DETAILED SOLUTIONS

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ESE 2023 : Prelims Exam
CLASSROOM TEST SERIES

ELECTRICAL ENGINEERING

Test 18

Full Syllabus Test 2 : Paper-II

1.	(a)	**26.**	(a)	**51.**	(c)	**76.**	(c)	**101.**	(c)	**126.**	(c)
2.	(d)	**27.**	(b)	**52.**	(b)	**77.**	(d)	**102.**	(b)	**127.**	(d)
3.	(d)	**28.**	(a)	**53.**	(d)	**78.**	(b)	**103.**	(d)	**128.**	(b)
4.	(b)	**29.**	(c)	**54.**	(b)	**79.**	(d)	**104.**	(b)	**129.**	(a)
5.	(c)	**30.**	(d)	**55.**	(c)	**80.**	(b)	**105.**	(d)	**130.**	(c)
6.	(b)	**31.**	(c)	**56.**	(b)	**81.**	(b)	**106.**	(b)	**131.**	(d)
7.	(b)	**32.**	(c)	**57.**	(a)	**82.**	(c)	**107.**	(c)	**132.**	(c)
8.	(b)	**33.**	(b)	**58.**	(d)	**83.**	(b)	**108.**	(a)	**133.**	(d)
9.	(b)	**34.**	(c)	**59.**	(d)	**84.**	(c)	**109.**	(c)	**134.**	(a)
10.	(b)	**35.**	(d)	**60.**	(c)	**85.**	(c)	**110.**	(d)	**135.**	(b)
11.	(c)	**36.**	(a)	**61.**	(b)	**86.**	(b)	**111.**	(a)	**136.**	(c)
12.	(b)	**37.**	(b)	**62.**	(a)	**87.**	(d)	**112.**	(d)	**137.**	(b)
13.	(b)	**38.**	(b)	**63.**	(d)	**88.**	(b)	**113.**	(c)	**138.**	(c)
14.	(c)	**39.**	(d)	**64.**	(d)	**89.**	(b)	**114.**	(b)	**139.**	(c)
15.	(d)	**40.**	(a)	**65.**	(a)	**90.**	(d)	**115.**	(c)	**140.**	(b)
16.	(c)	**41.**	(c)	**66.**	(c)	**91.**	(c)	**116.**	(a)	**141.**	(b)
17.	(d)	**42.**	(c)	**67.**	(c)	**92.**	(c)	**117.**	(d)	**142.**	(c)
18.	(c)	**43.**	(b)	**68.**	(d)	**93.**	(a)	**118.**	(c)	**143.**	(a)
19.	(b)	**44.**	(a)	**69.**	(b)	**94.**	(d)	**119.**	(c)	**144.**	(a)
20.	(d)	**45.**	(b)	**70.**	(b)	**95.**	(d)	**120.**	(c)	**145.**	(b)
21.	(c)	**46.**	(d)	**71.**	(c)	**96.**	(c)	**121.**	(b)	**146.**	(a)
22.	(d)	**47.**	(c)	**72.**	(b)	**97.**	(c)	**122.**	(a)	**147.**	(c)
23.	(b)	**48.**	(b)	**73.**	(b)	**98.**	(c)	**123.**	(d)	**148.**	(b)
24.	(c)	**49.**	(a)	**74.**	(d)	**99.**	(c)	**124.**	(b)	**149.**	(a)
25.	(c)	**50.**	(c)	**75.**	(d)	**100.**	(b)	**125.**	(b)	**150.**	(b)

DETAILED EXPLANATIONS

1. (a)

- A short circuit is a resistor (a perfectly, conducting wire) with zero resistance (R = 0). An open circuit is a resistor with infinite resistance ($R = \infty$).
- The number of branches b, the number of nodes n and the number of independent loop l in a network are related as,

$$b = l - n + 1$$

2. (d)

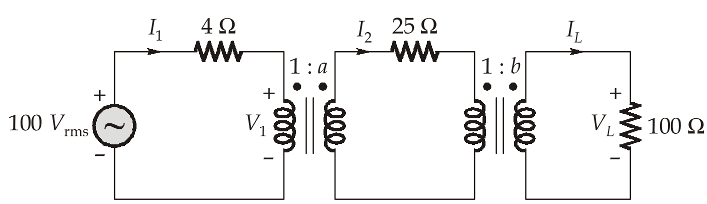
All statements are correct.

3. (d)

$$V = \text{Current} \times \text{Impedance}$$
$$= 5\angle 30° \times (5 - j3) \,||\, (5 + j3)$$
$$= 5\angle 30° \times \frac{(5 - j3) \times (5 + j3)}{5 - j3 + 5 + j3}$$
$$= 5\angle 30° \times \frac{25 + 9}{10} = 17\angle 30° \text{ V}$$

4. (b)

The circuit is as shown below,



$$I_L = \sqrt{\frac{500}{100}} = \sqrt{5} \text{ A}, \quad V_L = 100\sqrt{5} \text{ V}$$

$$I_1 = \frac{1000}{100} = 10 \text{ A}$$

$$V_1 = 100 - 4 \times 10 = 60 \text{ V}$$

$$P_{25\,W} = 1000 - 500 - 10^2 \times 4 = 100 \text{ W}$$

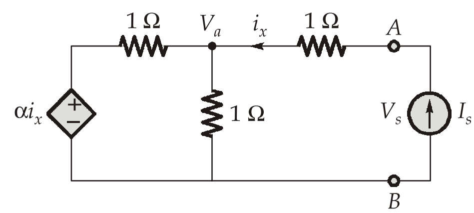
$$I_2 = \sqrt{\frac{100}{25}} = 2 \text{ A}$$

$$\frac{I_1}{I_2} = \frac{a}{1}$$

$$a = \frac{10}{2} = 5$$

5. (c)

To find out Thevenin equivalent of the circuit, put a test source between node A and B,



Applying node equation at V_a

$$\frac{V_a - \alpha i_x}{1} + \frac{V_a - 0}{1} = i_x$$

$$(1 + \alpha)i_x = 2V_a \quad \text{...(i)}$$

also
$$i_x = \frac{V_s - V_a}{1} \quad \text{...(ii)}$$

From equation (i) and (ii),

$$(1 + \alpha)i_x = 2(V_s - i_x)$$

$$i_x + \alpha i_x + 2i_x = 2V_s$$

$$V_s = \left(\frac{3+\alpha}{2}\right)I_s \qquad [\because i_x = I_s]$$

$$R_{th} = \frac{V_s}{I_s} = \frac{3+\alpha}{2} = 3$$

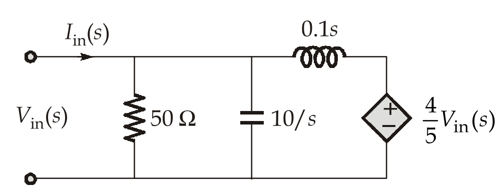
$$3 + \alpha = 6$$

$$\alpha = 3$$

6. (b)

Input admittance of the circuit is given by

$$Y_{in}(s) = \frac{I_{in}(s)}{V_{in}(s)}$$



by applying nodal analysis

$$I_{in}(s) = \frac{V_{in}(s) - 0}{50} + \frac{V_{in}(s) - 0}{\frac{1}{0.1s}} + \frac{V_{in}(s) - \frac{4}{5}V_{in}(s)}{0.1s}$$

$$I_{in}(s) = \frac{V_{in}(s)}{50} + 0.1sV_{in}(s) + \frac{1}{5}\frac{V_{in}(s)}{0.1s}$$

$$I_{in}(s) = V_{in}(s)\left[\frac{1}{50}+0.1s+\frac{2}{s}\right] = V_{in}(s)\left[\frac{s+5s^2+100}{50s}\right]$$

$$Y_{in}(s) = \frac{I_{in}(s)}{V_{in}(s)} = \frac{5s^2+s+100}{50s}$$

7. (b)

