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ESE- 2018 (Prelims) - Offline Test Series-Test-19
ELECTRICAL ENGINEERING

SUBJECT: Electrical and Electronic Measurements + Engineering Mathematics + Computer Fundamentals

01. Ans: (b)

Sol: In induction type energy meters, self-braking torque is proportional to the square of load current and it assumes increasing significance at higher loads. Hence at higher loads, registration tends to be lower than the actual value of reading.

02. Ans: (a)

Sol: (i) Given $T_d = KI$

$T_C = K_1\theta$ for spring control

$T_C = K_2\text{Sin}\theta$ for gravity control

At balance position

For spring:

$T_d = T_C$

$\Rightarrow K_1\theta = KI$

$$\Rightarrow \theta = \left(\frac{K}{K_1}\right)I \Rightarrow \text{linear scale}$$

For gravity:

$T_d = T_C$

$\Rightarrow K_s\sin\theta = KI$

$$\sin\theta = \frac{KI}{K_2}$$

$$\Rightarrow \theta = \text{Sin}^{-1}\left(\frac{KI}{K_2}\right) \Rightarrow \text{non linear}$$

(ii) Gravity control can be used only in vertically mounted systems.

03. Ans: (b)

Sol: Resolution= $\frac{V_{FS}}{2^N}$

$$14 \times 10^{-3} = \frac{3.5}{2^N}$$

$2^N = 250$

$N = 8$

04. Ans: (d)

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

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

05. Ans: (c)

06. Ans: (b)

Sol: In an energy meter the pressure coil current should lag voltage across pressure coil by 90° for accurate readings. Hence pressure coil circuit is designed in such a way that it is highly inductive and has low resistance.

07. Ans: (b)

Sol: In single phase induction type energy meters, the meter will register true energy only if the phase angle between applied voltage(v) and pressure coil current (I_P) is exactly equal to 90°[and also I_P should lag V]. Hence we use lag adjustment devices like shading bands so that I_P lags V by 90°.

08. 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+jωL

In D.C. ω = 0, So

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

$$\therefore \frac{\theta_{dc}}{\theta_{ac}} = \frac{Z_{ac}^2}{Z_{dc}^2}$$

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

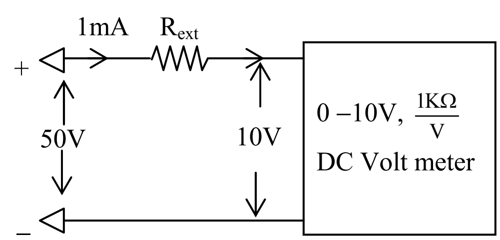
$$\Rightarrow \frac{\theta_{dc}}{\theta_{ac}} > (1)^2$$

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

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

09. Ans: (b)

Sol:



$$R_{exr} = \frac{50V - 10V}{1mA} = \frac{40V}{1mA} = 40\ k\Omega$$

10. Ans: (c)

Sol: 1. Digital counter is used for measurement of frequency.

2. As from Schearing bridge dissipation factor is obtained from that load angle can be obtained ($\tan\delta = \omega C_4 R_4$).

11. Ans: (c)

12. Ans: (b)

Sol: $$P = \frac{1}{2\pi}\int_0^{2\pi}(2+3\sin\omega t)(1+2\sin\omega t)$$

$$= \frac{1}{2\pi}\int_0^{2\pi} 2+7\sin\omega t+6\sin^2\omega t$$

$$= \frac{1}{2\pi}[2t]_0^{2\pi}+7[-\cos\omega t]_0^{2\pi}+6\left[\frac{1-\cos\omega t}{2}\right]_0^{2\pi}$$

$$= \frac{1}{2\pi}[2(2\pi)+3(2\pi)] = 5$$

13. Ans: (c)

14. Ans: (c)

Sol: Meter constant K = rev/kWh

$$= \frac{1380}{230\times30\times2\times1\times10^{-3}}$$

$$= 100 \text{ rev/kWh}$$

15. Ans: (d)

16. Ans: (b)

Sol: In X-Y mode of operation only frequency, phase measurement is done.

CRO takes more time from measurement of amplitude comparing to other instruments as reading of quantity is not displayed/obtained readily.

