ESE- 2019 (Prelims) - Offline Test Series Test-19

ELECTRICAL ENGINEERING

SUBJECT: ENGINEERING MATHEMATICS + COMPUTER FUNDAMENTALS + ELECTRICAL & ELECTRONIC MEASUREMENTS SOLUTIONS

01. Ans: (a)

Sol: $\left(1+e^{\frac{x}{y}}\right)dx + e^{\frac{x}{y}}\left(1-\frac{x}{y}\right)dy = 0$

$$\frac{\partial M}{\partial y} = \frac{-xe^{\frac{x}{y}}}{y^2}, \frac{\partial N}{\partial x} = e^{\frac{x}{y}}\left(\frac{1}{y}\right) - \frac{1}{y}\left(e^{\frac{x}{y}} + \frac{xe^{\frac{x}{y}}}{y}\right)$$

$$= -\frac{xe^{\frac{x}{y}}}{y^2}$$

$\therefore$ The above equation is an exact differential equation

$\left(x + ye^{\frac{x}{y}}\right) = c$ is the solution.

02. Ans: (b)

Sol: $\frac{d^3y}{dx^3} - 2\frac{d^2y}{dx^2} - \frac{dy}{dx} + 2y = 0$

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

$[D^2 (D-2) - 1(D-2)]y = 0$

$(D^2 - 1)(D-2)y = 0$

$\therefore$ AE has roots 1, –1, 2

$\therefore y = (C_1e^x + C_2\ e^{-x} + C_3e^{2x})$ is the general solution and e^x, e^{-x}, e^{2x} are the independent solutions.

03. Ans: (c)

Sol: $\frac{d^3y}{dx^3} + \frac{3d^2y}{dx^2} + \frac{3dy}{dx} + y = x^2e^{-x}$

$(D^3+3D^2+3D+1)y = x^2e^{-x}$

$(D+1)^3y = x^2e^{-x}$

$$\therefore\ y_p = \frac{x^2e^{-x}}{(D+1)^3}$$

$$= e^{-x}\frac{x^2}{[(D-1)+1]^3}$$

$$= e^{-x}\frac{x^2}{D^3}$$

$$= e^{-x}\frac{1}{3}.\frac{1}{4}.\frac{x^5}{5}$$

$$= \frac{x^5e^{-x}}{60}$$

04. Ans: (a)

Sol:. $(mz-ny)\frac{\partial z}{\partial x}+(nx-\ell z)\frac{\partial z}{\partial y}=(\ell y-mx)$

$\therefore$ A.E.'s are $\frac{dx}{(mz-ny)}=\frac{dy}{(nx-\ell z)}=\frac{dz}{(\ell y-mx)}$

From Lagrange's method of multipliers

$$\frac{dx}{(mz-ny)}=\frac{dy}{(nx-\ell z)}=\frac{dz}{(\ell y-mx)}$$

$$=\frac{\ell dx+mdy+ndz}{\ell(mz-ny)+m(nx-\ell z)+n(\ell y-mx)}$$

$$=\frac{\ell dx+mdy+ndz}{0}$$

$\therefore$ $(lx+my+nz)=a$ …. (1)

Similarly,

$$\frac{dx}{(mz-ny)}=\frac{dy}{(nx-\ell z)}=\frac{dz}{(\ell y-mx)}$$

$$=\frac{(xdx+ydy+zdz)}{\ell(mz-ny)+m(nx-\ell z)+n(\ell y-mx)}$$

$$=\frac{(xdx+ydy+zdz)}{0}$$

$$\therefore\ \left(\frac{x^2}{2}+\frac{y^2}{2}+\frac{z^2}{2}\right)=\frac{b}{2}$$

$\Rightarrow (x^2+y^2+z^2)=b$ …… (2)

$\therefore$ From (1) & (2)

$(x^2+y^2+z^2)=\phi\,(lx+my+nz)$

is the required solution.

