Answer Keys

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

Q.1   (B)

Since all the applied voltage appears across it.

Q.2   (C)

Let $y = \dfrac{u}{v}$, % error in y = % error in u – % error in v

Here u = $G_1 + G_2$, v = G_3

Q.3   (A)

When diode is ON, i = 1mA. When diode is OFF, i is zero after small reverse recovery time.

Q.6   (D)

Internal resistance = $\dfrac{2000V}{400A} = 5\Omega$

Internal voltage drop = $200A \times 5\Omega = 1000V$

Q.7   (A)

It is a balanced Wheatstone bridge.

Q.9   (B)

$P = \dfrac{EV}{X}\sin\delta \approx \dfrac{V^2}{X}\sin\delta$

Q.12   (B)

Q.13   (A)

All other XNOR, NOR, NAND gates can be derived from NOT, OR, AND gates.

Q.14   (C)

$$M = \sqrt{L_1 L_2}; \quad L_1 = \frac{N_1 \phi_1}{i_1}, \quad \phi_1 = B_1 A_1$$

$$\therefore \boxed{M \propto \sqrt{A_1 A_2}} \quad \frac{M_1}{M_2} = \sqrt{\frac{20 \times 20}{10 \times 10}} = \sqrt{4} = 2$$

$$M_2 = \frac{M_1}{2}$$

Q.15 (B)

B is stable as slip ≈ 1

A is unstable as slip ≈ 0

Q.17 (C)

$a = 1.42; \quad GM = -20 \log a$

Since $a > 1$, GM will be negative and unstable

Now, $G(j\omega)H(j\omega) = \dfrac{1 - j\omega T_1}{j\omega C(1 + j\omega T_2)}$

(Assuming one pole in RHS plane)

$\left| G(j\omega)H(j\omega) \right| = -90 - \tan^{-1}\omega T_1 - \tan^{-1}\omega T_2$

At $\omega = 0$, $\left| G(j\omega)H(j\omega) \right| = -90$

At $\omega = \infty$, $\left| G(j\omega)H(j\omega) \right| = -270$

Q.18 (D)

From Routh table,

The equation is

$2s^3 + 4s^2 + 2s + 4 = 0$

$s^2[4 + 2s] + [2s + 4] = 0$

$(s^2 + 1)(2s + 4) = 0$

$\boxed{s = \pm j = -0.5}$ LHS

Q.19 (B)

Since at $\omega = 2$ and $\omega = 25$, slope changes from 40dB/dec to −60dB/dec at both the value. So there are poles at $\omega = 2$ and $\omega = 25$.

Also at $\omega = 0.1$ slope is −40dB/dec.

∴ It means there are two poles at origin.

Hence the transfer function of the form,
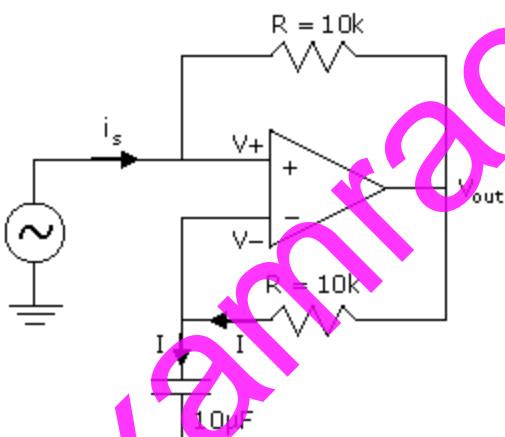
$$T(s) = \frac{K(s+5)}{s^2(s+2)(s+25)}$$

$$80 = 20\log\frac{5k}{(0.1)^2 \times 50} \Rightarrow K = 1000$$

Q.20   (C)

Trace = Sum of principal diagonal elements

Q.21   (D)

$$X_c = \frac{1}{j\omega C} = \frac{1}{j2\pi \times 50 \times 10 \times 10^{-6}} = \frac{-j100}{\pi}$$

$$I = \frac{V-}{X_c} = \frac{10}{X_c} = \frac{j\pi}{100}$$
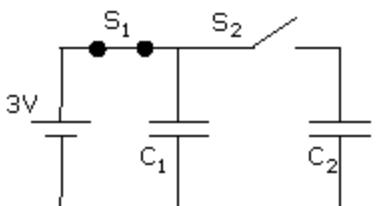
$$V_{out} = 10 + \frac{(10,000)\,j\pi}{100} = 10 + j100\pi$$

$$i_s = \frac{V_+ - V_{out}}{R} = \frac{10 - 10 - j100\pi}{10000} = -j10\pi \, mA = 10\pi mA \angle -90^\circ \, s$$

Q.22 (C)

When S_1 is closed, S_2 is open

C_1 is full charged to 3V
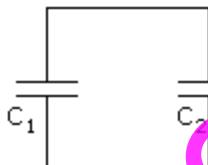
When S_1 is open

