ve values.

$$\lambda = 0, 1, 2$$

End of Solution

54. A random variable X takes values 0, 1, 2, 3, ... with probability proportional to $(x+1)\left(\frac{1}{5}\right)^x$. then, $P[X \le 2]$ is

(a) $\frac{1}{225}$ (b) $\frac{503}{911}$

(c) $\frac{608}{625}$ (d) $\frac{11}{25}$

Ans. (c)

X	:	0	1	2	3	.....
P(X)	:	K	$\frac{2K}{5}$	$\frac{3K}{5^2}$	$\frac{4K}{5^3}$	.....

We know that : $\sum_{i=0}^{\infty} P(X = X_i) = 1$

$$K + \frac{2K}{5} + \frac{3K}{5^2} + \frac{4K}{5^3} + ... = 1$$

$$K\left[1 + 2\left(\frac{1}{5}\right) + 3\left(\frac{1}{5}\right)^2 + 4\left(\frac{1}{5}\right)^3 + ...\right] = 1$$

$$K\left[1 - \frac{1}{5}\right]^{-2} = 1$$

$$\frac{16}{25} = K$$

$$\therefore \quad P(X \le 2) = P(X=0) + P(X=1) + P(X=2)$$

$$= \frac{16}{25} + \frac{2}{5}\left(\frac{16}{25}\right) + \frac{3}{25}\left(\frac{16}{25}\right)$$

$$= \frac{16}{25}\left[1 + \frac{2}{5} + \frac{3}{25}\right]$$

$$\frac{35 \times 16}{625} = \frac{608}{625}$$

End of Solution

55. A die is thrown as long as necessary for a 6 to turn up. Given that 6 does not turn up at the first throw. What is the probability that more than four throws are necessary?

(a) $\frac{125}{216}$
(b) $\frac{121}{323}$
(c) $\frac{271}{341}$
(d) $\frac{9}{19}$

Ans. (a)

A = {More than 4 throws are required to get 6}
B = {6 is not coming in 1st throw}

$$P(A/B) = \frac{P(A\cap B)}{P(B)} = \frac{P\left(\frac{B}{A}\right)\cdot P(A)}{P(B)}$$

$$= \frac{1\times\left(\frac{5}{6}\right)^4}{\left(\frac{5}{6}\right)} = \left(\frac{5}{6}\right)^3 = \frac{125}{216}$$

End of Solution

56. If A and B are independent events and $P[A] = P[B \mid A] = \frac{1}{2}$, then $P[A \cup B]$ is

(a) $\frac{2}{5}$
(b) $\frac{3}{7}$
(c) $\frac{5}{9}$
(d) $\frac{3}{4}$

Ans. (d)

$$P(A\cap B) = P(A).P(B) \quad (\because A, B \text{ are independent events})$$

$$P(A \cup B) = P(A) + P(B) - P(A).P(B)$$

$$= \frac{1}{2}+\frac{1}{2}-\frac{1}{2}\times\frac{1}{2}$$

$$= 1-\frac{1}{4} = \frac{3}{4}$$

End of Solution

57. The solution of the initial value problem $\frac{d^2y}{dx^2}+\frac{dy}{dx}-6y = 0$; $y(0) = 6$, $y'(0) = 2$ is

(a) $2e^{x} + 3e^{7x}$
(b) $e^{x} - e^{7x}$
(c) $4e^{2x} + 2e^{-3x}$
(d) $e^{x}(\sin x + \cos x)$

Ans. (c)

$$(D^2 + D - 6)y = 0,\ y(0) = 6,\ y'(0) = 2$$

y_{CF} : $f(m) = m^2 + m - 6 = 0$

$$m^2 + 3m - 2m - 6 = 0$$

$$m(m + 3) - 2(m + 3) = 0$$

$\Rightarrow$ $m = 2, -3$

$\therefore$ $y_{CF} = y = C_1e^{-3t} + C_2e^{2t}$

Put $t = 0,\ y = 6$

$$6 = C_1 + C_2 \quad ...(1)$$

$$y' = -3C_1e^{-3t} + 2C_2e^{2t}$$

Put $t = 0,\ y' = 2$

$$2 = -3C_1 + 2C_2 \quad ...(2)$$

Solving $C_2 = 4,\ C_1 = 2$

$\therefore$ $y = 4e^{2x} + 2e^{-3x}$

End of Solution

58. How is J-K flip-flop created from S-R latch?
(a) By adding more inputs
(b) By replacing the S and R inputs with NAND gates
(c) By connecting the inputs to the outputs
(d) By changing the clock input

Ans. (b)

End of Solution

59. How many select input lines are there in 1-to-8 demultiplexer?
(a) 2
(b) 1
(c) 4
(d) 3

Ans. (d)

End of Solution

60. How many comparators and resistors are used in n-bit flash A-to-D converter respectively?
(a) 2^n and $2^n - 1$
(b) 2^n and $2^n + 1$
(c) $2^n + 1$ and 2^n
(d) $2^n - 1$ and 2^n

Ans. (d)

End of Solution

61. What are the important characteristics that must be satisfied for the materials used to build permanent magnets?
(a) Low permeability, high coercive force and high Curie temperature
(b) Low permeability, high coercive force and low Curie temperature
(c) High permeability, high coercive force and high Curie temperature
(d) High permeability, low coercive force and low Curie temperature

Ans. (a)

End of Solution

62. What are the important characteristics that must be satisfied for the materials used to build core of the transformer?
(a) High permeability, low hysteresis and high eddy current losses
(b) High permeability, low hysteresis and eddy current losses
(c) High permeability, high hysteresis and eddy current losses
(d) Low permeability, low coercive force and low Curie temperature

Ans. (b)

End of Solution

63. What are the nominal values of drop in potential across conducting silicon diodes, Schottky diodes and light- emitting diodes respectively?
(a) 0.6 to 0.7 volt, 0.2 V and 1.4 V
(b) 0.6 to 0.7 volt, 1.2 V and 0.2 V
(c) 0.6 to 0.7 volt, 2.2 V and 1.4 V
(d) 0.6 to 0.7 volt, 0.2 V and 5.4 V

Ans. (a)
Silicon diodes, V_{drop} = 0.6 to 0.7 V
Schottky diodes, V_{drop} = 0.2 V
LED, V_{drop} = 1.4 V

End of Solution

64. Which one of the following statements is correct related to extrinsic and degenerate semiconductors?
(a) Lightly and moderately doped semiconductor is referred to as extrinsic and when it is doped to such high levels that it acts more like a conductor than a semiconductor, it is referred to as degenerate.
(b) Heavily doped semiconductor is referred to as extrinsic and when it is doped to such high levels that it acts more like a conductor than a semiconductor, it is referred to as degenerate.
c) Moderately doped semiconductor is referred to as extrinsic and when it is doped to such low levels that it acts more like a conductor than a semiconductor, it is referred to as degenerate.
(d) Lightly doped semiconductor is referred to as extrinsic and when it is doped to such low levels that it acts more like a conductor than a semiconductor, it is referred to as degenerate.