17. Ans: (d)

Sol: In measurements system undesirable static characteristics are drift, static error, dead zone and non-linearity while the desired characteristics are accuracy, sensitivity, reproducibility.

18. Ans: (a)

Sol: $M = -8\cos(\theta+60^0)$mH

$$\frac{dM}{d\theta} = 8\sin(\theta+60^0)\text{mH}$$

$$d = I^2\frac{dM}{d\theta}$$

$$= [25\times10^{-3}]^2\times[8\sin90^0]\times10^{-3}$$

$$= 5000\times10^{-9}$$

$$= 5\ \mu\text{N-m}$$

19. Ans: (d)

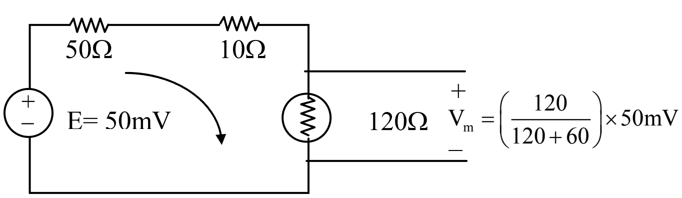
Sol: S = best resolution

= resolution in lowest voltage range

$$= \frac{2V}{2\times10^4} = 0.1 \text{ mV}$$

20. Ans: (a)

Sol:



$V_m = 33.3\text{mV}$

21. Ans: (b)

Sol: $E_H = k_H . I . B / t$

$$= \frac{-1\times10^{-6}\times3\times0.5}{2\times10^{-3}} = -0.75\text{mV}$$

22. Ans: (c)

23. Ans: (a)

24. Ans: (d)

Sol: $\omega_n \propto \sqrt{k}$ k = spring constant.

$$\frac{\omega_{n1}}{\omega_{n2}} = \sqrt{\frac{k_1}{k_2}} = 0.5 \ \omega_{n2} = 2\omega_{n1}$$

$$\delta \propto \frac{1}{\sqrt{k}}$$

$$\frac{\delta_1}{\delta_2} \propto \sqrt{\frac{k_2}{k_1}} = 2 \ \delta_2 = \delta_1 \times 0.5$$

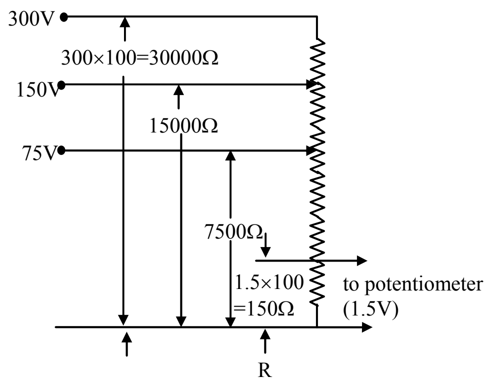
So, natural frequency is increased by 100% and damping ratio is decreased by 50%.

25. Ans: (d)

26. Ans: (d)

27. Ans: (d)

Sol:



$$\frac{\text{Unknown output voltage across potentiometer }(V_0)}{\text{input voltage}(V_i)\,[\text{across } 300V]}$$

$$=\frac{V_0}{V_i}=\frac{R}{30000}\Rightarrow\frac{V_0}{270}=\frac{150}{30000}$$

$$\Rightarrow V_0=\frac{270}{200}$$

$$\therefore V_0=1.35V$$

[$\because$ R = 30,000Ω corresponding to the input terminal of 300V]

Power consumption under null conditions is

$$P_0=\frac{V_i^2}{R}$$

$$=\frac{(270)^2}{30,000}$$

$P_0 = 2.43W$

Hence $V_0 = 1.35V$ $P_0 = 2.43$ W

28. Ans: (c)

Sol: Frequency ranges of the detectors used in AC bridges are as follows:

1. Head phones or Telephone detectors 250Hz to 3KHz
2. Vibration galvanometers 5Hz to 100Hz
3. Tunable amplifiers 10Hz to 100KHz.

D'Arsonval galvanometer is used to check for bridge balance in D.C bridges.

29. Ans: (c)

Sol: ***Proof by contradiction:***

S_1: Suppose, A and B are mutually exclusive and independent

$P(A \cap B) = P(A) . P(B)$

$\Rightarrow 0 = P(A) . P(B)$ ($\because$ A and B are mutually exclusive)

$\Rightarrow P(A) = 0$ or $P(B) = 0$.