At resonance, $I = I_R = 1\text{ mA}$

$$|I_R + I_L| = \sqrt{I_R^2+I_L^2} = \sqrt{1^2+I_L^2} > 1\text{ mA}$$

$$|I_R + I_L| > 1\text{ mA}$$

8. (b)

The number of possible trees $= |AA^T|$

$$AA^T = \begin{bmatrix} 0 & -1 & 1 & 0 & 0 \\ 0 & 0 & -1 & -1 & -1 \\ -1 & 0 & 0 & 0 & 1 \end{bmatrix}\begin{bmatrix} 0 & 0 & -1 \\ -1 & 0 & 0 \\ 1 & -1 & 0 \\ 0 & -1 & 0 \\ 0 & -1 & 1 \end{bmatrix}$$

$$= \begin{vmatrix} 2 & -1 & 0 \\ -1 & 3 & -1 \\ 0 & -1 & 2 \end{vmatrix} = 2(6-1)+1(-2) = 10-2 = 8$$

9. (b)

The equivalent resistance across the terminals of inductor,

$$R_{eq} = 50 + 20 + 10 = 80\ \Omega$$

Time constant, $T = \frac{L}{R_{eq}} = \frac{0.5}{80} = \frac{1}{160}\text{sec}$

The current through the inductor at $t = 0^+$,

$$i_L(0^+) = i_L(0^-) = \frac{150}{50} = 3\text{ A}$$

The current through the inductor,

$$i_L(t) = i_L(0^+)e^{\frac{-R_{eq}}{L}} = 3e^{-160t}\text{ A},\ t > 0$$

10. (b)

Here, $K_p = 5\text{ rad/V}$

$$m(t) = 2\cos(2\pi\ 2000t)\text{ V}$$

$$K_p\, m(t) = 5 \times 2\cos(2\pi\ 2000t) = 10\cos(2\pi\ 2000t)\text{rad}$$

$$\text{The peak phase deviation} = [10\cos(2\pi 2000t)]$$
$$= 10 \text{ rad}$$

11. (c)

In FM, the transmitted power is always unchanged irrespective of modulation index.

12. (b)

For frequency modulation (f_m)

$$\beta = \frac{K_f A_m}{f_m}$$

If modulating frequency is halved, then modulation index is doubled.

13. (b)

$$x_{Am}(t) = [A + 0.9\, A \cos \omega_m t] \cos \omega_c t$$
$$x_{Am}(t) = A_c[1 + m_a \cos\omega_m t] \cos \omega_c t$$

Comparing both, $m_a = 0.9$

The power efficiency, $\eta = \dfrac{m_a^2}{2 + m_a^2} \times 100 = \dfrac{0.9^2}{2 + 0.9^2} \times 100 = 28.83\%$

14. (c)

$$f_m = 1 \text{ kHz}$$

and $f_c = 10$ kHz

The upper sideband, $f_{USB} = f_c + f_m = (10 + 1) = 11$ kHz

The lower sideband, $f_{LSB} = f_c - f_m = (10 - 1) = 9$ kHz

15. (d)

$$\text{Insertion loss} = 9 \text{ dB} = 10\log\left(\frac{P_T}{P_R}\right)$$

$$\log_{10}\left(\frac{P_T}{P_R}\right) = \frac{9}{10} = 0.90$$

Where, P_T = Transmitted power

P_R = Power received by the load

$$\log_{10}\left(\frac{P_T}{P_R}\right) = 0.90$$

$$\log_2\left(\frac{P_T}{P_R}\right) \times \log_{10} 2 = 3 \times 0.3$$

$$\log_2\left(\frac{P_T}{P_R}\right) = 3$$

$\therefore$ The noise factor, $\frac{P_T}{P_R} = 2^3 = 8$

16. (c)

Number of levels, $L = 2^n$

The bandwidth of PCM,

$$BW = nf_s$$

Where, n = number of bits

f_s = sampling frequency

If L increases from 2 to 8, n increase from 1 to 3.

So bandwidth becomes 3 times.

17. (d)

Channel capacity, (by Shannon hartlay theorem)

$$= B \log_2(1 + S/N)$$
$$= 5 \log_2(1 + 31) = 5 \log_2(32)$$
$$= 5 \log_2(2^5) = 25 \text{ kbit/sec}$$

18. (c)

The bandwidth, $BW = \frac{R_b}{2} = \frac{nf_s}{2} = \frac{9 \times 20}{2} = \frac{180}{2} = 90 \text{ kHz}$

19. (b)

$$SQNR = \frac{\text{Signal power}}{\text{Noise power}}$$

Signal power, $P_s = P$

Noise power, $P_n = \frac{\Delta^2}{12}$

But, $\Delta = \frac{2A_m}{2^n}$

$$P_n = \frac{(2A_m)^2}{2^{2n} \times 12} = \frac{(A_m)^2}{3 \times 2^{2n}}$$

$$SQNR = \frac{P}{\frac{(A_m)^2}{(3 \times 2^{2n})}} = \frac{3P}{(A_m)^2} \cdot 2^{2n}$$

By seeing the expression of $SQNR$, we get $SQNR$ is nonlinear and signal-dependent.

21. (c)

At $\omega t = 0$, diode starts conducting

KVL for given circuit,

$$v_s = v_0 = L\frac{di_0}{dt} = V_m \sin\omega t$$

$$i_0 = \frac{V_m}{L}\int \sin\omega t \cdot dt$$

$$i_0(\omega t) = \frac{-V_m}{\omega L}\cos\omega t + A$$

at $\omega t = 0$,

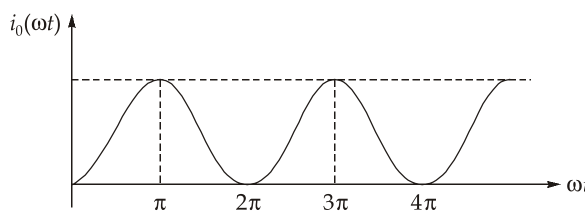
$$i_0(0) = 0$$

$$i_0(0) = 0 = \frac{-V_m}{\omega L} + A$$

$$A = \frac{V_m}{\omega L}$$

So,

$$i_0(\omega t) = \frac{V_m}{\omega L}(1 - \cos\omega t)$$



The diode will always conduct once it is turned on

So, average current,

$$I_0 = \frac{1}{2\pi}\int_0^{2\pi} i_0(\omega t)\, d(\omega t)$$

$$= \frac{1}{2\pi}\frac{V_m}{\omega L}\int_0^{2\pi}(1 - \cos\omega t)\, d(\omega t)$$

$$= \frac{1}{2\pi}\frac{V_m}{\omega L}[(2\pi - 0) - (0 - 0)]$$

$$I_0 = \frac{V_m}{\omega L}$$

22. (d)

The rms voltage for half wave rectifier,

$$V_{0\text{ rms}} = \frac{V_m}{2}$$

The input power factor,

$$\text{IPF} = \frac{P_{out}}{S_{in}}$$

For resistive load, $P_{out} = V_{0rms} I_{0rms}$

$$IPF = \frac{V_{0rms} I_{0rms}}{V_{in} I_{in}}$$

$$IPF = \frac{V_{0rms}}{V_{in}} \qquad (\because I_{0rms} = I_{in})$$

$$IPF = \frac{V_m / 2}{V_m / \sqrt{2}} = \frac{1}{\sqrt{2}} = 0.707$$

23. (b)

A TRIAC is a bidirectional thyristor with three terminals.

