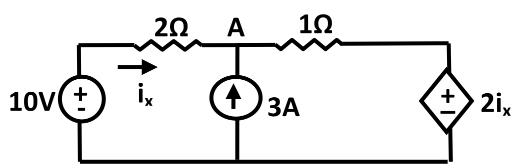
Answer Keys: IN-TS-1

1	C	2	A	3	B	4	C	5	B	6	B	7	A	8	B	9	B	10	B
11	B	12	C	13	B	14	B	15	B	16	B	17	D	18	D	19	A	20	C
21	D	22	C	23	D	24	C	25	A	26	C	27	B	28	B	29	C	30	C
31	C	32	C	33	A	34	B	35	A	36	D	37	D	38	B	39	D	40	C
41	D	42	B	43	B	44	C	45	A	46	A	47	A	48	B	49	C	50	D
51	A	52	C	53	D	54	B	55	B	56	D	57	A	58	C	59	A	60	B
61	C	62	B	63	B	64	D	65	C										

Explanation:

1. **[Ans .C],** Applying KCL at node A; and node voltage



$i_x + 3 = \frac{v-2i_x}{1}$ ---------- (1)

$i_x = \frac{10-v}{2}$ --------- (2)

$\Rightarrow V = -2i_x + 10$

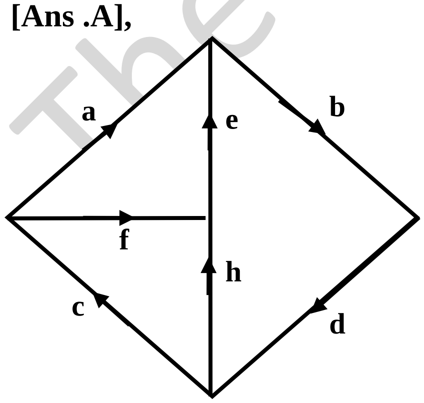
Replacing in 1,

$i_x + 3 = -2i_x + 10 - 2i_x$

$\Rightarrow 5i_x = 7$

$\Rightarrow i_x = 7/5 = 1.4A,$

2. **[Ans .A],**



e f g h, since current sources are O.C in a graph.

3. **[Ans .B],** $\frac{d(V_L - V_C)}{dI_L} = \frac{dV_R}{dI_L}$ ($\because$ V_R (t) = V_R (t) – V_C (t))

$= \frac{-dV_R}{dI_R}$ ($\because$ I_L = - I_R)

At any t,

$\therefore \frac{d(V_L - V_C)}{dI_L} = -10.$

4. **[Ans .C],** M = $xy^2 + \lambda x^2 y$

N = $(x + y)x^2$

for exact differential equation

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

$3x^2 + 2xy = 2xy + \lambda x^2$

$\Rightarrow \lambda = 3$

5. **[Ans .B]**

$$f(t) = \begin{cases} \frac{2}{T}.t & 0 \le + \le T/2 \\ 0 & \frac{T}{2} \le + \le T \end{cases}$$

$$R.M.S = \sqrt{\frac{1}{T/2}\int_0^{T/2} \frac{4}{T^2} t^2 dt} = \sqrt{1/3}$$

AB the hot-wire instrument measurement the R.M.S value of current

6. **[Ans .B],** which leads to very low f'(x_0)

7. **[Ans .A],**

$I = I_1 + I_2$

$\therefore$ Fractional error in I = $\frac{\delta I}{I} = \pm\left(\frac{I_1}{I}\frac{\delta I_1}{I_1} + \frac{I_2}{I}\frac{\delta I_2}{I_2}\right)$

$\frac{\delta I_1}{I_1} = \frac{2}{100} = 0.02 \& \frac{\delta I_2}{I_2} = \frac{5}{200} = 0.025$

I = 200 + 100 = 300A

$\therefore$ Fractional error in I = $\frac{\delta I}{I} = \pm(\frac{100}{300} \times 0.02 + \frac{200}{300} \times 0.025)$

$= \pm 0.0233$

$\therefore$ I can be written as 300 (1 ± 0.0233)