Ans. (a)
Extrinsic can be lightly and moderately doped.
Dyenerate can be heavily doped behaves like conductor.

End of Solution

65. What is an optoisolator?
(a) LED is paired with a photodiode or phototransistor in the same package and it allows DC coupling.
(b) LED is paired with a silicon diode in the same package and it allows AC coupling.

(c) LED is paired with a photodiode or phototransistor in the same package and it does not allow DC coupling.
(d) LED is paired with a photodiode or phototransistor in the same package and it does not allow AC coupling.

Ans. (a)

End of Solution

66. Which one of the following is correct related to Type-1 superconductors along with the critical transition temperature (T_c)?
(a) Lead (Pb) of 4.15 K, Mercury (Hg) of 7.196 K and Aluminium (Al) of 1.175 K
(b) Lead (Pb) of 7.196 K, Mercury (Hg) of 4.15 K and Aluminium (Al) of 1.175 K
(c) Lead (Pb) of 1.175 K, Mercury (Hg) of 4.15 K and Aluminium (Al) of 7.196 K
(d) Lead (Pb) of 7.196 K, Mercury (Hg) of 1.175 K and Aluminium (Al) of 4.15 K

Ans. (b)

Transition Temperature
Lead (Pb) – 7.2 K
Mercury (Hg) – 4.15 K
Aluminium (Al) – 1.17 K

End of Solution

67. Organic superconductors are composed of
(a) both an electron donor (the planar organic molecule) and an electron acceptor (a non-organic anion)
(b) an electron donor (the planar organic molecule) only
(c) an electron acceptor (a non-organic anion) only
(d) both an electron donor (a non- organic anion) and an electron acceptor (the planar organic molecule)

Ans. (d)

End of Solution

68. If the input signal is $x(n) = \text{sinc}\left(\frac{\omega_c n}{\pi}\right)$, then what is the energy of the signal? (Assume $\omega_c < \pi$)

(a) $\frac{\omega_c}{\pi}$
(b) $\frac{\pi}{\omega_c}$
(c) $\frac{\omega_c}{2\pi}$
(d) $\frac{2\pi}{\omega_c}$

Ans. (b)

$$x(n) = \text{sinc}\left(\frac{\omega_c n}{\pi}\right) = Sa(\omega_c n)$$

$$\text{Energy of } x(n) = \frac{\pi}{\omega_c} \text{ by Parseval's energy theorem.}$$

End of Solution

69. Let $X(e^{j\omega})$ be the Fourier transform of the signal $x(n) = \{-1, 0, 1, 2, 1, 0, 1, 2, 1, 0, -1\}$, where $-3 \le n \le 7$. What is the value of the following?

$$\int_{-\pi}^{\pi} \left|\frac{dX(e^{j\omega})}{d\omega}\right|^2 d\omega$$

(a) 28π
(b) 256π
(c) 316π
(d) 356π

Ans. (c)

$$nx(n) \rightleftharpoons \frac{jdX(e^{j\omega})}{d\omega}$$

$$f(n) = \frac{nx(n)}{j} \rightleftharpoons \frac{dX(e^{j\omega})}{d\omega} = F(e^{j\omega})$$

Now, $$\int_{-\pi}^{\pi} \left|\frac{dX(e^{j\omega})}{d\omega}\right|^2 d\omega = \int_{-\pi}^{\pi} \left|F(e^{j\omega})\right|^2 d\omega$$

$$= 2\pi \text{ Energy of } f(n)$$

$$= 2\pi \sum_{x=-\infty}^{\infty} |f(n)|^2 = 2\pi \sum_{x=-3}^{7} \left|\frac{n}{j} x(n)\right|^2$$

$$= 2\pi \sum_{x=-3}^{7} n^2 x^2(n) = 316\pi$$

End of Solution

70. What is the inverse Fourier transform of the following?

$$X(e^{j\omega}) = \begin{cases} 2j; & 0 < \omega \le \pi \\ -2j; & -\pi < \omega \le 0 \end{cases}$$

(a) $1 + \cos\left(\frac{\pi}{2} n\right)$
(b) $\frac{2}{n\pi} \sin\left(\frac{n\pi}{2}\right)$
(c) $\frac{4}{n\pi} \sin\left(\frac{n\pi}{4}\right)$
(d) $\frac{4}{n\pi} \sin^2\left(\frac{n\pi}{2}\right)$

Ans. (d)

$\because \quad X(e^{j\omega})$ = Imaginary-odd signal

$\therefore \quad x(n)$ = real-odd signal

End of Solution

71. If $x(n) = \delta(n-1) + \delta(n+1)$, what is the DTFT value for the given signal?

(a) $\sin(\omega)$
(b) $\cos(\omega)$
(c) $2\sin(\omega)$
(d) $2\cos(\omega)$

Ans. (d)

$$x(n) = \delta(n-1) + \delta(n+1)$$
$$X(e^{j\omega}) = e^{-j\omega} + e^{j\omega} = 2\cos\omega$$

End of Solution

72. If $x(n) = \cos(\omega_0 n)\, u(n)$, then what is the DTFT of the signal?

(a) $\pi[\delta(\omega-\omega_0) + \delta(\omega+\omega_0)]$
(b) $\pi[\delta(\omega-\omega_0) - \delta(\omega+\omega_0)]$
(c) $\pi + \pi^2[\delta(\omega-\omega_0) + \delta(\omega+\omega_0)]$
(d) $\pi^2 + \pi[\delta(\omega-\omega_0) + \delta(\omega+\omega_0)]$

Ans. (*)

$$f(n) = u(n) \rightleftharpoons \frac{1}{1-e^{-j\omega}} + \pi\delta(\omega) = F(e^{j\omega})$$

$$x(n) = \cos\omega_0 n.u(n) \rightleftharpoons X(e^{j\omega}) = \frac{1}{2}[F\{e^{j(\omega+\omega_0)}\} + F\{e^{j(\omega-\omega_0)}\}]$$

$$X(e^{j\omega}) = \frac{1}{2}\left[\frac{1}{1-e^{-j(\omega+\omega_0)}} + \pi\delta(\omega+\omega_0) + \frac{1}{1-e^{-j(\omega-\omega_0)}} + \pi\delta(\omega-\omega_0)\right]$$

All options are wrong.

End of Solution

73. What are the initial and final values of $y(t)$ respectively, if its Laplace transform is

$$Y(s) = \frac{10(2s+3)}{s(s^2+2s+5)}$$

(a) 4 and 1
(b) 1 and 6
(c) 3 and 5
(d) 0 and 6

Ans. (d)

$$y(t)|_{t=0} = \lim_{s\to\infty} sy(s) = 0$$

$$y(t)|_{t=\infty} = \lim_{s\to 0} sy(s) = 6$$

End of Solution

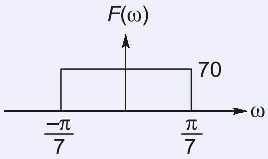
74. If the function $x(t) = 10\,\text{sinc}\left(\frac{t+4}{7}\right)$, then what is the total area undler the function?