24. (c)

GTO has more $\frac{di}{dt}$ rating at turn-on condition.

25. (c)

$$L\frac{di}{dt} = V_m \sin \omega t$$

$$\frac{di}{dt} = \frac{V_m}{L}\sin\omega t$$

$$\int_0^i dt = \frac{V_m}{L}\int_{\alpha/\omega}^{t} \sin\omega t\, dt$$

$$i(\omega t) = \frac{V_m}{\omega L}\cos\omega t\Big|_t^{\alpha/\omega}$$

$$i(\omega t) = \frac{V_m}{\omega L}(\cos\alpha - \cos\omega t)$$

The diode will stop conduction when

$$i(\omega t)\big|_{\omega t=\beta} = \frac{V_m}{\omega L}(\cos\alpha - \cos\beta) = 0$$

$$\cos \beta = \cos \alpha$$

$$\beta = 2\pi - \alpha$$

$$\beta = 2\pi - \frac{\pi}{3} = \frac{5}{3}\pi \text{ rad}$$

The conduction angle of inductor

$$\beta - \alpha = \frac{5}{3}\pi - \frac{\pi}{3} = \frac{4}{3}\pi \text{ rad}$$

$$(\beta - \alpha) = \frac{4}{3}\times 180 = 240°$$

26. (a)

$$V_0 = \left(\frac{\alpha}{1-\alpha}\right)V_s = \frac{0.4}{1-0.4}\times 60 = 40 \text{ V}$$

The output current, $I_0 = \dfrac{V_0}{R} = \dfrac{40}{5} = 8$ Amp

The ripple voltage, $\Delta V_c = \dfrac{\alpha I_0}{fC} = \dfrac{0.4\times 8}{100\times 10^3 \times 100\times 10^{-6}}$

$= 0.32$ V

27. (b)

- If peak of carrier is coincident with zero of the reference, then $N = \dfrac{f_c}{2f_r}$.
- If zero of carrier is coincident with zero of reference, then $N = \left(\dfrac{f_c}{2f_r} - 1\right)$.

28. (a)

ZCS operates with a constant on-time control, whereas ZVS operates with a constant off-time control.

30. (d)

In a degenerative semiconductor, the majority carriers are controlled by Fermi-Dirac statistics.

31. (c)

Doping is done to increase the conductivity of semiconductor materials.

32. (c)

$$\sigma = q(n\mu_n + p\mu_p)$$

The minimum conductivity will occur at

$$n = n_i\sqrt{\frac{\mu_p}{\mu_n}}, \quad p = n_i\sqrt{\frac{\mu_n}{\mu_p}}$$

So,

$$\sigma_{min} = q\left(n_i\sqrt{\frac{\mu_p}{\mu_n}\times\mu_n^2} + n_i\sqrt{\frac{\mu_n}{\mu_p}\times\mu_p^2}\right)$$

$$= n_i q\left(2\sqrt{\mu_p\cdot\mu_n}\right)$$

$$\sigma_{min} = 2n_i q\sqrt{\mu_p\mu_n}$$

33. (b)

The forward bias dynamic resistance

$$r = \frac{nV_T}{I}$$

Where, η = recombination factor

η = 2 (for silicon)

V_T = Thermal voltage

At room temperature, V_T = 26 mV

So, dynamic resistance, $r = \frac{2 \times 26}{2} = 26\ \Omega$

34. (c)

For multistage amplifier, the overall voltage gain

$$A_{\text{overall}} = A_1 \cdot A_2 \cdot A_3 \;.....$$

$$\Rightarrow \quad A_{\text{overall (dB)}} = A_{1\text{ (dB)}} + A_{2\text{ (dB)}} + A_{3\text{ (dB)}} + ...$$

36. (a)

$$g_m = \frac{\Delta I_D}{\Delta V_{GS}} = \frac{(3-1.5)10^{-3}}{(5-4.5)} = 3 \text{ mili mho}$$

37. (b)

Open loop gain, A = –100

Negative feedback, $\beta = \frac{-4}{100}$

$$\text{Closed loop gain} = \frac{A}{1+A\beta} = \frac{-100}{1+(-100)\left(\frac{-4}{100}\right)} = -20$$

38. (b)

Cut-off frequency, $f = \frac{BW}{A_{CL}}$

$$f_c = \frac{1\times10^6}{0.200/10^{-6}} = \frac{1}{0.20} = 5 \text{ Hz}$$

39. (d)

- The output of an op-amp can only change by a certain amount in a given time. This limit is called the slew rate of the op-amp.
- The op-amp slew rate can limit the performance of a circuit if the slew rate requirement is exceeded.

40. **(a)**

Hysteresis is desirable in a Schmitt trigger because it would prevent noise from causing false triggering.

41. **(c)**

The voltage, $$V_0 = 0.5\left[\frac{-22}{2.2} + \left(1+\frac{22}{2.2}\right)\left(\frac{22}{22+2.2}\right)\right] = 0.5[-10+10] = 0 \text{ V}$$

42. **(c)**

$$\text{Work done} = q\,V \text{ J}$$
$$= 1 \times 20 = 20 \text{ J}$$

Let the distance between point P_1 and P_2 be x

$$dV = -\int E \cdot dl = 20$$
$$= (-50\hat{a}_x)\cdot(-x\,\hat{a}_x) = 20$$
$$50x = 20$$
$$\Rightarrow \quad x = \frac{20}{50} = 40 \text{ cm}$$

43. **(b)**

Force on a current carrying conductor,

$$\vec{F} = i\cdot(\vec{l}\times\vec{B}) = 10(\hat{z}\times(0.5\hat{y}-0.5\hat{x}))$$
$$= 10\times 0.5[\hat{z}\times(\hat{y}-\hat{x})]$$
$$= 5(-\hat{x}-\hat{y}) = -5(\hat{x}+\hat{y})\text{N/m}$$

44. **(a)**

$$L = \frac{\mu_0 N^2 A}{l} = \frac{4\pi\times10^{-7}\times(1000)^2\times\pi\times(4\times10^{-2})^2}{0.1}$$
$$= \frac{4\pi^2\times10^{-7}\times10^6\times16\times10^{-4}}{10^{-1}} = 6400\,\pi^2\times10^{-6}\text{ H} = 6400\pi^2\ \mu\text{H}$$

45. **(b)**

$$J = \nabla\times\vec{H}$$
$$= \frac{1}{r}\begin{vmatrix} ra_r & a_\phi & a_z \\ \frac{\partial}{\partial r} & \frac{\partial}{\partial\phi} & \frac{\partial}{\partial z} \\ 6r & (5r)r & 1 \end{vmatrix} = \frac{1}{r}\left(\frac{\partial}{\partial r}(5r^2)-0\right)\hat{a}_z$$
$$= \frac{1}{r}\cdot 10r\,\hat{a}_z = 10\,\hat{a}_z$$

46. (d)

Electric flux through a surface area is the integral of normal component of the field over the area.

47. (c)

$$R_1 = 300 \pm 1\% = (300 \pm 3)\Omega$$
$$R_2 = 600 \pm 2\% = (600 \pm 12)\Omega$$
$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{300} + \frac{1}{600}$$
$$R = 200\ \Omega$$

Now, $$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$$

Differentiate both side w.r.t. R

$$-\frac{\partial R}{R^2} = -\frac{1}{R_1^2}\frac{\partial R_1}{\partial R} - \frac{1}{R_2^2}\frac{\partial R_2}{\partial R}$$
$$\frac{\partial R}{R} = \frac{\partial R_1}{R_1}\cdot\frac{R}{R_1} + \frac{\partial R_2}{R_2}\cdot\frac{R}{R_2}$$
$$\frac{\partial R}{200} = \frac{3}{300}\cdot\frac{200}{300} + \frac{12}{600}\cdot\frac{200}{600} = \frac{1}{75}$$
$$\partial R = \frac{1}{75}\times 200 = 2.66\ \Omega$$

48. (b)

Under dynamic conditions, null-type instrument are less preferred compared to deflection-type instrument.