05. Ans: (c)

Sol: $\sqrt[3]{10}=x$

$\Rightarrow x^3=10$

Let $f(x)=(x^3-10)=0$

$f'(x)=3x^2$

and let $x_0=2$

From Newton-Raphson method

$$x_1=x_0-\frac{f(x_0)}{f'(x_0)}$$

$$=x_0-\frac{(x_0^3-10)}{3x_0^2}$$

$$=\frac{2x_0^3+10}{3x_0^2}$$

$$=\frac{2(8)+10}{3\times4}=\frac{26}{12}$$

$=2.166\simeq2.17$

06. Ans: (b)

Sol: $\frac{dy}{dx}=(x^2+y)\Rightarrow f(x,y)=(x^2+y)$

$y(0)=1\Rightarrow x_0=0$ & $y_0=1$

$h=0.05$

$x_1=x_0+h=(0+0.05)=0.05$

$\therefore y(x_1)=y_1=y_0+hf(x_0,y_0)$

$=1+(0.05)\,f(0,1)$

$=1+(0.05)\times1$

$\therefore y_1=1.05$

07. Ans: (c)

Sol: $(x+\sin x)=1$

$f(x)=(x+\sin x-1)=0$

$f'(x)=(1+\cos x)$

$x_0=0$

$$\therefore\ x_1=x_0-\frac{f(x_0)}{f'(x_0)}$$

$$= 0 - \frac{(-1)}{1+1} = \frac{1}{2} = 0.5$$

08. Ans: (b)

Sol: $v(r, \theta) = r^3\cos3\theta$

$$\frac{\partial v}{\partial r} = 3r^2 \cos3\theta$$

$$\frac{\partial v}{\partial \theta} = -3r^3 \sin3\theta$$

Let $u(r, \theta) = C$

$$\Rightarrow du = \left(\frac{\partial u}{\partial r}dr + \frac{\partial u}{\partial \theta}d\theta\right) = 0$$

$$= \left(\frac{1}{r}\frac{\partial v}{\partial \theta}dr - r\frac{\partial v}{\partial r}d\theta\right) = 0$$

$$= \frac{1}{r}(-3r^3 \sin3\theta)\, dr - r\,(3r^2 \cos3\theta)d\theta = 0$$

$$= -(3r^2\sin3\theta dr + 3r^3 \cos3\theta d\theta) = 0$$

$$= -d(r^3 \sin3\theta) = 0$$

$\therefore\ u = -r^3 \sin3\theta$

09. Ans: (c)

Sol: $$\oint_{\left|z-\frac{i}{2}\right|=1} \frac{1}{(z^2+1)}dz = \oint_C \frac{1}{(z+i)(z-i)}dz$$

$$= \oint_C \frac{\left(\frac{1}{z+i}\right)}{(z-i)}dz$$

(from Cauchy's integral formula)

$$= 2\pi i\left(\frac{1}{i+i}\right)$$

$$= \pi$$

10. Ans: (b)

Sol: $$f(z) = \frac{1}{(z+1)} - \frac{2}{(z+3)}$$

C: $|z+1| = 1$

$z = -1$ is the only singular point lies inside 'C'

$$\therefore\ \frac{1}{2\pi i}\oint_C f(z)dz = \text{Residue of } f(z) \text{ at } z = -1$$

$= \text{The co-efficient of } (z+1)^{-1}$

$= 1$

11. Ans: (b)

Sol: $$\frac{1-e^{2z}}{z^4} = \frac{1}{z^4}\left[1-\left(1+2z+\frac{4z^2}{2!}+\frac{8z^3}{3!}+....\right)\right]$$

$$= -\left(\frac{2}{z^3}+\frac{2}{z^2}+\frac{4}{3z}+.....\right)$$

$\therefore\ z = 0$ is a pole of order '3'.

12. Ans: (d)

Sol: Let $A = \begin{pmatrix} 1 & 2 & -3 \\ 0 & 3 & -5 \\ 0 & 0 & 4 \end{pmatrix}$

Det A = 12

The co-factors of the diagonal elements are 12, 4, 3

$\therefore$ The diagonal elements of A^{-1} are

$$\frac{12}{12}, \frac{4}{12}, \frac{3}{12} \text{ (or) } 1, \frac{1}{3}, \frac{1}{4}$$

13. Ans: (c)

Sol: $\begin{pmatrix} 2010 & 2011 & 2012 \\ 2013 & 2014 & 2015 \\ 2016 & 2017 & 2018 \end{pmatrix}$

$(R_3 - R_2)$; $(R_2 - R_1)$

$\sim \begin{pmatrix} 2010 & 2011 & 2012 \\ 3 & 3 & 3 \\ 3 & 3 & 3 \end{pmatrix}$

$(R_3 - R_2)$, $\frac{R_2}{3}$

$\sim \begin{pmatrix} 2010 & 2011 & 2012 \\ 1 & 1 & 1 \\ 0 & 0 & 0 \end{pmatrix}$

$(2010\,R_2 - R_1)$

$\sim \begin{pmatrix} 2010 & 2011 & 2012 \\ 0 & -1 & -2 \\ 0 & 0 & 0 \end{pmatrix}$

$\therefore$ Rank = 2.