8. **[Ans .B],** P = $\frac{E^2}{R}$

$\log P = 2\log E - \log R$

$\frac{\delta P}{P} = 2\frac{\delta E}{E} - \frac{\delta R}{R}$

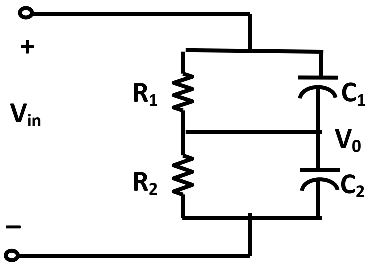
$\frac{\delta P}{P} \times 100 = 2\frac{\delta E}{E} \times 100 - \frac{\delta R}{R} \times 100$

$\frac{\delta P}{P} \times 100 = 2(3) — (-2) = 8$

9. **[Ans .B],**

Correct answer is $\frac{V_0}{V_i}$ = 1/SCR

10. **[Ans .B]**



$$\frac{V_0}{V_{in}} = \frac{R_2}{R_1+R_2} \cdot \frac{1+SC_1R_1}{1+S.\frac{R_1R_2}{R_1+R_2}(C_1+C_2)}$$

For $\frac{V_0}{V_{in}}$ = constant,

So, here, $R_1C_1 = \frac{R_1R_2}{R_1+R_2}(C_1+C_2)$

R = 10k or $R_1C_1 = R_2C_2$

11. **[Ans .B]**

$\frac{\log T_1}{\log T_2} = \frac{C_1}{C_2} \Rightarrow C_2 = 3.4\text{mg/dL}$

12. **[Ans .C]**

From Moseley's law

$$\lambda_2 = \lambda_1 \frac{(z_1-1)^2}{(z_2-1)^2} = \frac{2(24-1)^2}{(42-1)^2} = 0.63A^0$$

13. **[Ans .B]**
14. **[Ans .B]**
15. **[Ans .B]**
16. **[Ans .B]**
17. **[Ans .D]**
18. **[Ans .D],** For (D), $y(e^{J\omega}) = e^{J2\omega} . x(e^{J\omega})$

$|y(e^{J\omega})| = |x(e^{J\omega})|, \forall\omega$

19. **[Ans .A]**

y [n] = δ (n) + 2x [n-3] is non linear since super position principle fails and time variant as $y(n - n_0) \neq T\{x(n - n_0)\}$

20. **[Ans .C]**

For each amplifier transfer function is $\frac{A}{1+\frac{S}{\omega_0}}$

Here, $\omega_0 = 2\pi f_0$; f_0 is the 3 dB frequency.

For N identical cascaded stages transfer function is $\frac{A^N}{\left(1+\frac{S}{\omega_0}\right)^N}$; dc gain = A^N

Magnitude of gain = $\frac{A^N}{\left\{1+\left(\frac{\omega}{\omega_0}\right)^2\right\}^{\frac{N}{2}}}$

At 3 dB for this cascaded stage,

$\frac{A^N}{\left\{1+\left(\frac{\omega}{\omega_0}\right)^2\right\}^{\frac{N}{2}}} = \frac{A^N}{\sqrt{2}}$; which gives

$\omega = \omega_0\sqrt{2^{1/N} - 1}$ as 3 dB frequency

For 2 stage, $f_{3dB} = f_0\sqrt{\sqrt{2} - 1} = 0.6436f_0$

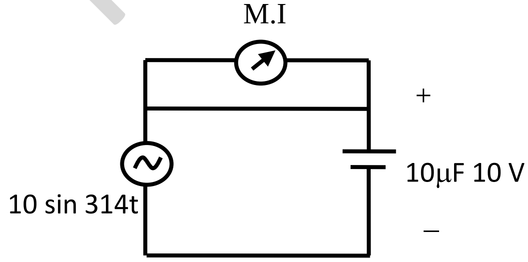
21. **[Ans .]**
22. **[Ans .]**
23. **[Ans .]**
24. **[Ans .C],** In bode – magnitude plot,
    Steady state decay = -20 (P – z) dB/decade
    Given z = 3, ∴ p – z = 3 ⇒ p = 6