(a) 28
(b) 40
(c) 70
(d) $\frac{40}{7}$

Ans. (c)

$$f(t) = 10\,\text{sinc}\left(\frac{t}{7}\right)$$

$$= 10Sa\left(\frac{\pi}{7}t\right) \rightleftharpoons$$



$$\text{Area of } x(t) = \text{Area of } f(t) = F(\omega)|_{\omega=0}$$
$$= 70$$

End of Solution

75. If $x(t) = \delta(3t) + u(3t)$, then what are the Laplace transform and the associated ROC for the function of time respectively?

(a) $\frac{1}{3}\left(\frac{s^2+1}{s}\right), R\{s\} > 3$
(b) $\frac{1}{3}s + \frac{3}{s}, R\{s\} < 3$
(c) $\frac{s^2+3}{3s}, R\{s\} < 0$
(d) $\frac{s+3}{3s}, R\{s\} > 0$

Ans. (d)

$$x(t) = \delta(3t) + u(3t)$$
$$= \frac{1}{3}\delta(t) + u(t)$$
$$X(s) = \frac{1}{3} + \frac{1}{s} = \frac{s+3}{3s}$$

ROC : $\sigma > 0$ or $R\{s\} > 0$

End of Solution

76. In a Wien bridge oscillator, if the value of R is 10 kΩ and the frequency of oscillation is 10 kHz, what is the value of capacitor C?

(a) 0.159 pF
(b) 15.9 pF
(c) 159 pF
(d) 1.59 pF

Ans. (*)

Given Wien bridge oscillator

$$R = 10\ \text{k}\Omega$$
$$f_0 = 10\ \text{kHz}$$
$$C = ?$$
$$f_0 = \frac{1}{2\pi RC}$$
$$C = \frac{1}{2\pi f_0 R} = 1.59\ \text{nF (or) } 1590\ \text{pF}$$

End of Solution

77. Consider the following statements regarding frequency stability oscillator:
1. Due to change in temperature, the values of the frequency determining components, viz., resistor, inductor and capacitor are changed.
2. Frequency can affect due to variation in biasing conditions and loading conditions.
3. The effective resistance of the tank circuit is unchanged when the load is connected.

Which of the above statements is/are correct?
(a) 1 and 2 only
(b) 2 and 3 only
(c) 2 only
(d) 1, 2 and 3

Ans. (a)

For frequency stability oscillator

Statement-1 and statement-2 are correct.

End of Solution

78. A power diode can be used as a switch because its resistance can be controlled with
(a) applied
(b) small current
(c) higher current
(d) applied voltage

Ans. (d)

End of Solution

79. The reverse current reduces and the voltage across the power diode grows more negative during the turnoff process of the power diode. This time is called
(a) fall time
(b) recovery time
(c) reverse recovery time
(d) rise time

Ans. (c)

End of Solution

80. What are the significant advantages of MOS power transistor over bipolar power transistor in the pulse power supplies?
(a) Very high input resistance and the input currents are of the order of nA.
(b) Very low input resistance and the input currents are of the order of kA.
(c) Very high input resistance and the input currents are of the order of kA.
(d) Very low input resistance and the input currents are of the order of nA

Ans. (a)

End of Solution

81. In a gate turnoff thyristor, the turning off is achieved by
(a) latching current at gate
(b) holding current at gate
(c) positive current at gate
(d) negative current at gate

Ans. (d)

End of Solution

82. The function of a capacitive filter in a Graetz diode bridge rectifier is to
(a) remove small load current ripples from the rectified output signal.
(b) minimize voltage variations in AC input signal.
(c) reduce harmonics in the rectified output signal.
(d) introduce more ripples into the rectified output signal.

Ans. (a, c)

End of Solution

83. The use of an inductive filter in a rectifier circuit provides satisfactory performance only when
(a) the load current is high
(b) the load voltage is high
(c) the load current is low
(d) the load voltage is low

Ans. (c)

End of Solution

84. If a separately excited DC motor is to be operated in the first quadrant only, the converter is used in
(a) single-phase half-controlled rectifier
(b) single-phase full-controlled rectifier
(c) single-phase dual-controlled rectifier
(d) four-quadrant chopper

Ans. (a)

End of Solution

85. The static Scherbius drive can able to provide
(a) variable torque control
(b) constant torque control
(c) braking operation
(d) variable speed

Ans. (d)

End of Solution

86. Which one of the following statements is correct regarding series resonant inverter?
(a) The load current is a square waveform.
(b) The output voltage waveform depends on the damping factor of load impedance.
(c) The trigger frequency is higher than the damped resonant frequency.
(d) The input voltage waveform depends on the damping factor of load impedance.

Ans. (c)

End of Solution

87. If a single-phase full-bridge voltage source inverter operates with *R* load, the nature of output current is
(a) square wave
(b) sine wave
(c) triangular wave
(d) pulse wave

Ans. (a)

End of Solution

88. Which one of the following cores is used for large mains transformers to reduce eddy current loss of high-frequency operation in power electronic circuit?
(a) Laminated iron core
(b) Laminated steel core ,
(c) Compressed ferromagnetic alloy core
(d) Ferromagnetic alloy core

Ans. (c)

End of Solution

89. When an induction motor and a heater are supplied from a phase-controlled single-phase AC voltage controllers, then
(a) only fundamental component of output voltage and current is useful in the induction motor but fundamental and harmonics are useful in the heater
(b) fundamental and harmonics are useful in the induction motor but only fundamental component of output voltage and current is useful in the heater
(c) both fundamental and harmonics are useful in the induction motor and heater
(d) only harmonics are useful in the induction motor and heater

Ans. (a)

End of Solution

90. Consider the following statements regarding IGBT:
1. 1. It combines into it the advantages of both MOSFET and BJT.
2. It is free from second breakdown problem present in BJT.
3. It has low input impedance and high power loss.
Which of the above statements is/are correct?
(a) 1 only
(b) 2 and 3 only
(c) 1 and 2 only
(d) 1,2 and 3

Ans. (c)

End of Solution

91. A 50 Hz, four-pole turbo-generator rated at 30 MVA, 13.2 kV has an inertia constant of $H = 10$ kW-s/kVA. What is the value of kinetic energy stored in the rotor at synchronous speed?
(a) 180 megajoules
(b) 200 megajoules
(c) 300 megajoules
(d) 400 megajoules

Ans. (c)

$$\text{K.E.} = H \times S = 10 \times 30 = 300 \text{ Megajoules}$$

End of Solution

92. Which of the following is correct regarding the advantages of DC transmission over AC transmission?
(a) Power per conductor is more, more corona loss and possibility of higher operating voltages
(b) Power per conductor is more, less corona loss and possibility of higher operating voltages
(c) Power per conductor is more, no skin effect and possibility of lower operating voltages
(d) Power per conductor is more, there is charging current and possibility of higher operating voltages

Ans. (b)

End of Solution

93. Which one of the following statements is correct regarding shunt/series capacitor?
(a) Shunt capacitor improves the power factor whereas series capacitor improves the stability of transmission line.
(b) Series capacitor improves the power factor whereas shunt capacitor improves the stability of transmission line.
(c) Shunt capacitor improves both the power factor and the stability of transmission line.
(d) Series capacitor improves both the power factor and the stability of transmission line.