This is a contradiction, because A and B are possible events.

Hence, A and B are not independent.

S_2: Suppose A and B are independent and mutually exclusive.

Then, $P(A) . P(B) = P(A \cap B) = 0$

$\Rightarrow P(A) = 0$ or $P(B) = 0$

Which is a contradiction, because A and B are possible events.

Hence, A and B are not mutually exclusive.

30. Ans: (b)

Sol: **Case 1:** The first 5 cars sold are not defective and 6^{th} car is defective.

The Probability for this event $=\frac{C(8,5)}{C(10,5)}.\frac{2}{5}$

Case 2: The first 5 cars sold have one defective car and 6^{th} car sold is defective.

The probability for this event $= \frac{C(8,4).C(2,1)}{C(10,5)} \cdot \frac{1}{5}$

The required probability

$$= \frac{C(8,5)}{C(10,5)} \cdot \frac{2}{5} + \frac{C(8,4).C(2,1)}{C(10,5)} \cdot \frac{1}{5}$$

$$= \frac{1}{5} = 0.2$$

31. Ans: (d)

Sol: A mode of the distribution of a continuous random variable X, is the value of x where the probability density function attains a relative maximum.

consider, $\frac{df}{dx} = 0$

$\Rightarrow 2x\, e^{-bx} - b\, x^2\, e^{-bx} = 0$

$\Rightarrow (2 - bx)\, x = 0$

$\Rightarrow x = 0 \;\text{ or }\; x = \frac{2}{b}$

Thus the mode of X is $\frac{2}{b}$.

32. Ans: (c)

Sol: Required number of outcomes

= number of ways we can select four numbers from the six numbers {1, 2, 3, 4, 5, 6} with repetitions allowed

= V(6, 4) = C(6 – 1 + 4, 4) = 126

33. Ans: (d)

Sol: $|A| \neq 0$

$\Rightarrow$ A is a non singular matrix

$\Rightarrow$ 'adj A' is also non singular

$\Rightarrow$ rank of adj A = 3

34. Ans: (a)

Sol: The eigen values of A are 1, 1, 1

The eigen vectors corresponding to the eigen value $\lambda = 1$ is given by

$[A - \lambda I]\, X = 0$

$$\Rightarrow \begin{bmatrix} 0 & 2 & 3 \\ 0 & 0 & 4 \\ 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$

$\Rightarrow 2y + 3z = 0$ and $4z = 0$

$\Rightarrow y = 0$ and $z = 0$

$\therefore$ Any non zero vector, with y and z components as 0, is an eigen vector of A.

$\therefore$ Option (A) is correct.

35. Ans: (a)

Sol: For the system AX = B, if A is non singular, then rank of coefficient matrix = rank of the augmented matrix = number of variables = n

$\therefore$ The system has a unique solution.

36. Ans: (b)

Sol: The only possible points of discontinuity for f(x) are x = 1 and x = 3.

At x = 1,

$\underset{x\to 1-}{\text{Lt}} f(x) = \underset{x\to 1+}{\text{Lt}} f(x) = f(1) = 1$

$\Rightarrow$ f(x) is continuous at x = 1

At x = 3,

$\underset{x\to 3-}{\text{Lt}} f(x) = -9$ and

$\underset{x\to 3+}{\text{Lt}} f(x) = 0$

$\therefore$ f(x) is not continuous at x = 3

37. Ans: (b)

Sol: By Lagrange's mean value theorem consider,

$$f^1(C) = \frac{f(1) - f(0)}{1 - 0}$$

$\Rightarrow 12C^2 - 10C + 1 = 0$

$$\Rightarrow C = \frac{10 + \sqrt{52}}{24} = \frac{5 + \sqrt{13}}{12}$$

38. Ans: (a)

Sol: f(x) is an even function. The probability density function is symmetric about y axis. Thus, the median of X = 0