Statement-3 is incorrect.

49. (a)

$$\text{Resolution} = \frac{400}{20000} = 0.02$$
$$\text{Maximum error} = \frac{0.4}{100}\times 200 + 0.02\times 5 = 0.9\text{ V}$$
$$\%\ \text{error} = \frac{0.9}{200}\times 100 = 0.45\%$$

50. (c)

In 3-phase dynamometer, fixed coils are connected in series with lines and moving coils are connected across the lines.

51. (c)

Here, $$R_1 = \frac{R_2 R_3}{R_4} = \frac{500 \times 400}{800} = 250\ \Omega$$

$$L_1 = R_2 R_3 C_4$$
$$= 500 \times 400 \times 1 \times 10^{-6} = 0.2\ \text{H}$$

$$\text{Quality factor} = \frac{\omega L}{R_1} = \frac{2\pi \times 10^3 \times 0.2}{250} = 5.024$$

52. (b)

For dual-slope A/D converter

$$\text{Max. time conversion} = (2^{n+1})T_{clk}$$

Here, $$n = 9 \text{ bit}$$

$$T_{clk} = \frac{1}{102.4 \times 10^3}$$

$$\text{Output frequency} = \frac{102.4 \times 10^3}{2^{9+1}} = 100\ \text{Hz}$$

53. (d)

Here, $$m = \frac{10}{1 \times 10^{-3}} = 10^4$$

$$R_{sh} = \frac{R_m}{m-1} = \frac{50}{10^4 - 1} = 0.005\ \Omega$$

54. (b)

Only statetment-3 is correct.

55. (c)

Electrostatic instruments may be used on both ac and dc.

56. (b)

Input resistance of multimeter,

$$Z_L = 1000 \times 20 = 20000\ \Omega$$

Output resistance of circuit,

$$Z_0 = 10\ \text{k}\Omega$$
$$V_0 = 5\ \text{V}$$

$$\text{Reading of multimeter} = \frac{20}{20+10} \times 5 = \frac{10}{3}\ \text{V}$$

$\therefore$ % error in voltage reading

$$= \frac{\frac{10}{3} - 5}{5} \times 100 = -\frac{5}{3 \times 5} \times 100 = -33.33\%$$

57. (a)

$$\% \text{ error} = \frac{P_m - P_T}{P_T} \times 100$$

$$= \tan\phi \tan\beta \times 100$$

$$= (\tan\cos^{-1} 0.5) \times \frac{(2\pi f)L}{R} \times 100$$

$$= \sqrt{3} \times \frac{2 \times 3.14 \times 50 \times 0.4}{2000} \times 100 = 10.86\%$$

58. (d)

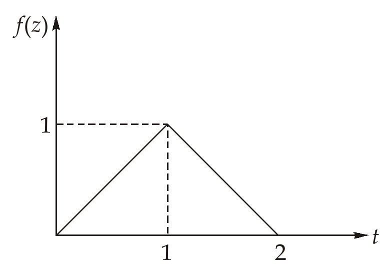
$$\text{Gauge factor } (G_f) = \frac{\Delta R / R}{\text{Strain}} = \frac{0.25}{500 \times 5 \times 10^{-4}} = 1$$

59. (d)

The system is nonlinear because $x^2(t)$ is present which is nonlinear term.

Here the output depends only on the present input, the system is static.

60. (c)



$$f(t) = r(t) - 2r(t-1) + r(t-2)$$

Where, $r(t)$ = ramp signal

$$L[r(t)] = \frac{1}{s^2}$$

So, $F(s) = L[f(t)] = L[r(t) - 2r(t-1) + r(t-2)]$

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

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

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

61. (b)

$$y(t) = x(t - t_0) + x(t + t_0) \quad \text{...(i)}$$

By time shifting property,

$$x(t \pm t_0) \rightleftharpoons e^{\pm jK\omega_0 t} X(k)$$

Taking Fourier series of both the sides of equation (i),

$$Y(K) = e^{-jK\omega_0 t_0} X(k) + e^{jK\omega_0 t_0} X(k)$$

$$y(K) = \left(e^{jK\omega_0 t_0} + e^{-jK\omega_0 t_0}\right) X(k)$$

$$y(K) = 2\cos(K\omega_0 t_0) X(k)$$

$$y(K) = 2\cos\left(K\frac{2\pi}{2} \times 1\right) X(k)$$

$$y(K) = 2\cos(\pi K)\, X(K)$$

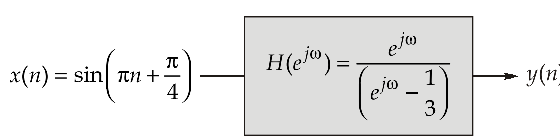
62. (a)

The fourier transform of a rectangular pulse is sinc function.

63. (d)

$$h(n) = \left(\frac{1}{3}\right)^n u(n)$$

$$x(n) = \sin\left(\pi n + \frac{\pi}{4}\right)$$



The DTFT of $h(n)$: $H(e^{j\omega}) = \frac{e^{j\omega}}{\left(e^{j\omega} - \frac{1}{3}\right)}$

$$x(n) = \sin\left(\pi n + \frac{\pi}{4}\right), \qquad \omega = \pi$$

$$H(e^{j\pi}) = \frac{e^{j\pi}}{e^{j\pi} - \frac{1}{3}} = \frac{-1}{-1 - \frac{1}{3}} = \frac{3}{4} e^{j0}$$

So, $$y(n) = \frac{3}{4} e^{j0} \sin\left(\pi n + \frac{\pi}{4}\right)$$

$$y(n) = \frac{3}{4} \sin\left(\pi n + \frac{\pi}{4}\right)$$

64. (d)

The property of z-transform for scaling in the z-domain,

$$x(n) \overset{ZT}{\rightleftharpoons} X(z)$$

$$a^n x(n) \overset{ZT}{\rightleftharpoons} X(a^{-1}z) = X\left(\frac{z}{a}\right)$$

65. (a)

$$I = \int_{-\infty}^{\infty} \cos(2\pi t) e^{-t^2/2} \delta(1-2t)\,\text{dt}$$

$$= \int_{-\infty}^{\infty} \cos 2\pi t\; e^{-t^2/2} \frac{1}{2}\delta\left(t-\frac{1}{2}\right)\text{dt}$$

$\because$ $f(t)\ \delta(t - t_0) = f(t_0)\delta(t - t_0)$ and area under impulse is 1,

$$I = \frac{1}{2} \times \cos\left(2\pi \times \frac{1}{2}\right) \times e^{-1/8} = -\frac{1}{2}e^{-1/8}$$

66. (c)

$$F(A,\ B,\ C) = (A+B+\overline{C})\cdot(A+\overline{B}+\overline{C})\cdot(\overline{A}+\overline{B}+C)\cdot(\overline{A}+\overline{B}+\overline{C})$$

The above function can be expressed as

$$F(A,B,C) = \Sigma M(1,\ 3,\ 6,\ 7)$$

The function in SOP form can be expressed as

$$F(A,\ B,\ C) = \Sigma m(0,\ 2,\ 4,\ 5) = \overline{A}B\overline{C} + \overline{A}\overline{B}\overline{C} + A\overline{B}\overline{C} + A\overline{B}C$$

67. (c)

The EX-OR is used to find the 1's complement of the 4-bit number. The 4-bit number adder adds the 1's complement and 1010 with the carry to get the 10's complement of the original number (A).