Ans. (a)

End of Solution

94. In smart grid, the model load, FACTS devices and control, protection platform as compared to conventional grid are respectively
(a) dynamic, specified and adaptive nature
(b) dynamic, adaptive and adaptive nature
(c) dynamic, adaptive and defined nature
(d) static, adaptive and adaptive nature

Ans. (a)

End of Solution

95. A large hydropower station has a head of 324 m and an average flow of 1370 m^3/s. The reservoir of water behind the dams and dikes is composed of series of lakes covering an area of 6400 km^2. What is the available hydraulic power?
(a) 4350 kW
(b) 4350 MW
(c) 435 MW
(d) 435 kW

Ans. (b)

$$P_{avg} = 9.81 \times 10^{-3} \times \eta \times W \times Q \times H$$
$$\eta = 100\% \Rightarrow 1.0$$
$$P_{avg} = 9.81 \times 10^{-3} \times 1 \times 1000 \times 1370 \times 324$$
$$= 4354.6 \approx 4350 \text{ MW}$$

End of Solution

96. Consider the following statements regarding semiconductor diode:
1. In the non-conducting region (when the p-n junction is reverse biased), the diode current is exactly zero.
2. The diode requires a small positive voltage to be applied before it enters the conducting region.
3. For large input voltages and/or currents, the diode enters breakdown regions in the forward direction.

Which of the above statements is/are correct?
(a) 1 and 2
(b) 2 only
(c) 1 only
(d) 2 and 3

Ans. (b)

Regarding semiconductor diode,
The diode requires a small positive voltage to be applied before it enters. The conducting region.

End of Solution

97. The mobilities of free electrons and holes in pure silicon are 1300 cm^2/V-s and 500 cm^2/V-s respectively. What is the value of intrinsic conductivity for silicon? (Assume $n_i = 1.5 \times 10^{10}$ cm^{-3} for silicon at room temperature)
(a) 2.69×10^{13} S/cm
(b) 4.32×10^{-6} S/cm
(c) 4.32×10^{13} S/cm
(d) 2.69×10^{-6} S/cm

Ans. (b)

Intrinsic conductivity, $\sigma_i = n_i(\mu_n + \mu_p)q$

$= 1.5 \times 10^{10}(1300 + 500)1.6 \times 10^{-19}$

$= 4.32 \times 10^{-6}$ s/cm

End of Solution

98. What happens to the depletion region and the depletion region capacitance of a p-n junction diode with increased reverse-biased voltage?
(a) The depletion region shrinks and the depletion region capacitance decreases
(b) The depletion region shrinks and the depletion region capacitance increases
(c) The depletion region widens and the depletion region capacitance decreases
(d) The depletion region widens and the depletion region capacitance increases

Ans. (c)

As reverse bias voltage increases the depletion region wider and the depletion region capacitance decreases.

End of Solution

99. Consider the following statements regarding voltage-divider bias in a transistor :
1. The voltage-divider bias configuration uses two DC bias sources to provide forward-reverse bias to the transistor.
2. The voltage-divider bias provides a very small base current to the transistor compared to the bias current.
3. Two resistors R_1 and R_2 form a voltage divider that provides the base bias voltage to the transistor.

Which of the above statements is/are correct?
(a) 1 and 2 only
(b) 2 and 3 only
(c) 2 only
(d) 1,2 and 3

Ans. (b)

For voltage divider bias 2 and 3 statements are correct.

End of Solution

100. In an *n*-type semiconductor, the Fermi level is 0.3 eV below the conduction level at a room temperature of 300 K. If the temperature is increased to 360 K, what is the new position of the Ferm level?
(a) Remain unchanged
(b) 0.26 eV above the conduction level
(c) 0.36 eV above the conduction level
(d) 0.36 eV below the conduction level

Ans. (d)

The fermi level is 0.3 eV below. The conduction level at 300 K in n-type. As temperature increases to 360 K then the gap between conduction level and fermi level increases.

End of Solution

101. Consider the following statements regarding common-base transistor amplifier:
   1. In the active region, the collector-base junction is forward biased while the base-emitter junction is reverse biased.
   2. In the cutoff region, the collector-base and base-emitter junctions of a transistor are both reverse biased.
   3. In the saturation region, the collector-base and base-emitter junctions are both forward biased.

   Which of the above statements is/are correct?

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

Ans. (b)

Common base amplifier, (2) and (3) are correct.

End of Solution

102. What are the biasing states of collector-base junction and base-emitter junction in the active region of a common-emitter transistor amplifier?
   (a) Both collector-base junction and base-emitter junction are forward biased
   (b) Both collector-base junction and base-emitter junction are reverse biased
   (c) The collector-base junction is forward biased and the base-emitter junction is reverse biased
   (d) The collector-base junction is reverse biased and the base-emitter junction is forward biased

Ans. (d)

In common emitter transistor amplifier,

V_{BE} forward biased

V_{CB} reverse biased

End of Solution

103. Match the following lists:

List-I (n-p-n BJT operating regions)	List-II (n-p-n BJT characteristics)
P. Cutoff region	1. $I_C = \beta_F I_B$, $I_B > 0$, $V_{BE} > V_{BE(on)}$, $V_{CE} > V_{CE(sat)}$,
Q. Saturation region	2. $I_C = I_B = I_E = 0$, $V_{BE} < V_{BE(on)}$, $V_{BC} < V_{BC(on)}$
R. Forward active region	3. $I_B > 0$, $I_C > 0$, $I_C < \beta_F I_B$, $V_{BE} > V_{BE(on)}$

Select the correct answer using the code given below,

Codes:

	P	Q	R
(a)	1	2	3
(b)	2	3	1
(c)	1	3	2
(d)	2	1	3

Ans. (b)

$$P \rightarrow 2$$
$$Q \rightarrow 3$$
$$R \rightarrow 1$$

End of Solution

104. Consider the following statements regarding negative feedback in amplifier circuits:
1. It has reduction in overall voltage gain.
2. It has enhanced frequency response.
3. It has higher output impedance.

Which of the above statements is/are correct?

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

Ans. (a)

In negative amplifier
1. It has reduction in overall voltage gain.
2. It has enhanced frequency response.

End of Solution

105. In the Hartley oscillator, L_2 = 0.4 mH and C = 0.004 μF. If the frequency of the oscillator is 120 kHz, what is the value of L_1? (Neglect the mutual inductance)

(a) 4 mH
(b) 0.04 mH
(c) 0.4 mH
(d) 40 mH

Ans. (b)

$$F_0 = \frac{1}{2\pi\sqrt{L_T C}}$$

$$120 \text{ kHz} = \frac{1}{2\times 3.14\sqrt{(L_1+L_2)C}}$$

$$L_1 = 0.04 \text{ mH}$$

End of Solution

106. The lap-connected armature winding is suitable for
(a) low-voltage and high-current generators
(b) low-voltage and low-current generators
(c) high-voltage and low-current generators
(d) high-voltage and high-current generators

Ans. (a)

$$A = P = \text{number of parallel path more}$$

$\therefore$ High current and low voltage.