39. Ans: (c)

Sol: The Characteristic equation of the matrix A is $|A - \lambda I| = 0$

$$\begin{vmatrix} -5-\lambda & -3 \\ 2 & -\lambda \end{vmatrix} = 0$$

$(-5 - \lambda)(-\lambda) + 6 = 0 \Rightarrow \lambda^2 + 5\lambda + 6 = 0$

By cayley – Hamilton theorem every square matrix must satisfies its own characteristic equation

$\therefore A^2 + 5A + 6I = 0$

$A^2 = -5A - 6I$

$A^3 + 5A^2 + 6A = 0$

$A^3 = -5(-5A - 6I) - 6A = 19A + 30I.$

40. Ans: (c)

Sol: The characteristic equation is

$|A - \lambda I| = 0$

$\Rightarrow \lambda^2 + 3\lambda - 10 = 0$

$\Rightarrow \lambda = 2$ and $\lambda = -5$

The eigen vectors for $\lambda = -5$ are given by

The equation $[A - \lambda I]X = 0 \Rightarrow (A + 5I)X = 0$

$$\Rightarrow \begin{bmatrix} 8 & -4 \\ 2 & -1 \end{bmatrix}\begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

$\Rightarrow 2x - y = 0$

$\Rightarrow \begin{bmatrix} x \\ y \end{bmatrix} = K\begin{bmatrix} 1 \\ 2 \end{bmatrix}$ where K is arbitrary non zero constant.

For K = –1

$\Rightarrow X = (x, y) = (-1, -2)$

41. Ans: (a)

Sol: $M = ax^2 + by^2$, $N = cxy$

$$\frac{\partial M}{\partial y} = 2by, \quad \frac{\partial N}{\partial x} = cy$$

$$\frac{\partial M}{\partial y} = \frac{\partial N}{\partial x}$$

$\Rightarrow 2b = c$

42. Ans: (b)

Sol: $\dfrac{1}{D^2-2D+4}e^x\cos x$

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

$= e^x \dfrac{1}{D^2+2D+1-2D-2+4}\cos x$

$= e^x \dfrac{1}{-1+1+2}\cos x \;\Rightarrow \dfrac{1}{2}e^x\cos x$

43. Ans: (b)

Sol: $\dfrac{dy}{dx} = 4x^3 e^{-y}$

Using variable separable method

$e^y = x^4 + c$

at x =1, y =0, $\Rightarrow$ c = 0 $\Rightarrow e^y = x^4$

44. Ans: (d)

Sol: $\dfrac{dy}{dt} = (1-2t) + y^2(1-2t)$

$\dfrac{dy}{dt} = (1-2t)(1+y^2)$

$\displaystyle\int \frac{1}{1+y^2}dy = \int (1-2t)dt$

$\tan^{-1}y = t - \dfrac{t^2}{2}\times 2 + c$

$y = \tan[t(1-t) + c]$

45. Ans: (c)

46. Ans: (b)

Sol: Here, $x_0 = 0$, $y_0 = 1$, $f(x, y) = -y$

$y_1 = y_0 + h.\ f(x_0, y_0)$

$= 1 + (0.01)(-1) = 0.99$

47. Ans: (c)

Sol: Let $f(x) = x^3 - 2x - 5 = 0$

$f^1(x) = 3x^2 - 2$

$f(0) = -5 < 0$

$f(1) = -6 < 0$

$f(2) = -1 < 0$

$f(3) = 16 > 0$

$f(4) = 51 > 0$

48. Ans: (c)

49. Ans: (d)

Sol: $y' = x^2 - y^2$

$y(0) = 1$

$y_1^P = y_0 + h.\ f(x_0, y_0)$

$= 1 + 0.1(-1)$

$= 0.9$

Modified value of y_1 is

$$y_1^C = y_0 + \frac{h}{2}\left[f(x_0, y_0) + f\left(x_1, y_1^P\right)\right]$$

$$= 1 + \frac{0.1}{2}\left[-1 + (0.01 - 0.81)\right]$$

$= 1 - 0.09$

$= 0.91$

50. Ans: (b)

Sol: e^z is a periodic function with periodic $2\pi i$

$f(z) = e^z = e^{x+iy}$

$= e^x e^{iy} = e^x(\cos y + i \sin y)$

$= e^x[\cos(y + 2n\pi) + i \sin(y + 2n\pi)]$

$= e^x e^{i(y+2n\pi)}$

$= e^{x+iy+i2n\pi} = e^{z+i2n\pi}$

$\Rightarrow f(z) = f(z + 2ni\pi)$

$\therefore$ e^z is a periodic function of period $2\pi i$.