68. (d)

A Mod-16 ripple counter uses four flip-flops with t_{pd} = 50 ns. Thus $f_{\max}$ for the ripple counter is

$$f_{\max} = \frac{1}{4 \times 50\,\text{ns}} = 5 \text{ MHz (ripple counter)}$$

69. (b)

Flip-flop is a simplest kind of sequential circuit, with a memory cell that only has two states i.e 1 or 0.

71. (c)

$$[A] = 3A$$

$$\begin{array}{lr} \text{Binary equivalent} \rightarrow & 0\,0\,1\,1\;\;1\,0\,1\,0 \\ & +\,0\,1\,1\,0\;\;0\,0\,0\,0 \\ \hline & 1\,0\,0\,1\;\;1\,0\,1\,0 \\ & D_7 D_6 D_5 D_4 D_3 D_2 D_1 D_0 \end{array}$$

- D_7 bit is 1, so sign flag is set and it shows a negative number.
- When 60 H is added to 3A H then there is no carry from the 3rd bit to the 4th bit, hence auxiliary carry is reset.
- Number of '1's in the result is 4 times, hence parity flag is set.
- Result is not zero so zero flag is reset.

72. (b)

WAIT : It is related to 8086. It makes the lock pin low till the execution of the next instruction and the processor enters into an idle state in which the processor does no processing.

HLT : It finishes the current instruction and halts any further execution.

NOP : It is used when no operation is performed and no flags are affected during the execution.

73. (b)

8085 has 5 hardware interrupts :
INTR, TRAP, RST 5.5, RST 6.5, RST 7.5 and out of these TRAP is non-maskable and remaining are maskable.

76. (c)

OSI has 7 layers, but TCP/IP has 5 layers.

77. (d)

The three major methods of allocating disk space in wide use are:

1. **Contiguous allocation:** It requires each file to occupy a set of contiguous blocks on the disk.
2. **Linked allocation:** In this allocation each file is a linked list of disk blocks, the disk blocks may be scattered anywhere on the disk. It also solves the external framentation and size declaration problems of contiguous allocation.
3. **Indexed allocation:** Each file has its disk-block addresses.

78. (b)

Using LRU (Least Recently Used) algorithm,

3	4	5	6	5	4	1	3	4	2	4	3	1	2
3	4	5	6	5	4	1	3	4	2	4	3	1	2
	3	4	5	6	5	4	1	3	4	2	4	3	1
		3	4	4	6	5	4	1	3	3	2	4	3
×	×	×	×			×	×		×			×	×

Number of page faults = 9

79. (d)

Call by value: When function is invoked, values of actual parameters are copied to function's formal parameters and two types of parameters are stored in different memory locations. So the value of actual parameter is not modified by formal parameter.

Call by reference: In this method when function is invoked, the address of the variable is passed to the function as parameter, so both actual and formal parameters have same location. The value of actual parameter can be modified by formal parameter.

80. (b)

Gantt Chart:

P_1	P_2	P_2	P_2	P_1	P_4	P_3

0 1 2 3 4 8 14 22

	AT	BT	CT	TAT (CT – AT)	WT (TAT – BT)
P_1	0	5	8	8	3
P_2	1	3	4	3	0
P_3	2	8	22	20	12
P_4	3	6	14	11	5

$$\text{Average WT} = \frac{3+0+12+5}{4} = 5 \text{ ms}$$

82. (c)

Total number of loops are 5,

Non-touching loops are 2

$$\frac{C}{R} = \frac{5\times3+2\times3}{1-(-5\times1-5\times3-2\times3-2\times1+3)-(5\times3+3\times2)} = \frac{21}{5}$$

83. (b)

$$G(s) = \frac{(s+1)}{s(s+4)}$$

Given open-loop is of type-1,

So error is only due to ramp input

$$K_v = \lim_{s\to0} sG(s) = \lim_{s\to0} s\cdot\frac{(s+1)}{s(s+4)} = \frac{1}{4}$$

$$e_{ss} = \frac{0.5}{K_v} = 0.5\times4 = 2$$

84. (c)

$$c(t) = Ae^{-8t}\sin(6t+\theta)$$

Laplace transform, $$\text{TF} = \frac{K}{(s+8)^2+6^2}$$

$$\text{CE} = s^2 + 16s + 64 + 36$$
$$= s^2 + 16s + 100$$
$$\omega_n = \sqrt{100} = 10 \text{ rad/sec}$$
$$2\,\xi\omega_n = 16$$
$$\xi = \frac{16}{2\times 10} = 0.8$$

85. (c)

Routh array,

s^4	3	5	2
s^3	10	5	0
s^2	3.5	2	
s^1	–0.714	0	
s^0	2		

Total number of sign change is 2,

So number of roots in right of s-plane = 2

and number of roots in left of s-plane = 4 – 2 = 2

86. (b)

The sensitivity of roots of the characteristic equation when K varies is defined as root sensitivity, and is given by,

$$s_k = \frac{ds/s}{dK/K} = \frac{K}{s}\cdot\frac{ds}{dK}$$

So, the value of root sensitivity at breakaway point is infinity.

87. (d)

$$\text{CE} = 1 + G(s)H(s)$$
$$= 1+\frac{K(s+1)}{s(s+2)(s+4)(s+5)}$$

$$\text{Number of asymptotes} = |P-Z| = |4-1| = 3$$

$$\text{Centroid } (\sigma) = \frac{0-2-4-5-(-1)}{|4-1|}$$
$$= -\frac{10}{3} = -3.33$$

88. (b)

$$CE \equiv 225 - \omega^2 + j24\,\omega$$

$$\omega_n = \sqrt{225} = 15 \text{ rad/sec}$$

$$2\xi\omega_n = 24$$

$$\Rightarrow \quad \xi = \frac{24}{2 \times 15} = 0.8$$

$$M_p = \frac{1}{2\xi\sqrt{1-\xi^2}} = \frac{1}{2 \times 0.8\sqrt{1-0.8^2}} = \frac{1}{2 \times 0.8 \times 0.6}$$

$$= \frac{100}{96} = 1.041$$

89. (b)

Gain margin is amount of gain in decibel that should be added to make system unstable.

90. (d)

Properties of $\phi(t)$:

$$\phi(0) = I$$

$$\phi^{-1}(t) = \phi(-t)$$

$$\phi(t_2 - t_1) = \phi(t_2 - t_0) \cdot \phi(t_0 - t_1)$$

$$\phi(t_2 + t_1) = \phi(t_1) \cdot \phi(t_2)$$

$$[\phi(t)]^k = \phi(kt)$$

$$\phi(t_2 - t_1) = \phi(t_2)\,\phi(-t_1) = \phi(t_2)\,\phi^{-1}(t_1)$$

91. (c)

Here, $A = \begin{bmatrix} 1 & 4 \\ -1 & 0 \end{bmatrix}, \; B = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$

and $C = \begin{bmatrix} 1 & 0 \end{bmatrix}$

$$\text{T.F.} = C[sI - A]^{-1} B$$

$$= \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} s-1 & -4 \\ 1 & s-0 \end{bmatrix}^{-1} \begin{bmatrix} 1 \\ 1 \end{bmatrix}$$

$$= \frac{\begin{bmatrix} 1 & 0 \end{bmatrix}}{s(s-1)+4} \begin{bmatrix} s & 4 \\ -1 & s-1 \end{bmatrix} \begin{bmatrix} 1 \\ 1 \end{bmatrix}$$

$$= \frac{\begin{bmatrix} 1 & 0 \end{bmatrix}}{s^2 - s + 4} \begin{bmatrix} s+4 \\ s-2 \end{bmatrix} = \frac{s+4}{s^2 - s + 4}$$