End of Solution

107. Which one of the following statements is **not** correct regarding interpoles of DC machines?
(a) They are small yoke-fixed poles spaced in between the main poles.
(b) Their polarity, in the case of generators, is the same as that of the main pole ahead.
(c) They are connected in parallel with the armature so that they carry part of the armature current.
(d) They automatically neutralize not only reactance voltage but cross magnetization as well.

Ans. (c)

Interpoles are connected in series with armature winding.

End of Solution

108. A DC series motor, running a fan at 1000 r.p.m., takes 50 A from 250 V mains. The armature plus field resistance is 0.6 Ω. If an additional resistance of 4.4 Ω is inserted in series with the armature circuit, what is the value of the motor speed when the field flux is proportional to the armature current?
(a) 621 r.p.m
(b) 641 r.p.m
(c) 651 r.p.m
(d) 661 r.p.m

Ans. (b)

For a fan,

Load torque, $T_L \propto n^2$

Electromagnetic torque, $T_c = K_c \phi I_a$

Since field flux, $\phi \propto I_a$,

$T_e \propto I_a^2$

Under study state, $T_e = T_L$

or $I_{a1}^2 \propto n_1^2$

and $I_{a2}^2 \propto n_2^2$

$\therefore$ $$I_{a2} = I_{a1}\left(\frac{n_2}{n_1}\right) = 50\frac{n_2}{1000} = \frac{n_2}{20}\text{ Amp}$$

Now counter e.m.f. $E_{a1} = 250 - 50(0.6) = 220$ V and counter e.m.f. $E_{a2} = 250 - \frac{n_2}{20}(4.4 + 0.6) = \left(250 - \frac{n_2}{4}\right)$ volts

Now, $\frac{E_{a2}}{E_{a1}} = \frac{n_2\phi_2}{n_1\phi_1}$

$\therefore$ $\frac{250 - \frac{n_2}{4}}{220} = \frac{n_2 \cdot \frac{n_2}{20}}{(1000)(50)}$

or $n_2^2 + 1137n_2 - 11.37 \times 10^5 = 0$

Its solution gives, $n_2 = 641$ r.p.m.

End of Solution

109. A three-phase, 60 Hz, 25 hp, wye-connected induction motor operates at a shaft speed of almost 1800 r.p.m. at no load and 1650 r.p.m. at full load. What are the values of speed of the rotor field with respect to the rotor itself and with respect to the stator field respectively?

(a) 150 r.p.m. and 1800 r.p.m.
(b) 1650 r.p.m. and 0 r.p.m.
(c) 150 r.p.m. and 0 r.p.m.
(d) 1800 r.p.m. and 150 r.p.m.

Ans. (c)

Rotor field w.r.t. rotor 150 rpm

Rotor field w.r.t. stator field 0

Given, $N_S = 1800$

$N = 1650$

$sNS = 150$

End of Solution

110. The rotor input of a three-phase induction motor running with a slip of 10% is 100 kW. What is the value of the gross power developed by the rotor?

(a) 10 kW
(b) 80 kW
(c) 90 kW
(d) 95 kW

Ans. (c)

$s = 0.1$

Rotor input = 100 kW

Gross power developed = $(1 - s)$ rotor input

$= (1 - 0.1)(100) = 90$ kW

End of Solution

111. What is the value of percentage voltage regulation of an alternator having 0.75 leading power factor loads, when the no-load induced e.m.f. is 2400 V and the rated terminal voltage is 3000 V?

(a) 20%
(b) –20%
(c) 25%
(d) –25%

Ans. (b)

$$\% \text{ voltage regulation} = \frac{2400-3000}{3000}\times 100 = -20\%$$

End of Solution

112. Two identical alternators are running in parallel and carry equal loads. What will happen if the excitation of one alternator is increased without changing its steam supply?

(a) It will keep supplying almost the same load
(b) kVAR supplied by it would decrease
(c) kVA supplied by it would decrease
(d) Its power factor will increase

Ans. (a)

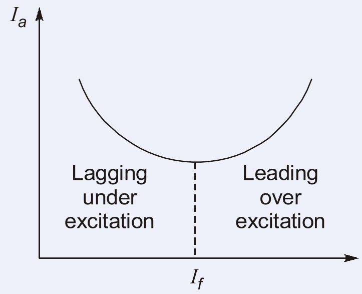
End of Solution

113. A synchronous motor connected to infinite bus-bar has, at constant full load, 100% excitation and unity power factor. When there is a change in excitation only, the armature current will have

(a) leading power factor with under excitation
(b) lagging power factor with overexcitation
(c) leading power factor with overexcitation
(d) no change in power factor

Ans. (c)

For motor



End of Solution

114. What are the values of maximum step rate for permanent-magnet and variable-reluctance stepper motors respectively?
(a) 300 pulses per second and 1200 pulses per second
(b) 700 pulses per second and 1200 pulses per second
(c) 1200 pulses per second and 1200 pulses per second
(d) 300 pulses per second and 300 pulses per second

Ans. (a)
Permanent magnet stepper motor
= 300 pulses per sec
Variable reluctance stepper motor has more step rate comparatively, (relatively)
(step rate : No. of steps/sec)

End of Solution

115. Consider the following statements regarding ideal transformer :
1. The winding resistances of the primary and secondary of the transformer are zero.
2. The eddy current loss of the transformer is zero.
3. The core of the transformer is having a finite permeability.
Which of the above statements is/are not correct?
(a) 1 and 3
(b) 2 only
(c) 3 only
(d) 1 and 2

Ans. (c)

End of Solution

116. Consider the following characteristics of Complex Instruction Set Computer (CISC) processor :
1. It is having a small number of instructions.
2. It is having less addressing modes.
3. Most instructions can manipulate operands in the memory.
4. Control unit is microprogrammed.
Which of the above characteristics is/are **not** correct?
(a) 1 only
(b) 1 and 2
(c) 1 and 4
(d) 3 and 4

Ans. (b)
CISC cpu contain more addressing modes and larger instruction set.

End of Solution

117. In which of the following processors, the designer can add easily new instruction without changing the architecture of the processor?
(a) CISC processor only
(b) RISC processor only
(c) Both CISC and RISC processors
(d) Neither CISC processor nor RISC processor

Ans. (a)

CISC cpu supports microprogrammed control unit. So, this control unit is flexible to implement new instructions.

End of Solution

118. Which one of the following is used to increase the performance of CPU, that means executing more instructions in less time?
(a) Sequencing (b) Pipelining
(c) Scheduling (d) Spooling

Ans. (b)

Pipelining allows overlapping execution to improve the performance.

End of Solution

119. Which one of the following buses was designed to improve bandwidth and decrease latency in computer systems?
(a) PCI bus (b) VESA bus
(c) EISA bus (d) ISA bus

Ans. (a)

PCI bus

Peripherad component interconnect bus → 1 GByte/sec

33 MHz 133 MHz

VESA (486 only) → 128 MBps {132 Mbps, older local bus architecture

ISA {EISA and old type.