51. Ans: (d)

Sol: Given that

$$f(x) = 1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \frac{x^6}{6!} + -----$$

$\Rightarrow f(x) = \cos x$

$$\therefore \lim_{x \to \frac{\pi}{2}} \cos x = 0$$

52. Ans: (b)

Sol: $L^{-1}\left\{\dfrac{1}{s\left(s^2 + a^2\right)}\right\}$

$$= \frac{1}{a^2} L^{-1}\left\{\frac{1}{s} - \frac{s}{s^2 + a^2}\right\} = \frac{1}{a^2}(1 - \cos at)$$

53. Ans: (d)

Sol: $\displaystyle\int_{x=0}^{2} \int_{y=0}^{\lambda(x)} \int_{z=0}^{\mu(x,y)} dz\, dy\, dx$

$$= \int_{x=0}^{2} \int_{y=0}^{4-2x} \int_{z=0}^{4-2x-y} dz\, dy\, dx$$

Now

$\lambda(x) - \mu(x,y) = (4 - 2x) - (4 - 2x - y) = y$

54. Ans: (c)

55. Ans: (d)

Sol: Database is an application software and not OS service.

56. Ans: (d)

Sol: When a running process is moved out of RAM, then it is kept at specific space in harddisk known as swap space.

57. Ans: (b)

Sol: Compaction is the solution for external fragmentation.

58. Ans: (d)

Sol: Structure is derived data-type in C-Language

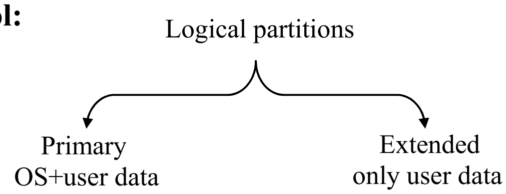
59. Ans: (b)

Sol: Optimal page replacement policy given minimum page faults.

60. Ans: (c)

61. Ans: (b)

Sol:



62. Ans: (d)

Sol: All are valid statements.

63. Ans: (a)

Sol: Elements stored sequentially in memory.

64. Ans: (c)

Sol: a & b is bitwise AND operation

$a = 5 \Rightarrow 101$

$\underline{b = 6 \Rightarrow 110}$

$a\&b \Rightarrow 100 \Rightarrow 4$

65. Ans: (c)

Sol: Addressing mode specifies that how and from where operands can be obtained for a specific instruction.

66. Ans: (d)

67. Ans: (a)

Sol: Non-maskable interrupts are always accepted.

68. Ans: (d)

Sol: $256MB = 256M \times 1B$

$= 2^{28} \times 1B$

Address = 28-bits

69. Ans: (c)

Sol: Cache & RAM $\Rightarrow$ Volatile

ROM & HDD $\Rightarrow$ Non-volatile

70. Ans: (c)

Sol: Average memory access time

$= 0.8 * 5 \text{ ns} + 0.2 * 50 \text{ ns}$

$= 4\text{nsec} + 10\text{nsec}$

$= 14\text{nsec}$

71. Ans: (c)

Sol: $1 \text{ chip capacity} = \frac{\text{total capacity}}{\text{No. of chips}}$

$$= \frac{1GB}{32} = \frac{2^{30}\text{ B}}{2^5} = 2^{25}\text{ B} = 2^{23} \times 2^2\text{ B}$$

1 cell capacity = 2^2 B = 4B

72. Ans: (a)

Sol: Associative memories are content addressable memories, in those searching is performed with content not with addresses. The content matching in each cell is performed parallelly with the help of the matching logic in each cell.

73. Ans: (a)

Sol: Non-preemptive system cannot take away CPU from any process if it is not either terminated or it is not going to block state (for any I/O execution).

Hence process can make two transitions from running state to block/wait state or to terminate state.

74. Ans: (a)

Sol: Dual scope A/D converter is most preferred A/D conversion approach in digital multimeters since it provides highest accuracy and also highest noise rejection.

75. Ans: (a)

Sol: Both statements are true, statement-II is the correct explanation of Statement-I.

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