92. (c)

$$A = \begin{bmatrix} 1 & 1 \\ -5 & -2 \end{bmatrix}, \qquad B = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

and $$C = \begin{bmatrix} -1 & 1 \end{bmatrix}$$

Observability matrix, $$[V] = \begin{bmatrix} C \\ CA \end{bmatrix}$$

$$CA = \begin{bmatrix} -1 & 1 \end{bmatrix}\begin{bmatrix} 1 & 1 \\ -5 & -2 \end{bmatrix} = \begin{bmatrix} -6 & -3 \end{bmatrix}$$

$$[V] = \begin{bmatrix} -1 & 1 \\ -6 & -3 \end{bmatrix}$$

93. (a)

Here, $$R_1 = 5\ \Omega$$

$$R_2 = 4\ \Omega$$

$$C = 1\text{ F}$$

$$\tau = R_2C = 4 \times 1 = 4$$

$$\beta = \frac{R_1 + R_2}{R_1} = \frac{5+4}{4} = \frac{9}{4}$$

$$\omega_m = \sqrt{\frac{1}{\tau}\frac{1}{\beta\tau}} = \frac{1}{\tau}\sqrt{\frac{1}{\beta}} = \frac{1}{4}\sqrt{\frac{4}{9}} = \frac{2}{4}\cdot\frac{1}{3} = \frac{1}{6}$$

94. (d)

When, $$\frac{v}{f} \neq \text{const.}$$

$$P_e \propto V^2$$

$$\frac{80}{P_e} = \frac{(240)^2}{(320)^2}$$

$\Rightarrow$ $$P_e = 80 \times \left(\frac{320}{240}\right)^2 = 80 \times \left(\frac{4}{3}\right)^2 = 80 \times \frac{16}{9}$$

$$P_e = 142.22\text{ W}$$

95. (d)

Frequency of induced voltages in 1-phase transformer is constant because there is no relative motion between coils.

96. (c)

To have minimum inrush current in the transformer the switch-on instant should be at maximum input voltage.

97. (c)

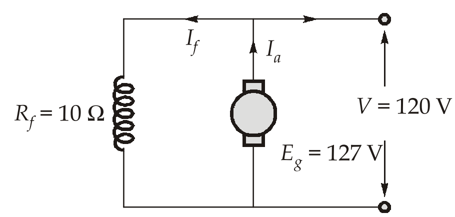
For closed delta, transformer output = $3V_L I_{ph}$

For open delta, transformer output = $\sqrt{3}V_L I_{ph}$

$$\% \text{ increase in capacity} = \frac{(VA)_{\Delta-\Delta} - (VA)_{V-V}}{(VA)_{V-V}} \times 100$$

$$= \frac{3-\sqrt{3}}{\sqrt{3}} = (\sqrt{3}-1) \times 100 = 73.2\%$$

98. (c)



$$I_f = \frac{120}{10} = 12A$$

$$I_a = \frac{127-120}{0.025} = 280 \text{ A}$$

$$I_a = I_f + I_L$$

$$I_L = 280 - 12 = 268 \text{ A}$$

99. (c)

$$E \propto (\phi_{sh} - \phi_{se}) \text{ \{for differential DC generator\}}$$

$$E_1 \propto (0.8 - 0.2)$$

$$\propto 0.6$$

when series is short circuited,

$$\phi_{se} = 0$$

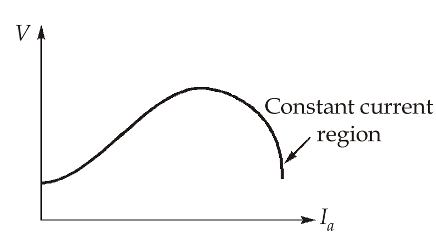
$$E_2 \propto (0.8 - 0) \propto 0.8$$

$$(E_2 - E_1) \propto 0.8 - 0.6$$

$$\propto 0.2$$

So, terminal voltage increases by 20%.

100. (b)



Constant current region in external characteristic (V-I) of a series generator is used in welding.

102. (b)

For eliminating n^{th} harmonics, chording angle should be

$$\alpha = \frac{180°}{n}$$

To elimninate harmonics winding also should be short pitched

$$= 180 - \alpha$$

$$= \left(180 - \frac{180}{n}\right)$$

So, $$180 \times \frac{4}{5} = 180\left(1 - \frac{1}{n}\right)$$

$$\frac{4}{5} = 1 - \frac{1}{n}$$

$\Rightarrow$ $$\frac{1}{n} = 1 - \frac{4}{5} = \frac{1}{5}$$

$\Rightarrow$ $$n = 5 = \text{fifth harmonics}$$

103. (d)

$$V = 300 \text{ V}; \; X = 2\ \Omega, \; I = 15 \text{ A}$$

$$\vec{E} = \vec{V} + jX\vec{I}$$

$$= 300 \angle 0 + j2 \times 15 \angle{+90°}$$

$$= 300 + (j2) \times (j15)$$

$$= 300 - 30 = 270 \text{ V}$$

$$\text{Voltage regulation} = \frac{E - V}{V} \times 100$$

$$= \frac{270 - 300}{300} \times 100 = -\frac{30}{300} \times 100 = -10\%$$

104. (b)

$$N_s = \frac{120 \times 50}{4} = 1500 \text{ rpm}$$

$$N_m = 1350 \text{ rpm}$$

$$S_m = \frac{N_s - N_m}{N_s} = \frac{1500 - 1350}{1500} = \frac{150}{1500} = \frac{1}{10}$$

$$X_2 S_m = r_2'$$

$$X_2 = \frac{0.4}{1/10} = 4\ \Omega$$

105. (d)

Skewing of slots in rotor helps in suppressing undesirable harmonics, improving heat transfer, reducing noise in an induction machine.

106. (b)

Frequency of rotating magnetic field is same as that of the supply frequency, while rotor frequency is slip times of supply frequency.

107. (c)

$$P_{\text{in}} = 50 \text{ kW} \quad \text{St. loss} = 1 \text{ kW}$$
$$P_g = 50 - 1 = 49 \text{ kW}$$
$$N_s = \frac{120 \times 50}{4} = 1500 \text{ rpm}, \qquad N_r = 1440 \text{ rpm}$$
$$S = \frac{1500 - 1440}{1500} = 0.04$$
$$P_m = P_g(1 - S)$$
$$= 49(1 - 0.04) = 47.04 \text{ kW}$$
$$P_{sh} = 47.04 - 3 = 44.04 \text{ kW}$$
$$\text{efficiency} = \frac{P_{sh}}{P_{in}} = \frac{44.04}{50} = 88.08\%$$

108. (a)

$$\text{Step angle, } \alpha = \frac{N_s - N_r}{N_s \cdot N_r} \times 360 = \frac{10 - 8}{10 \times 8} \times 360 = 9°$$

109. (c)

$$A^{-1} = \frac{(\text{adj}\, A)}{|A|}$$
$$|A| = -4 \times 5 = -20$$
$$|A| \cdot (A^{-1}) = (\text{adj } A)$$
$$\lambda \text{ of } adjA = \frac{|A|}{\lambda_1}, \frac{|A|}{\lambda_2} = \frac{-20}{-4}, \frac{-20}{5} = 5, -4$$

110. (d)

$$x = (N)^{1/2N}$$
$$x^{2N} = N$$
$$x^{2N} - N = 0$$
$$f(x) = x^{2N} - N$$
$$f'(x) = 2N \cdot x^{2N-1}$$