End of Solution

120. Consider the following functions of Root Hub :
1. It performs power distribution to the devices.
2. It enables and disables the ports.
3. It reports status of each port to the user.

Which of the above functions is/are correct?
(a) 1 only (b) 2 and 3 only
(c) 1 and 2 only (d) 1,2 and 3

Ans. (c)

Root hub has the capability to enable and disable USB ports. This functionality can be useful for trouble shooting H/w issues, conserving power and controlling H/W issues, conserving power and controlling access to USB devices.

End of Solution

121. A set of independent current measurements is recorded as 10.03 A, 10.10 A and 10.08 A. What are the values of average current and range of error respectively?
(a) 10.08 A and ±0.03 A
(b) 10.08 A and ±0.04 A
(c) 10.09 A and ±0.04 A
(d) 10.09 A and ±0.03 A

Ans. (b)
Given readings
$\Rightarrow$ 10.03 A, 10.10 A, 10.11 A, 10.08 A

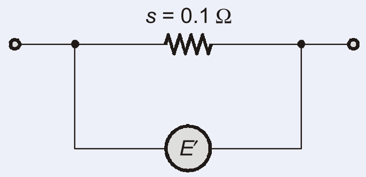
$$I_{avg} = \frac{10.03 + 10.10 + 10.11 + 10.08}{4} = \frac{40.32}{4} = 10.8 \text{ Amp}$$

$$\text{Range of error} = \frac{I_{max} - I_{min}}{2} = \frac{10.11 - 10.03}{2} = \pm 0.04$$

End of Solution

122. During the measurement of low resistance using a potentiometer, the following readings were obtained :
The voltage drop across the low resistance under test = 0.4221 V.
The voltage drop across a 0.1 Ω standard resistance = 1.0235 V.
What are the values of unknown resistance and current respectively?
(a) 0.041208 Ω and ±10.235 A
(b) 0.031208 Ω and ±10.235 A
(c) 0.021208 Ω and ±10.235 A
(d) 0.041208 Ω and ±11.235 A

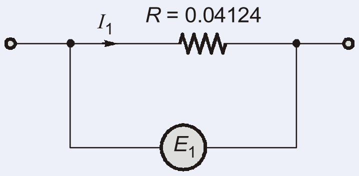
Ans. (a)
Let, R = unknown resist
V.D. across low resistance
$\Rightarrow$ E_1 = 0.4221 volt
V.D. across standard resistance
$\Rightarrow$ E' = 1.0235 volt
Let, S = standard resistance
$\Rightarrow$ S = 0.1 Ω



$$E_1 = \left(\frac{E'}{I'}\right) \times I_1$$

$$0.4221 = \frac{1.0235}{0.1} \times R$$

$\Rightarrow$ R = 0.04124 Ω



$$I_1 = \frac{E_1}{R} = \frac{0.4221}{0.04124} = 10.235 \text{ Amp}$$

End of Solution

123. The coil of a moving-coil voltmeter is 40 mm long and 30 mm wide, and has 100 turns on it. The control spring exerts a torque of 240×10^{-6} N-m when the deflection is 100 divisions on full scale. If the flux density of the magnetic field in the air gap is 1.0 Wb/m^2, what is the value of the resistance that must be put in series with the coil to give one volt per division by neglecting the resistance of the voltmeter coil?

(a) 5 kΩ
(b) 15 kΩ
(c) 50 kΩ
(d) 75 kΩ

Ans. (c)

Moving coils – (V)

$$\Rightarrow \quad A = 40 \text{ mm} \times 30 \text{ mm} = 40 \times 30 \times 10^{-6} \text{ m}^2$$

Number of turns, $N = 100$,

$$\tau_c = 240 \times 10^{-6} \text{ N-m}$$

Deflections = 100 division FSD,

$$B = 1.0 \text{ Wb/m}^2$$

at S.S

$$|\tau_d| = |\tau_c|$$

$$\Rightarrow \quad B\,INA = \tau_c$$

$$B \times \frac{V}{R} \times N \times A = \tau_c$$

$$1 \times \frac{100}{R} \times 100 \times 40 \times 30 \times 10^{-6} = 240 \times 10^{-6}$$

$$\Rightarrow \quad R = 50000\ \Omega = 50\ \text{k}\Omega$$

End of Solution

124. Which one of the following statements is correct regarding moving-iron instrument when voltages or currents are measured?
(a) It indicates the same value of the measurement for both ascending and descending values.
(b) It indicates the higher value of the measurement for ascending values.
(c) It indicates the higher value of the measurement for descending values.
(d) It indicates the lower value of the measurement for descending values.

Ans. (c)

End of Solution

125. A moving-coil instrument gives a full scale deflection of 10 mA, when the potential difference across its terminals is 100 mV. What is the value of shunt resistance for a full-scale deflection corresponding to 100 A?
(a) 0.0001 Ω (b) 0.001 Ω
(c) 0.01 Ω (d) 0.1 Ω

Ans. (b)

$$I_{FSD} = 10 \text{ mA},$$
$$V_{FSD} = 100 \text{ mV}$$
$$\Rightarrow \quad R_m = \frac{V_{FSD}}{I_{FSD}} = \frac{100 \text{ mV}}{10 \text{ mA}} = 10\ \Omega$$
$$\underset{I_m}{\underset{\Downarrow}{(0-10 \text{ mA})}} = \underset{I_{ext}}{\underset{\Downarrow}{(0-100 \text{ A})}}$$
$$m = \frac{I_{ext}}{I_m} = \frac{100}{10\times10^{-3}} = 10000$$
$$R_{sh} = \frac{R_m}{m-1} = \frac{10}{(1000-1)} = 0.001\ \Omega$$

End of Solution

126. The power in a three-phase circuit is measured with the help of 2 wattmeters. The reading of one of the wattmeters is positive and that of the other is negative. The magnitudes of readings are different. What is the value of the power factor of the circuit under this condition?
(a) 0.5 (lagging) (b) Zero (lagging)
(c) Less than 0.5 (lagging) (d) Unity

Ans. (c)

$$P_1 = +\text{ve}$$
and $$P_2 = -\text{ve}$$
$$\Rightarrow \quad 0 < \text{p.f.} < 0.5$$

End of Solution

127. What is the range of frequency measured by the typical frequency meter?
(a) 1 MHz (b) 10 Hz
(c) 1 kHz (d) 1 GHz

Ans. (d)

Typical frequency meter can measure the frequency from few Hz to second GHz.