S_2 is closed

$Q = C_1 V_1 = C_2 V_2$

$1F \times 3V = 2F \times V_2$; $V_2 = 1.5V$

Q.24 (A)

Apply KVL for input loop

$$V_{in} = (2k\Omega) I_1 + (49 I_1 + I_1)/(100\mu F)s$$

$$= (2K I_1) + \frac{50 I_1}{5 \times 100\mu F} = 2k I_1 + \frac{I_1}{(2\mu F)S}$$

$$C_{off} = 2\mu F$$

Q.25 (D)

XRA A $\rightarrow$ Accumulator is cleared, A $\leftarrow$ 00H

MVI B $\xleftarrow{\text{F0H}}$ B $\leftarrow$ F0H

SUB B $\leftarrow$ (A) $\leftarrow$ (A) $-$ (B)

(A) $\leftarrow$ FFFFFF10H

Q.26 (C)

$$y_{Bus} = \begin{bmatrix} y_{11} & y_{12} & y_{13} & y_{14} \\ y_{21} & y_{22} & y_{23} & y_{24} \\ y_{31} & y_{32} & y_{33} & y_{34} \\ y_{41} & y_{42} & y_{43} & y_{44} \end{bmatrix}$$

here

$y_{11} = y_{10} + y_{12} + y_{13} + y_{14} = -5j$ ----- [1]

$y_{22} = y_{20} + y_{22} + y_{23} + y_{24} = -10j$ ----- [2]

$y_{33} = y_{30} + y_{32} + y_{33} + y_{34} = -9j$ ----- [3]

$y_{44} = y_{40} + y_{42} + y_{43} + y_{44} = -8j$ ----- [4]

$y_{12} = y_{21} = -y_{12} = 2j$

$y_{13} = y_{31} = -y_{13} = 2.5j$

$y_{14} = y_{41} = -y_{14} = 0j$

$y_{23} = y_{32} = -y_{23} = 2.5j$

$y_{24} = y_{42} = -y_{24} = 4j$

From equation 1,

$y_{10} = y_{11} - y_{12} - y_{13} - y_1$

$y_{10} = -5j + 2j + 2.5j + 0j = -5j + 4.5j = -0.5j$

From Eqn. 2
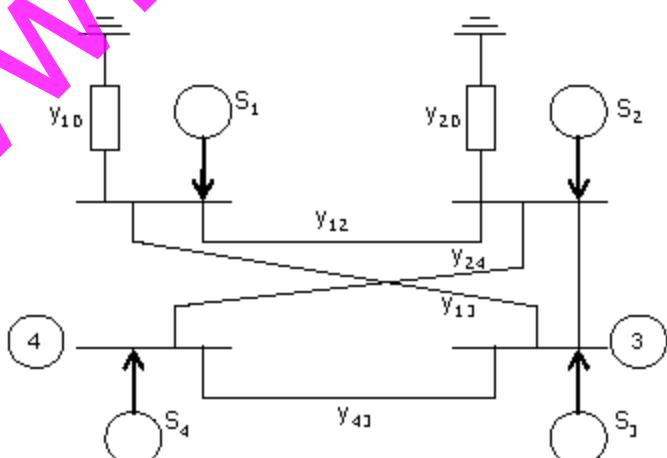
$y_{20} = y_{22} - y_{12} - y_{23} - y_{24} = -10j + 2j + 2.5j + 4j = -1.5j$

From Eqn. 3

$y_{30} = y_{33} - y_{31} - y_{32} - y_{34} = -9j + 2.5j + 2.5j + j4 = 0$

From Eqn. 4,

$y_{40} = y_{44} - y_{41} - y_{42} - y_{43} = -8j - 0 + 4j + j4 = 0$

Q.28 (D)

Phase crossover frequency

$$-90 - 0.1\omega \times \frac{180}{\pi} = -180$$

$$\therefore \omega = 15.7$$

$$a = |G(j\omega)|_{\omega=15.7}; \quad GM = 20 \log a = 23.9dB$$

Q.32 (A)

$$G = \frac{P}{\cos\phi} = \frac{500MW}{0.9} = 555.56MVA$$

$$KE \text{ stored} = \frac{1}{2} \times M \times \left(\frac{2\pi N}{60}\right)^2 = \frac{1}{2} \times 27.5 \times 10^3 \left[\frac{2\pi \times 3000}{60}\right]^2$$