25. **[Ans .A]**

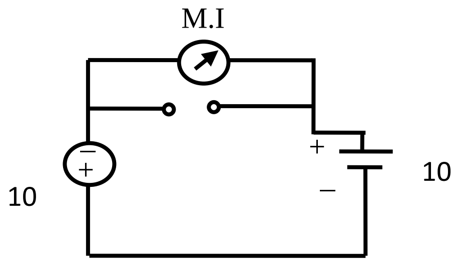
s^5	1	-1	-4
s^4	-1	-7	-4
s^3	-8	-8	
s^2	-6	-4	
s^1	-8/3		
s^0	-4		

number of sign changes = number of roots with positive read port = 1
∴ number of roots on left half of s – plane = 5-1 = 4

26. **[Ans .C]**
During positive cycle



Here M.I get's shorted, so no reading
During negative cycle



So by KVL, voltage across
M.I is 20V

$\therefore V_{RMS} = \frac{20}{\sqrt{2}} = 14.14V$

27. **[Ans .B],** A = $\begin{bmatrix} -1 & 2 & 3 \\ 0 & 4 & -1 \\ 0 & 0 & 1 \end{bmatrix}$

Eigen value of A are $\lambda_1 = -1$, $\lambda_2 = +1$, $\lambda_3 = 4$,

Eigen value of matrix B = $\lambda^3 + \lambda^2 + A + I$, are

$[\lambda_1]_B = \lambda_1^3 + \lambda_1^2 + \lambda_1 + 1 = 0$

$[\lambda_2]_B = \lambda_2^3 + \lambda_2^2 + \lambda_2 + 1 = 4$

$[\lambda_3]_B = \lambda_3^3 + \lambda_3^2 + \lambda_3 + 1 = 85$

Trace of B = $[\lambda_1]_B + [\lambda_2]_B + [\lambda_3]_B = 89$

28. **[Ans .B],** $(D^2 - 2D + 1)y = \frac{e^x}{x}$

C.F = $(C_1 + C_2x)\, e^x$

P.I = $\frac{1}{(D-1)^2}\frac{e^x}{x} = e^x . \frac{1}{(D+1-1)^2} . \frac{1}{x}$

$= e^x \frac{1}{D} \log x = e^x \int \log x \, dx$

$= e^x (x \log x - x)$

complete solution = $(C_1 + C_2x)\, e^x + e^x\, (x \log x - x)$

$= (C_1 + C_2x + x \log x - x)\, e^x$

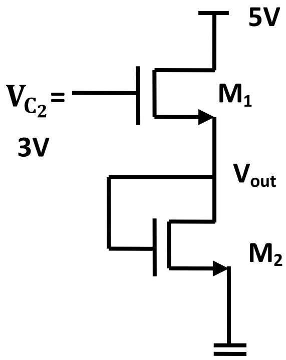
29. **[Ans .C],** Probability of drawing a green balls from box y if the transferred ball is green ,

$P_1 = \frac{4}{6} x \frac{8}{13} = \frac{16}{39}$

probability of drawing of green ball from box y if the transferred ball is red , $P_1 = \frac{2}{6}\, x \frac{7}{13} = \frac{7}{39}$

Required probability = $P_1 + P_2 = \frac{22}{39}$

30.



M_2 is diode connected so is in saturation

For M_1; $V_D = 5V$ & $V_G = 3V$

$V_{Th} = 1V$ (given) → Threshold voltage

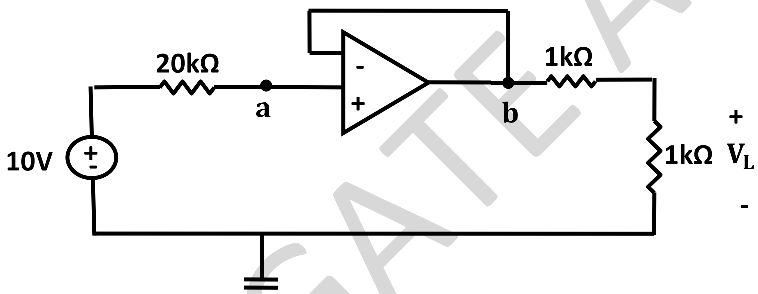
So, $V_D > V_G - V_{Th}$; so M_1 is also in saturation