End of Solution

128. A $3\frac{1}{2}$ digit DVM has an accuracy specification of ±0.5 percent of reading ±1 digit. What is the possible error in volt, when the instrument is reading 5.00 V on the 10 V range?
(a) 0.015 V (b) 0.025 V
(c) 0.035 V (d) 0.045 V

Ans. (c)

$3\frac{1}{2}$ DVM, reading = 5 volt

FSD = 10 volt

Accuracy = ±0.5% reading + 1 digit

$\Downarrow \quad \Downarrow$

Total error = Error - (1) + Error - (2)

$$\text{Error-1} = \pm\frac{0.5}{100}\times 5 = 0.025$$

Error-2 = digit

$$1 \text{ digit} = \frac{V_{FSD}}{10^N} = \frac{10}{10^3} = 0.01$$

Total error = 0.025 + 0.01 = ±0.035

End of Solution

129. Which one of the following statements is correct regarding potentiometric recorders?
(a) A sensitivity of 4 VB/mm is attained with an error of less than ±0.25% with a bandwidth of 0.8 Hz.
(b) A sensitivity of 10 VB/mm is attained with an error of less than ±0.35% with a bandwidth of 0.9 Hz.
(c) A sensitivity of 5 VB/mm is attained with an error of less than ±0.25% with a bandwidth of 1 Hz.
(d) A sensitivity of 8 VB/mm is attained with an error of less than ±0.45% with a bandwidth of 0.8 Hz.

Ans. (a)

End of Solution

130. If the bandwidth of an oscilloscope is given as direct current to 10 MHz, what is the fastest rise time a sine wave can have to be accurately reproduced by the instrument?
(a) 35 ns
(b) 17.5 ns
(c) 0.175 μs
(d) 35 μs

Ans. (a)

Given, D.W = 10 MHz

$$t_r = \frac{0.35}{\text{B.W.}} = \frac{0.35}{10\times10^6} = 0.35\times10^{-7} = 35 \text{ nsec}$$

End of Solution

131. What is the key factor that must be considered while selecting a transducer for a particular application?
(a) Only the input characteristics should be considered
(b) Only the output characteristics should be considered
(c) Only the transfer characteristics should be considered
(d) Input, output and transfer characteristics should be considered

Ans. (d)

End of Solution

132. If a transducer has an output impedance of 1 Ω and a load resistance of 1 kΩ, it behaves as
(a) a constant current source
(b) a constant voltage source
(c) a constant power source
(d) a constant energy source

Ans. (b)

End of Solution

133. If a 50 Hz, 220/440 V, 50 kVA, single-phase transformer operates on 220 V, 40 Hz supply with secondary winding, then what about the core losses of the transformer?
(a) The hysteresis losses and the eddy current losses of the transformer increase
(b) The hysteresis losses and the eddy current losses of the transformer decrease
(c) The hysteresis losses remain same whereas the eddy current losses decrease
(d) The hysteresis losses increase whereas the eddy current losses remain same

Ans. (d)

50 Hz 220/440 V, 50 kVA

Operates on 220 V, 40 Hz

$$B_m \propto \frac{V}{f}$$

$V_1 = 220,$ $V_2 = 220$

$f_1 = 50,$ $f_2 = 40$

$\frac{V}{f}$ ratio not constant, V same $f\downarrow$

$\therefore\ B_m \uparrow$

$$P_e \propto B_m^2 f^2$$

$$P_e \propto \left(\frac{V}{f}\right)^2 f^2$$

$$P_e \propto V^2 \quad \text{...(i)}$$

$$P_h \propto B_m^{1.6} f$$

$$P_h \propto \left(\frac{V}{f}\right)^{1.6} f$$

$$P_h \propto V^{1.6} f^{-0.6} \quad \text{...(ii)}$$

As voltage remain same, eddy current loss do not change, it remain same from (i), but Hysteresis loss increase from (ii).

End of Solution

134. An 1100/415 V, delta-star transformer feeds power to a 30 kW, 415 V, three-phase induction motor having an efficiency of 90% and full-load p.f. 0.833 . What are the rating of the transformer and line current of low voltage side respectively?

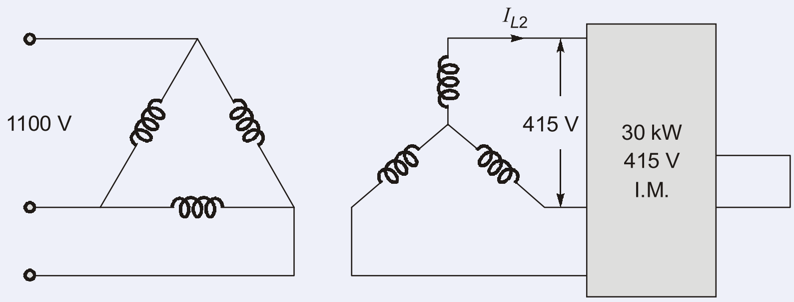
(a) 35 kVA, 55.65 A
(b) 40 kVA, 55.65 A
(c) 40 kVA, 45.65 A
(d) 45 kVA, 55.65 A

Ans. (b)

3-phase, Δ-Y, 1100/415 V load 30 tw , 415 V

$$\eta = 90\%$$

p.f. : 0.833



30 kW is output

$$\text{Input} = \frac{\text{Output}}{\eta} = \frac{30}{0.9} = 33.333 \text{ kW}$$

$$\therefore \quad \sqrt{3} V_{L2} I_{L2} \cos\phi = 33.333 \text{ kW}$$

$$\therefore \quad I_{L2} = \frac{33.333 \times 10^3}{\sqrt{3} \times 415 \times 0.833} = 55.67 \text{ A}$$

$\therefore$ Current on LV side = 55.67 A

Rating of transformer $= \sqrt{3} V_{L2} I_{L2}$

$= \sqrt{3} \times 415 \times 55.67 = 40$ kVA

End of Solution

135. The kVA rating of an ordinary two winding transformer increases when connected as an autotransformer because
(a) transformation ratio increases
(b) secondary current increases
(c) energy is transferred both inductively and conductively
(d) secondary voltage increases

Ans. (c)

End of Solution

136. In Double Data Rate SDRAM, if 100 MHz clock rate and 64 bits data bus transfers data, then what is the approximate transfer rate for DDR3?
(a) 1600 MB/s
(b) 6400 MB/s
(c) 3200 MB/s
(d) 800 MB/s

Ans. (a)

"DDRSDRAM → Double data rate synchronous data ROM

Given frequency = 100 MHz, So, $T = \frac{1}{f} = 0.01$ μsec

In one clock 2 bits are transferred in double data RAM since in both rising and falling edge of clock the data transfer takes place. Hence, through 64 bits bus, 16 bytes are transferred.

∴ Transfer rate $= \frac{16B}{0.01 \mu sec} = 1600$ MB/sec

End of Solution

137. What is the approximate rotational delay if the disk drive has 8 surfaces, each surface has 1024 tracks, each track has 64 sectors, each sector can hold 512 bytes and rotation speed of 6000 r.p.m.? (It is assumed that the sector is away from head half of the track)
(a) 0.005 s
(b) 0.050 s
(c) 0.500 s
(d) 0.505 s

Ans. (a)

Rotational latency:

6000 revolutions - 1 min (60 sec) ⇒ 1 revolution - ?