According to Newton Raphson method,

$$x_{k+1} = x_k - \frac{f(x_k)}{f'(x_k)} = x_k - \frac{x_k^{2N} - N}{2Nx_k^{2N-1}}$$

$$= \frac{2Nx_k^{2N} - x_k^{2N} + N}{2N\,x_k^{2N-1}}$$

$$x_{(k+1)} = \left(\frac{2N-1}{2N}\right)x_k + \frac{x_k^{1-2N}}{2}$$

111. (a)

$$D^2 - 4D + 4 = 0$$
$$(D-2)(D-2) = 0$$
$$D = 2, 2$$
$$y = (C_1 + C_2 x)e^{2x}$$
$$y(0) = C_1 = 0$$
$$\Rightarrow \quad C_1 = 0$$
$$y(1) = e^2 = C_2 e^2$$
$$\Rightarrow \quad C_2 = 1$$
$$y = x\,e^{2x}$$
$$y(3) = 3\,e^6$$

112. (d)

We parameterize the curve using $t = y$

$$x = 2 - 3t^2; \qquad -1 \le t \le 1$$
$$y = t$$

Then

$$dx = -6t\,dt$$
$$dy = dt$$

$$\int_C 2y^3 dx + 3x^2 dy = \int_{-1}^{1} \left[2t^3(-6t) + 3(2-3t^2)^2\right]dt$$

$$= \int_{-1}^{1} (15t^4 - 36t^2 + 12)dt$$

$$= \left[\frac{15t^5}{5} - \frac{36t^3}{3} + 12t\right]_{-1}^{1}$$

$$= \left[3t^5 - 12t^3 + 12t\right]_{-1}^{1}$$

$$= (3 - 12 + 12) - (-3 + 12 - 12)$$

$$= 6$$

113. (c)

$$\int_0^4 f(x)dx = \frac{h}{3}[(y_0 + y_4) + 4(y_1 + y_3) + 2y_2]$$

$$= \frac{1}{3}[(0.029 + 0.5) + 4(0.05 + 0.25) + 2 \times 0.1]$$

$$= \frac{1}{3}[0.529 + 1.20 + 0.2]$$

$$= 0.643 \approx 0.64$$

114. (b)

For a field to be solenoidal,

$$\nabla \cdot \vec{V} = 0$$

$$\nabla \cdot \vec{V} = \frac{\partial V_x}{\partial x} + \frac{\partial V_y}{\partial y} + \frac{\partial V_z}{\partial z} = 0$$

Where,

$$\vec{V} = (x^2y + yz)\hat{i} + (cxy^2 - xz^3)\hat{j} - (4xyz - 2x^2y^2)\hat{k}$$

$$\nabla \cdot \vec{V} = \frac{\partial}{\partial x}(x^2y + yz) + \frac{\partial}{\partial y}(cxy^2 - xz^3) + \frac{\partial}{\partial z}(-4xyz + 2x^2y^2)$$

$$\nabla \cdot \vec{V} = 2xy + 2c\,xy - 4\,xy = 0$$

$$2 + 2c - 4 = 0$$

$$c = 1$$

115. (c)

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

$$f(0) = -1, f(1) = 0$$

$$f'(z) = \frac{2}{(z+1)^2}\ ; \qquad f'(0) = 2$$

$$f''(z) = \frac{-4}{(z+1)^3}, \qquad f''(0) = -4$$

$$f'''(z) = \frac{12}{(z+1)^4}\ ; \qquad f'''(0) = 12 \text{ and soon}$$

Taylor series :

$$f(z) = f(z_0) + (z - z_0)f'(z_0) + \frac{(z-z_0)^2}{2!}f''(z_0) + \frac{(z-z_0)^3}{3!}f'''(z_0) + \ldots$$

$$= -1 + 2z + \frac{z^2}{2}(-4) + \frac{z^3}{6}(12) + \ldots.$$

$$= -1 + 2z - 2z^2 + 2z^3 \ldots.$$

$$f(z) = -1 + 2(z - z^2 + z^3 \ldots.)$$

116. (a)

Put, $x = e^{-t/5}$ so that,

$$\log\left(\frac{1}{x}\right) = \frac{t}{5}$$

$$dx = -\frac{1}{5}e^{-t/5}dt$$

$$I = \int_0^1 x^5\left[\log\left(\frac{1}{x}\right)\right]^3 dx = \frac{1}{625}\int_0^\infty e^{-6t/5}\cdot t^3\,dt$$

Let,

$$z = \frac{6t}{5},$$

$$dt = \frac{5}{6}dz$$

$$I = \frac{1}{625}\int_0^\infty e^{-z}\left(\frac{5}{6}z\right)^3 \times\frac{5}{6}dz$$

$$I = \frac{1}{6^4}\int_0^\infty e^{-z}z^3dz = \frac{\lceil 4}{6^4} = \frac{1}{6^3} = \frac{1}{216}$$

117. (d)

All statements are correct.

118. (c)

We need absolute maximum of $f(x) = x^3 - 9x^2 + 24x - 5$ in the interval [1, 6]

$$f(x) = x^3 - 9x^2 + 24x - 5$$

$$f'(x) = 3x^2 - 18x + 24$$

i.e. $$x^2 - 6x + 8 = 0$$

$$x = 2, 4$$

Now, $$f''(x) = 6x - 18$$

$$f''(2) = 12 - 18 = -6 < 0 \text{ (So } x = 2 \text{ is a point of local maximum)}$$

And $$f''(4) = 24 - 18 = 6 > 0 \text{ (So } x = 4 \text{ is a point of local minimum)}$$

Now tabulate the values of f at end point of interval and at local maximum point, to find absolute maximum in given range, as shown below:

x	$f(x)$
1	11
2	15
4	11
6	31

Clearly the absolute maximum is at $x = 6$ and absolute maximum value is 31.

119. (c)

Number of trails, $n = 180$

The cases in which number of first dice exceeds the number on 2nd dice

(2, 1); (3, 1); (3, 2); (4, 1); (4, 2);(4, 3); (5, 1); (5, 2); (5, 3); (5, 4); (6, 1); (6, 2); (6, 3); (6, 4); (6, 5)

As, there are 15 cases out of 36 in which we have success

Probability of success, $P = \frac{15}{36} = \frac{5}{12}$

$$E(X) = np = 180 \times \frac{15}{36} = 75$$

120. (c)

$$A = 1, \quad B = 0, \quad C = -K^2$$

As $B^2 - 4AC > 0$,

It will be hyperbola.

121. (b)

In BCC iron, $a\sqrt{3} = 4r$

In FCC iron, $a\sqrt{2} = 4r$

Therefore, there is contraction in volume when BCC iron changes to FCC iron.

122. (a)

All ferroelectric materials are piezoelectric materials but the converse is not true.

123. (d)

We know, $q = CV$

$\Rightarrow$ Polarisation $(P) = \frac{q}{A} = \frac{C}{A} \cdot V$

Where A is area of the crystal capacitor

$$\Delta P = \left(\frac{V}{A}\right) \times \Delta C$$

$$\Rightarrow \quad \frac{\Delta P}{P} = \frac{\Delta C}{C}$$

$$\text{Uniaxial stress } (\sigma) = Y \cdot \frac{\Delta C}{C} = Y \cdot \frac{\Delta P}{P}$$

$$= 150 \cdot \frac{20}{400} = 7.5 \text{ GPa}$$

124. (b)

$$M = \chi_m H$$

$$\Rightarrow \quad H = \frac{2.5}{0.005} \text{A/m} = 500 \text{ A/m}$$

$$B = \mu_0(H + M)$$

$$= 4\pi \times 10^{-7} \times (500 + 2.5)$$

$$= 6.31 \times 10^{-4} \text{ Wb/m}^2$$

125. (b)

$$B = 1\ \text{Wb/m}^2, \qquad t = 2.5\ \text{mm}$$
$$I = 5\ \text{A}, \qquad R_H = 5 \times 10^{-7}$$
$$V_H = R_H \frac{BI}{W}$$
$$= 5\times10^{-7} \times \frac{1\times5}{2.5\times10^{-3}} = 1\ \text{mV}$$

126. (c)

Alloy of copper and tin is known as bronze.