14. Ans: (c)

Sol: $\begin{pmatrix} 3 & 2 & 7 \\ 2 & 4 & 1 \\ 1 & -2 & 6 \end{pmatrix}$

$R_1 - (R_2+R_3)$, $(2R_3 - R_2)$

$\sim \begin{pmatrix} 0 & 0 & 0 \\ 2 & 4 & 1 \\ 0 & -8 & -13 \end{pmatrix}$

$\therefore$ One dependent and two independent

15. Ans: (c)

Sol: $A = \begin{pmatrix} 3 & 0 & 0 \\ -2 & 5 & 0 \\ 5 & 6 & -4 \end{pmatrix}$

The eigen values of 'A' are $\lambda = 3, 5, -4$

$|A| = -60$

$\therefore$ The eigen values of Adj A are $\frac{|A|}{\lambda} = -20$, -12, 15

16. Ans: (d)

Sol: $\underset{x \to \frac{\pi}{4}}{\text{Lt}} \left(\frac{\cos x - \sin x}{x - \frac{\pi}{4}} \right) \left(\frac{0}{0} \text{form} \right)$

$= \underset{x \to \frac{\pi}{4}}{\text{Lt}} \frac{-\sin x - \cos x}{1}$

$= \frac{-1}{\sqrt{2}} - \frac{1}{\sqrt{2}}$

$= \frac{-2}{\sqrt{2}} = -\sqrt{2}$

17. Ans: (b)

Sol: $f(x) = \max\{x, -x\}$ in $(-2, 2)$

$= \begin{cases} -x & , x \in [-2, 0] \\ x & , x \in [0, 2] \end{cases}$

It is always continuous in $(-2, 2)$

But $f'(x) = \begin{cases} -1 & , x \in [-2, 0] \\ 1 & , x \in [0, 2] \end{cases}$

$\therefore$ At x = 0 $f'(x)$ is not unique

Hence f(x) is continuous but not differentiable

18. Ans: (b)

Sol: $f(x, y) = y^x$

$$\frac{\partial f}{\partial x} = y^x \log y$$

$$\frac{\partial^2 f}{\partial y \partial x} = y^x\left(\frac{1}{y}\right) + \log y\left(xy^{x-1}\right)$$

$$\left(\frac{\partial^2 f}{\partial y \partial x}\right) at(1,2) = (1 + 1og2)$$

19. Ans: (d)

Sol: $\int_0^{\frac{\pi}{2}}\int_0^{\frac{\pi}{2}} \sin(x+y)dxdy$

$$= \int_0^{\frac{\pi}{2}}\int_0^{\frac{\pi}{2}} \sin x \cos y\, dxdy + \int_0^{\frac{\pi}{2}}\int_0^{\frac{\pi}{2}} \cos x \sin y\, dxdy$$

$$= \int_0^{\frac{\pi}{2}} \cos ydy \int_0^{\frac{\pi}{2}} \sin xdx + \int_0^{\frac{\pi}{2}} \sin ydy \int_0^{\frac{\pi}{2}} \cos xdx$$

$$= (\sin y)_0^{\frac{\pi}{2}} (-\cos x)_0^{\frac{\pi}{2}} + (-\cos y)_0^{\frac{\pi}{2}} (\sin x)_0^{\frac{\pi}{2}}$$

= – (1– 0) (0 –1) – (0 –1)(1– 0)

= 1+1

= 2

20. Ans: (d)

Sol: Since ϕ is harmonic and $\phi = \left(ax^2y - y^3\right)$

Or $\nabla^2\phi = 0$

$$\therefore \frac{\partial^2\phi}{\partial x^2} + \frac{\partial^2\phi}{\partial y^2} = 0$$