⇒ $\frac{60}{6000}$ sec $= 0.01$ sec

Average rotational latency $= \frac{1}{2}$ revolution time $= \frac{1}{2} \times 0.01 \text{sec} = 0.005$ sec

End of Solution

138. How many pages are in the disk, if the capacity of a virtual disk is 2 MB and each page is 2 kB in a byte-addressable system?
(a) 2048 (b) 1024
(c) 100 (d) 500

Ans. (b)

$$\text{Pages in } Sm = \frac{\text{SM size}}{\text{Page size}}$$

$$= \frac{2\text{ MB}}{2\text{ kB}} = \frac{2^{20}}{2^{10}} = 2^{10} = 1024$$

End of Solution

139. Which one of the following is used to keep the track of program statistics that may be a valuable tool for system administrators who wish to reconfigure the system to improve computing services?
(a) Programming table (b) Spooling
(c) Logging (d) Making file

Ans. (c)

End of Solution

140. If communicating processes reside in a temporary queue and the queue has a maximum length of zero, then the link cannot have any messages waiting in it. The sender must block until the recipient receives the message. In what way can such queues be implemented?
(a) Bounded capacity (b) Unbounded capacity
(c) Non-zero capacity (d) Zero capacity

Ans. (d)
Zero capacity queue is referred to as a message system with no buffering. Zero capacity queue has maximum capacity of zero. So message queue doesn't have any waiting message in it.

End of Solution

141. Consider the following set of processes that arrive at time 0 with the length of the CPU burst given in milliseconds:

Process	Burst time
P_1	24
P_2	3
P_3	3

What is the average waiting time under the Round-Robin Scheduling, if we use a time quantum of 4 milliseconds?
(a) 5.66 milliseconds (b) 3.50 milliseconds
(c) 7.00 milliseconds (d) 6.55 milliseconds

Ans. (a)

$Pi\ d$	Burst Time	
P_1	~~24~~	20
P_2	~~3~~	0
P_3	~~3~~	0

$TQ = 4$

Ready queue : | P_1 | P_2 | P_3 | P_1 |

Chart :

P_1	P_2	P_3	P_1

0 4 7 10 30

	CT	TAT (CT – AT)	WT (TAT – BT)
P_1	30	30	6
P_2	7	7	4
P_3	10	10	7

$$\text{Avg. WT} = \frac{6+4+7}{3} = 5.66$$

End of Solution

142. Consider the following set of processes, assumed to have arrived at time 0 in the order P_1, P_2, ..., P_5, with the length of the CPU burst given in milliseconds:

Process	Burst time	Priority
P_1	10	3
P_2	1	1
P_3	2	4
P_4	1	5
P_5	5	2

Assuming that low numbers represent high priority, what is the average waiting time under the priority scheduling?

(a) 5.66 milliseconds
(b) 4.50 milliseconds
(c) 8.20 milliseconds
(d) 6.55 milliseconds

Ans. (c)

$Pi\ d$	Burst Time	Priority
P_1	10	3
P_2	1	1 (High)
P_3	2	4
P_4	1	5
P_5	5	2

Chart:

P_2	P_5	P_1	P_3	P_4

0 1 6 16 18 19

	CT	TAT (CT – AT)	WT (TAT – BT)
P_1	16	16	6
P_2	1	1	0
P_3	18	18	16
P_4	19	19	18
P_5	6	6	1

$$AT = 0$$

$$\text{Average WT} = \frac{(6+0+16+18+1)}{5} = 8.2$$

End of Solution

143. Which one of the following statements is correct regarding superheaters in steam power plants?
(a) In modern utility high-pressure boilers, more than 40% of the total heat absorbed in the generation of steam takes place in the superheaters.
(b) In modern utility high-pressure boilers, less than 40% of the total heat absorbed in the generation of steam takes place in the superheaters.
(c) In modern utility high-pressure boilers, less than 20% of the total heat absorbed in the generation of steam takes place in the superheaters.
(d) In modern utility high-pressure boilers, less than 30% of the total heat absorbed in the generation of steam takes place in the superheaters.

Ans. (a)

End of Solution

144. What are the advantages of bundle conductors?
(a) Reactance is reduced, GMR is increased and voltage gradient is reduced
(b) Surge impedance is reduced, GMR is decreased and voltage gradient is increased
(c) Reactance is increased, GMR is increased and voltage gradient is reduced
(d) Corona loss is reduced, GMR is increased and voltage gradient is increased

Ans. (d)

End of Solution

145. If the loading of the line is less than the surge impedance loading, then which one of the following statements is correct?
(a) The absorbed reactive power is greater than the generated reactive power and receiving-end voltage is greater than sending-end voltage.
(b) The absorbed reactive power is less than the generated reactive power and receiving-end voltage is greater than sending-end voltage.

(c) The absorbed reactive power is greater than the generated reactive power and receiving-end voltage is less than sending-end voltage.
(d) The absorbed reactive power is less than the generated reactive power and receiving-end voltage is less than sending-end voltage.

Ans. (b)

End of Solution

146. What are the overall diameter and dia of metal sheath of a single-core cable respectively for working voltage of 80 kV, the dielectric strength of the insulating material being 60 kV/cm?

(a) 2.66 cm and 2.66*e* cm
(b) 3.66 cm and 3.66*e* cm
(c) 4.66 cm and 4.66*e* cm
(d) 3.66 cm and 2.66*e* cm

Ans. (a)

$$r = \frac{V}{E} = \frac{80}{60} = 1.33$$

Overall dia of core = $2 \times r = 2 \times 1.33$

= 2.66 cm

Overall dia of cable including sheath

= $2r\ e = 2.66e$ cm

End of Solution

147. Which one of the following is correct regarding reduction of corona loss?

(a) Corona losses can be reduced by using large dia conductors, hollow conductors and bundled conductors
(b) Corona losses can be reduced by using small dia conductors, hollow conductors and bundled conductors
(c) Corona losses can be reduced by using large dia conductors, hollow conductors and single conductors
(d) Corona losses can be reduced by using large dia conductors, solid conductors and single conductors

Ans. (b)

End of Solution

148. Which one of the following types of relay is used to give directional feature to reactance relay?

(a) IDMT relay
(b) Impedance relay
(c) Mho relay
(d) Non-directional reactance relay

Ans. (c)

End of Solution

149. What are the values of breaking current and making current of a circuit breaker respectively, rated at 1000 A, $2000\sqrt{3}$ MVA, 20 kV, 3 s, oil circuit breaker?

(a) 100 kA and 255 kA
(b) 200 kA and 255 kA
(c) 100 kA and 200 kA
(d) 200 kA and 200 kA

Ans. (a)

$$\text{Breaking capacity} = 2000\sqrt{3}\text{ MVA}$$

$$I_{BK} = \frac{S_{BK}}{\sqrt{3}\times V_L} = \frac{2000\times 10^3\times\sqrt{3}}{\sqrt{3}\times 20} = 100\text{ KA}$$

$$\text{Making current }(I_{mc}) = 2.55\times I_{BK}$$
$$= 2.55\times 100\text{ KA}$$
$$= 255\text{ KA}$$

End of Solution

150. The nodal admittance formulation, using the nodal voltages as the independent variables, is the most economic

(a) in the view of computer time only
(b) in the view of computer memory only
(c) in the view of both computer time and memory
(d) in the view of stability

Ans. (c)

End of Solution

■■■■