127. (d)

With increase in Carbon content the strength, hardness and brittleness increases but the ductility and toughness decreases.

128. (b)

Soft iron in characterized by low rententivity, low coercivity and high saturation magnetization.

129. (a)

$$\rho = \frac{M}{V}$$
$$\Rightarrow \quad V = \frac{M}{\rho} = \frac{6.4\times10^3}{8.6\times10^3}\text{m}^3$$
$$\text{Magnetic moment} = MV$$
$$M = \frac{4}{6.4}\times 8.6\ \text{A/m} = 5.375\ \text{A/m}$$

130. (c)

Superconductor is a conductor of infinite conductivity below critical temperature.

131. (d)

Residual resistivity of a metal is temperature independent.

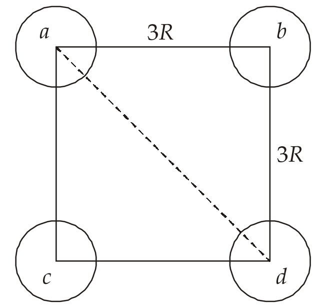
132. (c)

In materials like iron, the magnetic properties depend on the direction in which they are measured. This is magnetic anisotropy.

134. (a)

- Semi-fixed cost is the cost which depends upon maximum demand but is independent of units generated.
- Running cost is the cost which depends only upon the number of units generated.

136. (c)



$$D_{ad} = \sqrt{(3R)^2 + (3R)^2}$$

$$D_{ad} = 3\sqrt{2}\,R$$

$$\text{The GMR} = \sqrt[4]{(D_{ab} \cdot D_{ac} \cdot D_{ad})e^{-1/4}}\ R$$

$$= \sqrt[4]{0.7788R \times 3R \times 3R \times 3\sqrt{2}}\ R$$

$$= (29.73)^{1/4}\ R$$

137. (b)

We know, $$Q \propto \frac{V^2}{f}$$

So, $$Q_2 = Q_1\left(\frac{0.95^2}{0.90}\right) = 200 \times \frac{0.95^2}{0.90} = 200.56 \text{ MVAR}$$

138. (c)

The receiving voltage at no load

$$V_{R(NL)} = \frac{V_S}{A} = \frac{240}{0.95} = 252.63 \text{ kV}$$

The percentage voltage regulation

$$\% V_R = \frac{V_{R(NL)} - V_{R(FL)}}{V_{R(FL)}} \times 100 = \frac{252.63 - 220}{220} \times 100 = 14.83\%$$

139. (c)

$$Z_{\text{positive}} = Z_{\text{negative}} = Z_s - Z_m = 30 - 10 = 20\ \Omega$$

$$Z_{\text{zero}} = Z_s + 2Z_m = 30 + 2 \times 10 = 50\ \Omega$$

140. (b)

$$S_{D2} = (0.8 + j0) \text{ pu}$$

This 0.8 pu active power is supplied by the generator G_1

$$P = 0.8 = \frac{1 \times 1}{0.625} \sin\delta$$

$$\delta = \sin^{-1}(0.625 \times 0.8) = 30°$$

The reactive power at load side

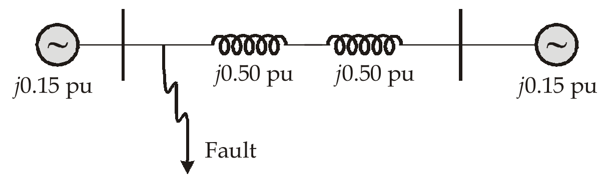
$$Q_R = \frac{V_1 V_2}{X}\cos\delta - \frac{V_1^2}{X} = \frac{1 \times 1}{0.625}\cos(30°) - \frac{1}{0.625}$$

$$Q_R = -0.214 \text{ pu}$$

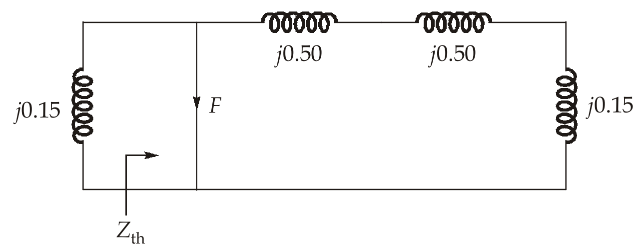
So, the VAR rating of capacitor,

$$Q_C = -Q_R = 0.214 \text{ pu}$$

142. (c)



The Thevenin equivalent circuit is shown below:



$$Z_{th} = 0.15 \parallel (0.50 + 0.50 + 0.15)$$

$$Z_{th} = 0.15 \parallel (1.15) = \frac{0.15 \times 1.15}{1.30} = 0.1327$$

$$Z_{th}(\%) = 13.27\%$$

143. (a)

$$\text{3-}\phi \text{ fault current } I_{3\phi} = 10 = \frac{E}{X_1}$$

$$\frac{1}{X_1} = 10$$

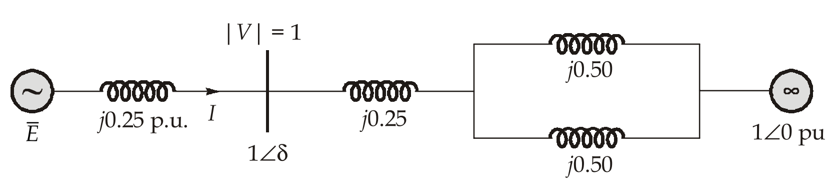
$$\Rightarrow \quad X_1 = 0.10 \text{ pu}$$

$$\text{line to line fault} \quad I_{f(L\text{-}L)} = \frac{\sqrt{3}E}{X_1 + X_2} = 2$$

$$\frac{\sqrt{3} \times 1}{0.10 + X_2} = 2$$

$$X_2 = \frac{\sqrt{3}}{2} - 0.10 = 0.77 \text{ pu}$$

144. (a)



$$P = \frac{1 \times 1}{0.25 + \frac{0.50}{2}} \sin\delta = 1$$

$$\sin\delta = 0.5$$

$$\delta = 30°$$

$$\bar{I} = \frac{1\angle 30° - 1\angle 0°}{j0.50}$$

So internal voltage, $E = V + I(j0.2)$

$$E = 1\angle 30° + \frac{1\angle 30° - 1\angle 0°}{j0.50} \times j0.25$$

$$E = 1\angle 30° + 0.5\angle 30° - 0.5\angle 0°$$

$$\bar{E} = 1.5\angle 30° - 0.5\angle 0°$$

$$|\bar{E}| = \sqrt{1.5^2 + 0.5^2 - 2\times 0.5\times 1.5\times\cos 30°}$$

$$|\bar{E}| = \sqrt{1.2}$$

$$|\bar{E}| = 1.096 \text{ pu}$$

So power angle equation $P_e = \dfrac{|E||V_\infty|}{(0.5+0.25)}\sin\delta$

$$P_e = \frac{1.096\times 1}{0.75}\sin\delta$$

$$P_e = 1.46 \sin\delta$$

145. (b)

The critical resistance,

$$R_{critical} = \frac{1}{2}\sqrt{\frac{L}{C}} = \frac{1}{2}\sqrt{\frac{1}{0.01\times 10^{-6}}} = 5\text{ k}\Omega$$

146. (a)

There is no current through a capacitor if the voltage across it is not changing with time. A capacitor is therefore an open circuit to dc.

147. (c)

As the temperature of the FET increases, the mobility decreases.

150. (b)

Both the statement is individually correct.

■■■■