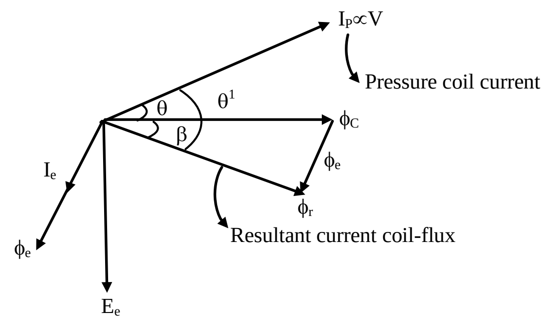
2ay – 6y = 0

2y(a – 3) = 0

$\therefore$ a = 3

21. Ans: (c)

Sol: In an electro-dynamo meter type instrument eddy currents are induced in the solid metal parts and within the thickness of conductors by alternating magnetic field of current coil. These eddy currents produce a flux of their own and alter the magnitude and phase of current coil field.



In the above phasor diagram it can be seen that due to eddy currents induced, the phase angle between pressure coil flux and resultant current coil flux is increased.

Hence for lagging power factors the meter will shows a low value and show a high value for leading power factors- error due to eddy current is opposite to that of error due to inductance in pressure coil.

22. Ans: (b)

Sol: Energy density in an electrostatic field is considerably smaller than that in electromagnetic field.

23. Ans: (b)

Sol: In moving Iron (MI) voltmeters

$$\theta \propto I^2 \frac{dL}{d\theta} [\theta = \text{deflection}]$$

$$\theta \propto \frac{V^2}{Z^2} \frac{dL}{d\theta}$$

V = applied voltage

Z = impedance of moving coil of MI instrument.

$Z = R + j\omega L$

In D.C. $\omega = 0$, So

$$Z_{dc} < Z_{ac} \Rightarrow \frac{Z_{ac}}{Z_{dc}} > 1$$

$$\therefore \frac{\theta_{dc}}{\theta_{ac}} = \frac{Z_{ac}^2}{Z_{dc}^2} \Rightarrow \frac{\theta_{dc}}{\theta_{ac}} = \left(\frac{Z_{ac}}{Z_{dc}}\right)^2 \Rightarrow \frac{\theta_{dc}}{\theta_{ac}} > (1)^2$$

$\Rightarrow \theta_{dc} > \theta_{ac}$

Hence voltmeter indicates lower values for ac voltages than for corresponding dc voltages.

24. Ans: (d)

Sol: (i) Controlling torque is not required in both 1-ϕ and 3-ϕ electrodynamometer type power factor meters

(ii) Frequency changes will cause errors in 1-ϕ pf meter but not in 3-ϕ pf meters

25. Ans: (c)

Sol: Poynting vector wattmeter is works on the principle of Hall-effect. This wattmeter used for measuring the power loss density at the surface of a magnetic material.

26. Ans: (c)

Sol: The loss of charge method is more suitable for measurement of high resistance.

27. Ans : (c)

Sol: CPT's are used because they are cheaper than the electromagnetic transformers above a certain voltage range.

28. Ans: (c)

Sol:

(i) The pressure coil of 1-ϕ inductance type energy meter has pure inductance.

(ii) The pressure coil of an electrodynamometer type wattmeter has pure resistance.

29. Ans: (b)

Sol: When the degree of damping is such that the pointer rises quickly to its deflected position without oscillations, the damping is said to be "critical" and the instrument is said to be "dead beat".

30. Ans: (c)

Sol: The working principle of the varley loop test which is used to detect the fault location of cables is based on Wheatstone bridge.

31. Ans: (c)

Sol: Heaviside bridge : Measurement of mutual inductance interms of a known self-inductance.

Heydweiller bridge : Measurement of a mutual inductance interms of a standard capacitance.

Campbell's bridge : Measurement of a mutual inductance interms of a known standard mutual inductance.

32. Ans: (c)

Sol: Integrating type DVM uses the principle of dual slope A/D conversion. In dual slope A/D conversion, error in time constant gets cancelled out during charging and discharging. So any error in time constant is not reflected in the A/D conversion.

33. Ans: (b)

Sol: Distortion analyzer contains the rms values of all the harmonics present in the input signal. The individual harmonics cannot be separated out.

But incase of a wave analyzer or spectrum analyzer the individual harmonic content can be separated out.

34. Ans: (c)

Sol: The term "$\frac{1}{2}$ digit" refers to the fact that the most significant bit (MSB) can be only "0" or "1" while all other digits can be anything between "0" or "9".