Now applying KCL at V_{out} ;

$$I_{M_1} = \mu_w C_{ox}\left(\frac{W}{L}\right)(V_G - V_{out} - V_{Th})^2 = I_{M_2} = \mu_w C_{ox}\left(\frac{W}{L}\right)(V_{out} - V_{Th})^2$$

$I_{M_1} = I_{M_2}$ gives, $V_{out} = \frac{V_G}{2} = 1.5V$

31. **[Ans .C],** Applying Thevenin's equivalent to left side of (A) point



$v_a = 10V$; $v_b = 10V$ (buffer)

$v_L = v_b \cdot \frac{1k\Omega}{1k\Omega + 1k\Omega} = 5V$

32. **[Ans .C]**

Solution: For given system,

$\emptyset(S) = (SI - A)^{+} = \frac{1}{(S^2+2)}\begin{bmatrix} S & 1 \\ -2 & S \end{bmatrix}$

$\emptyset(t) = L^{-1}(\emptyset(S)) = \begin{bmatrix} \cos\sqrt{2}t & 1/\sqrt{2}\sin 2t \\ -\sqrt{2}\sin\sqrt{2}t & \cos\sqrt{2}t \end{bmatrix}$

$|\emptyset(t)| = 1 = \lambda_1 . \lambda_2$

Given $\lambda_1 = \lambda$, $\therefore \lambda_2 = 1/\lambda$

33. **[Ans .A]**

$R_{XY}(t_1,t_0)=1.5\delta(t_1-t_0+\tau)+1.5\delta(t_0-t_1+\tau)$

34. **[Ans .B]**
35. **[Ans .A]**

The difference in phase, ϕ b/w the two says some if say p. Ray d has travelled an extra distance 2t (assuming nearly normal incidence) in a modicum where the wavelength is $\lambda_2 = (n_1/n_2)\,\lambda_1$. Moreover, one of the says (b, if $n_2 > n_1$) has suffered a 180^0 phase change in reflection. Consequently.

$$\phi = \frac{2\pi}{\lambda_0}(2t)\pi = 2\pi\left(\frac{2n_2t}{n_1\lambda_1} - \frac{1}{2}\right)$$

36. **[Ans .]**
37. **[Ans .D]**
38. **[Ans .B]**
39. **[Ans .D]**
40. **[Ans .C]**

The energy of y (t) = 3x (t).e^{-j3t} is,

$E_x = \frac{1}{2\pi}\int_{-\infty}^{\infty}|X(\omega)|^2 d\omega$

$E_y = \frac{1}{2\pi}\int_{-\infty}^{\infty}|Y(\omega)|^2 d\omega$

$= \frac{1}{2\pi}\int_{-\infty}^{\infty} 9|X(\omega)|^2 d\omega$

$=\frac{9}{2\pi}\,[2(\omega_0-\omega_1)\times 16 + 2\times(\omega_1)\times 9]$

$=\frac{9}{2\pi}\,[32\omega_0 - 32\omega_1 + 18\omega_1]$

$= \frac{9[32\omega_0-14\omega_1]}{2\pi}$

$= \frac{9(16\omega_0-7\omega_1)}{\pi}$

41. **[Ans .D]**

For $2^n\mu(n)$, Z.T. is $|z| > 2$

For $-\left(\frac{1}{3}\right)^n \mu(-n-1)$, Z.T. is $|z| < 1/3$.

Intersection of ROCs is $\emptyset$.

42. **[Ans .B]**

y [n] = A x[n-n_0] = A $\sin[\omega_0(n-n_0)+\emptyset]$

The group delay function,

$\frac{-d\theta(\omega)}{d\omega}$ = tg = n_0 here

So, $d\theta(\omega) = -n_0\, d\omega/\omega=\omega_0$

$\therefore\ \theta(\omega) = -n_0\omega_0 + k^1$

To avoid phase change $k^1 = 2\pi k$

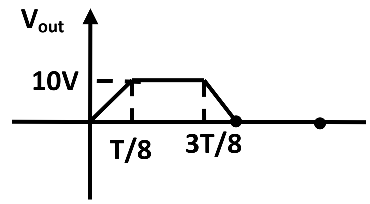
This form of $\theta(\omega)$ is called as unwrapped phase.