35. Ans: (c)

Sol: A thin aluminium film is usually deposited on the non viewing side of the phosphor of a CRT because:

1. It does not allow the screen to be negatively charged
2. It acts as a heat sink and prevents phosphor burn
3. The light scatter from the phosphor is reduced

36. Ans: (c)

Sol: **Astigmatism** : Additional focusing control.

Aquadag: Collection of secondary electrons.

Persistance: When the electron beam is switch off the phosphor crystals returns to their initial state and release a quantum of light energy.

Graticule: A grid of lines that serves as a scale when making time and amplitude measurement.

37. Ans: (c)

Sol: I_{rms} = Hot-wire ammeter reading = 32 A

$$I_{avg} = \frac{\text{Rectifier meter reading}}{1.1}$$

$$= \frac{30}{1.1} = 27.027 \text{ A}$$

Form-factor, $k_f = \frac{I_{rms}}{I_{avg}}$

$$= \frac{32}{27.027} = 1.184$$

38. Ans: (c)

Sol: Both the variable persistence and bistable storage oscilloscopes depend, for their operation, on the principle of secondary emission.

Bistable storage tube is slower than variable persistence storage tube.

39. Ans: (c)

Sol: The frequency range of the oscilloscopes can be increased by sub-dividing the deflecting plates in a number of sections in the path of the electron beam.

40. Ans: (c)

Sol: **active transducers:** In a process of conversion of non electrical to electrical if a transducer does not require external power supply then it is called active transducers.

Ex: Thermocouple, piezoelectric transducer, photovoltaic cell, pH electrode.

Passive transducers: In external power supply then it is called passive transducers.

Ex: Reluctance pick-up, magnetostriction gauge.

41. Ans: (d)

Sol: Power consumed by Current coil = VI

$$= 6 \times 5 = 30\text{W}$$

Power consumed by pressure coil $= \frac{V^2}{R_{pc}}$

$$= \frac{200 \times 200}{8000} = 5\text{W}$$

Total power = 30 + 5 = 35W

42. Ans: (a)

Sol: measured value, A_m = 100W

- Power loss in potential coil,

$$P_\ell = \frac{220 \times 220}{4840} = 10\text{W}$$

- Actual value, A_t = 100–10W = 90W
- Percentage error % $E_r = \frac{A_m - A_t}{A_t} \times 100$

$$= \frac{100-90}{90} \times 100 = 11\%$$

43. Ans: (c)

Sol: All metal gauges have low gauge factor of the order 2.5 because the conductivity of the material is changes with applied strain in the elastic region

44. Ans: (b)

Sol: To reduce the effect of fringing in capacitive type transducer a guard ring is provided and it is kept at ground potential.

45. Ans: (a)

Sol: For signal conditioning of a piezo-electric type transducer we require charge amplifier.

46. Ans: (d)

Sol: Given time period T = 10ms

Count (C) = 034 = 34

$\therefore$ Frequency (f) = $\frac{C}{T} = \frac{34}{10\times10^{-3}}$

$\Rightarrow$ f = 3400 Hz

47. Ans: (b)

Sol: It's a special representation of +0 as a float.

48. Ans: (c)

Sol: $(6.25)_{10} = (110.01)_2$

$1.1001 * 2^{+2}$

0	10000001	100100 …….00
Sign bit	Exponent (Excess 127 code)	Fraction

40C80000

49. Ans: (c)

Sol: Gantt chart

P_1	P_2	P_1	P_3	P_2	P_1	P_1

0 5 10 15 20* 23* 28 33*

Turn around Time = Finish time – Arrival time

$P_1 \Rightarrow 33 - 0 = 33$,

$P_2 \Rightarrow 23 - 4 = 19$, $P_3 \Rightarrow 20 - 7 = 13$

Waiting time = Turn around time – burst time

$P_1 \Rightarrow 33 - 20 = 13$,

$P_2 \Rightarrow 19 - 8 = 11$, $P_3 \Rightarrow 13 - 5 = 8$

Average Waiting Time = $\frac{13+11+8}{3}$

$= \frac{32}{3} = 10.66$

Ready Queue	P_1	P_2	P_1	P_3	P_2	P_1	P_1
In Time	0	4	5	7	10	15	28
Remaining Burst	20	8	15	5	3	10	5