43. **[Ans .]**

44. **[Ans .C]**

T = Time period

Average value



$= \frac{1}{T}$ [Area of Trapezoid] $= \frac{1}{T} \times \left[\frac{1}{2} \times \left(\frac{T}{2} + \frac{T}{4}\right) \times 10\right]$

=3.75 V

45. **[Ans .]**

46. **[Ans .]**

47. **[Ans .A]**

For A, poles are root of $s^2+5s-6= 0$

∴ Poles are -6 & +1

∴ A is unstable

For B, $T(s) = \frac{\frac{4}{(s^2+5s-6)}}{1+\frac{4}{(s^2+5s-6)}.\frac{(s-1)}{(2)}} = \frac{4}{(s^2+7s-8)}$

∴ Poles are roots of $s^2 + 7s - 8 = 0$

∴ Poles are – 8 & +1

∴B is unstable

48. **[Ans .B],** $i_L(0) = 2A$, $V_C(0) = 2V$

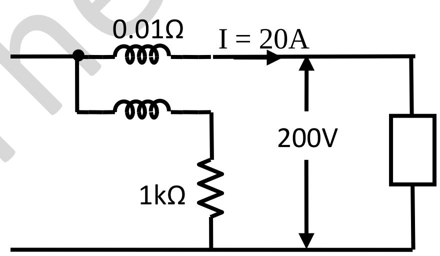
$i_L(t) = 2e^{-t}$

$\frac{di_L(t)}{dt} = 2e^{-t}$, At $f = 0^+$ $\frac{di_L(t)}{dt}|_{t=0^+} = -2$ A/S

49. **[Ans .C],** $\frac{dV_C}{dt}|_{t=0^+} = -2$ V/sec $\frac{dI_L}{dt}|_{t=0^+} = -2$ A/sec

$\frac{dv_C}{dI_L} = 1$

50. **[Ans .A]**



Load power = VI cos ϕ = 200 ×20 × 0.8

For the above connections

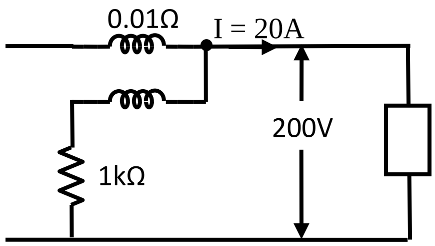
Power loss is current coil = $I^2R_C = (20)^2 \times 0.01 = 4w$

∴ wattmeter reading = 3200 + 4w = 3204w

% error = $\left(\frac{4}{3200}\right) \times 100 = 0.125\%$

51. **[Ans .B]**

For the connections power loss in voltage coil = $\frac{V^2}{R_P} = \left(\frac{200}{1000}\right)^2$ =40w



∴ wattmeter reading = 3200 + 40 = 3240w

% error = $\left(\frac{4}{3200}\right) \times 100 = 1.25\%$

52. **[Ans .C]**

The potential difference b/w the two cylix dees is

$$= \frac{\theta}{2\pi G_0 G_r} \ln \frac{R_2}{R_1}$$

Where θ = change per unit length on any one of the cylinder i.e ($\theta = \theta/x$)

Hence $C = \frac{2\pi\, G_0\, G_r x}{\ln R_2/R_1}$

∴ when tank is empty ($R_2/R_1 = 2$)

$$C = \frac{2\pi \times 8.85 \times 8}{\ln 2} PF \Longrightarrow C = 642PF$$

When tank is full (1/8) of cylinder is empty.