50. Ans: (a)

Sol: t_m = 20 ns, s = 200 ns, P = 0.3

EAT = $(1 - P) \times t_m + P \times s$

= 0.7 × 20 ns + 0.3 × 200 ns

= 74 ns

51. Ans: (b)

52. Ans: (a)

Sol: t_c =3ns , t_m = 15ns, h_c = 0.8

$T_m = h_c \times t_c + (1-h_c)\times t_m$ (Read through, cache read policy)

$T_m = 0.8 \times 3ns + 0.2 \times 15ns$

= 5.4 ns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53. Ans: (a)

Sol: $t_n = 2+1+3+2+1=9$

$t_p = \max(2+1, 1+1, 3+1, 2+1, 1+1) = 4$

speed up $= \frac{t_n}{t_p} = \frac{9}{4} = 2.25$

(For large number of instructions)

54. Ans: (b)

Sol: Operand forwarding

*It handle RAW hazards.

55. Ans: (a)

56. Ans: (c)

Sol: $(3F000000)_{16}$

0	011111110	00………00
Sign	Exponent	Mantissa

$+(1.00)\times 2^{(126-127)}$

$+(0.1)_2 = +(0.5)_{10}$

57. Ans: (a)

Sol: Convoy's effect may appear in first come first served process scheduling policy.

58. Ans: (b)

Sol: Starvation may occur in unfair process scheduling policy.

59. Ans: (a)

Sol: Gantt chart:

P_1	P_2	P_3	P_2	P_1
0–2	2–4	4–9 *	9–17 *	17–30 *

TAT = FT – AT	WT = TAT – BT
$P_1 \to 30 - 0 = 30$	$P_1 \to 30 - 15 = 15$
$P_2 \to 17 - 2 = 15$	$P_2 \to 15 - 10 = 5$
$P_3 \to 9 - 4 = 5$	$P_3 \to 5 - 5 = 0$

Average Waiting Time $= \frac{15+5+0}{3}$

$= \frac{20}{3} = 6.66$

60. Ans: (c)

Sol: Number of processes = P

Number of instances of R needed by each process = r

Minimum number of instances of R = P× (r – 1) + 1

(So that system must be deadlock free)

61. Ans: (a)

Sol: Optimal page replacement policy

2	7	9	4	2	9	7	4	2
2	2	2	2			2		
	7	7	4			4		
		9	9			7		
✓	✓	✓	✓			✓		

62. Ans: (b)

63. Ans: (d)

Sol: $t_n = 2+1+3+2 = 8$

t_p = maximum stage delay including pipeline overhead

= maximum (2+1,1+1,3+1,2+1) = 4

K= 4(number of stages), N = 100 (number of instructions)

$$\text{Speedup} = \frac{N \times t_n}{(K + N - 1) \times t_p}$$

$$= \frac{100 \times 8}{(4 + 100 - 1) \times 4} = 1.94$$

64. Ans: (c)

65. Ans: (c)

Sol: MAC Address (48 bits)

66. Ans: (d)

Sol: Hosts = N

Links (In Fully Mesh) = ${}^{N}C_2$

$$= \frac{N \times (N-1)}{2} = \frac{10 \times (10-1)}{2} = 45$$

67. Ans: (c)

Sol:

- CRC and checksum are error detection techniques only
- Hamming code is error detection and correction technique.

68. Ans: (c)

69. Ans: (a)

Sol: Both statements are individually true and statement-II is correct explanation of statement-I.

70. Ans: (a)

Sol: They have a very weak operating magnetic field and introduction of a permanent magnet required for eddy current damping would distort the operating magnetic field.

$\therefore$ Statement (II) is correct explanation for statement (I).

71. Ans: (a)

Sol: Both statements are true and statement II is the correct explanation of statement 1.

72. Ans: (c)

Sol: Statement (I) is correct but statement (II) is false because sensitivity of *LVDT* is in V/mm.

73. Ans: (a)

Sol: Statement (I) and Statement (II) are true and Statement (I) is correct explanation for Statement (II).

74. Ans: (b)

Sol: Both the statements are correct. But the reason for taking two readings with direction of current reversed is to eliminate errors due to thermoelectric emfs.

75. Ans: (a)

Sol: Both statements are individually true and statement (II) is correct explanation of statement (I).

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