$C = 642 \times \frac{1}{8} + 642 \times \frac{7}{8} \times 2.4 = 1428PF$

When tank is empty $G = \frac{642}{100} = 6.42PF$

53. **[Ans .D]**

Hence V_0 is → ∴ $V_0 = \frac{15 \times 6.42}{642} - \frac{15 \times 6.42}{1428}$

$= \frac{15 \times 6.42 \times 786}{642 \times 1428} = 82.5mv$

54. **[Ans .B]**

$N = z^+ - p^+$

$N = -2$, $z^+ = 0$, ∴ $p^+ = 2$

Type of system = 2, ∴ order = $2 + p^+ = 4$

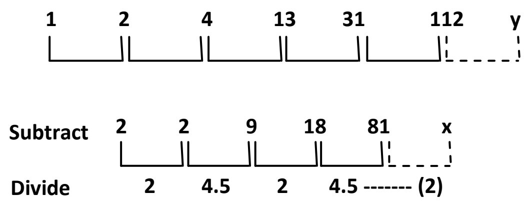
55. **[Ans .B],** root locus branches = |2 – P| =4

type of system is 2 ⟹ 2^{nd} order pole at 0

root locus starts from open loop poles.

Hence from 0

56. **[Ans. D]**



$81 \times 2 = x$

$112 + 81 \times 2 = y = 274$

57. **[Ans. A]**

As the fruit seller is buying equal lots, we will have to make number of oranges of both the lots equal. Also, since he is selling all the orange, we will have to make the number of oranges brought and sold equal.

∴ L.C.M of 5, 4, 9 = 180.

The fruit seller is buying two lots of oranges, each lot having 180 oranges.

∴ 1^{st} lot = 36 Rs. ⇒ Total spent = 45 + 36 = 81 Rs.

2^{nd} lot = 45 Rs.

The fruit seller sells 9 oranges for 2 Rs. Therefore 560 Oranges for 80 Rs.

∴ Loss of 1 Rupee as loss % = $\frac{1}{81} \times 100 = 1.23\%$.

58. **[Ans. C]**

59. **[Ans. A]**

60. **[Ans. B]**

Choices A & C do not state the comparison logically. The expression ***as old as*** indicates equality of age, but the sentence indicates that the Brittany monuments predate the Mediterranean monuments by 2,000 years.

In B, the best choice, ***older than*** makes this point of comparison clear. B also correctly uses the adjective

61. **[Ans. C]**

62. **[Ans. B]**

63. **[Ans. B]**

In one day X can finish $1/15^{th}$ of the work

In one days Y can finish $1/10^{th}$ of the work.

Let us say that in one day Z can finish 1/2th of the work.

When all the three work together in one day they can finish $\frac{1}{15} + \frac{1}{10} + \frac{1}{Z} = \frac{1}{5}$ of the work

$\therefore \frac{1}{2} = \frac{1}{30}$

$\therefore$ Ratio of efficiencies = $\frac{1}{5} : \frac{1}{10} : \frac{1}{30} = 2 : 3 : 1.$

$\therefore$ Z receives 1/6th of the total money.

$\therefore$ Accordingly money is divided as 240: 360 : 120.

$\Rightarrow$ Z = 120

64. **[Ans. D]**

The probability that a customer entered the store makes a purchase = 0.4.

$\Rightarrow$ 2 customers make a purchase and one does not is $(0.4)^2 \times 0.6$

The two of the three people can be selected in $^3c_2$ or 3 ways.

$\therefore$ Required probability = $3 \times 0.4^2 \times 0.6 = 0.288$.

65. **[Ans. C]**

$$\left.\begin{matrix} E_1, E_2, E_3 & \rightarrow \text{English men} \\ F_1, F_2, F_3 & \rightarrow \text{French men} \end{matrix}\right\} \quad \left.\begin{matrix} 1.\ E_1 \leftrightarrow E_2 \\ E_2 \leftrightarrow E_3 \\ F_1 \leftrightarrow F_2 \\ F_2 \leftrightarrow F_3 \\ F_3 \leftrightarrow E_3 \\ E_3 \leftrightarrow E_2 \\ E_2 \leftrightarrow E_1 \\ F_3 \leftrightarrow F_2 \\ F_1 \leftrightarrow F_1 \end{matrix}\right\} \text{9 calls}$$