$$= 1357.07MJ$$

$$N = \frac{120f}{P} = 3000rpm$$

$$H = \frac{KE}{MVA} = \frac{1357.07}{555.56} = 2.44MJ/MVA$$

Q.40
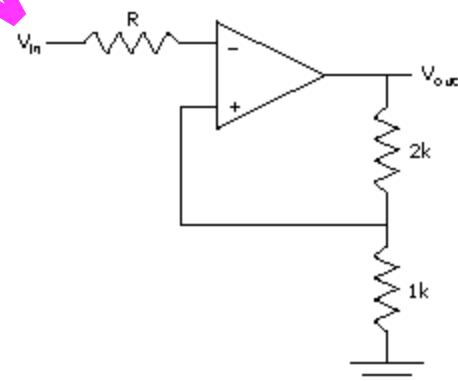
$(0,2) \rightarrow (2,0)$ $m = \dfrac{0-2}{2-0} = -1$ $y - 2 = -1[x - 0] = -x$ $\boxed{x + y = 2}$	$\displaystyle\int_{(x,y)} F(x,y)\,dxdy$ $= \displaystyle\int_0^2 x^2 + x(2-x)\,dx + \int_2^0 y^2 + y(2-y)\,dy = 0$
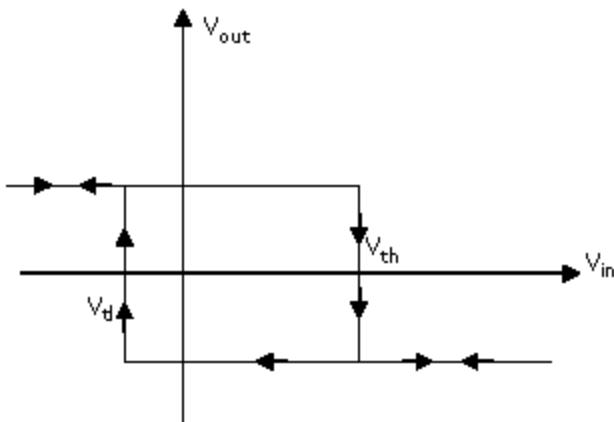
Q.41 (D) For

Hysterisis Diagram is

$$V_{th} = \left(\frac{1k}{3k}\right)V_H = 2V = t_2$$
$$V_{tl} = \left(\frac{1k}{3k}\right)(-3) = -1V = t_4$$

After t_2, $V_{out} = -3VA$
After t_4, $V_{out} = 6VA$

Q.42   (C)

$$Z_{auxiliary} = r_a + j\omega L_a = 1 + j \times 2\pi \times 50 \times \frac{10}{\pi} = 1 + j1000$$

$$Z_{main} = r_m + j\omega L_m = 0.1 + j2\pi \times 50 \times \frac{0.1}{\pi} = 0.1 + j10 \simeq 10\underline{|90}$$

starting torque $= K I_a I_m \sin(I_a, I_m) \rightarrow \sin(0) = 0$

Q.43   (A)

$$V_L = L\frac{di}{dt}; \quad i = \frac{1}{L}\int V\,dt$$

$$i = \left[\frac{\pi}{0.1}\right]\int 10\sin 100\pi t = \left(100\pi\right)\frac{\cos 100\pi t}{100\pi t}$$

$$i(t) = \cos 100\pi t$$

$$i(t) = 0 \text{ when } \cos 100\pi t = 0 \Rightarrow 100\pi t = n\frac{\pi}{2}$$

$$\boxed{t = \frac{n}{200}}$$

When $n=1$, $t=5$msec; $n=2$, $t=10$msec; $n=3$, $t=15$msec

$\therefore$ Answer is (A)

Q.47 (B)
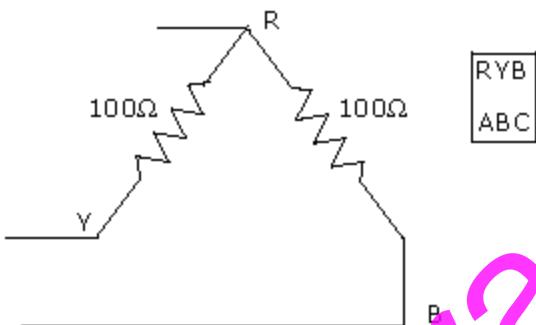
By Superposition theorem,

When 4V is shorted, $i^1 = 0$, as all the current will flow through short. When 5A is open, $i^{11} = 2A$

Therefore $i_{2\Omega} = 2A$

Q.48 (C)

| Wattmeter reading | = | Current through the coil (I) | x | Voltage across Pressure coil (V) | x | Cos(phase angle between V & I) |

| RYB |
| ABC |

$$I_{BR} = I_{CC} = \frac{400 \lfloor 120}{100} = 4 \lfloor 120$$

$$V_{YB} = V_{PC} = 400 \lfloor -120$$

$$W = 4 \lfloor -120 \times 400 \lfloor -120 \times \cos(240) = -800W$$

Q.49 (A)

For triangular wave,

Avg value $\rightarrow \dfrac{V_m}{3}$

rms value $\rightarrow \dfrac{V_m}{\sqrt{3}}$

$\therefore \dfrac{V_m}{3} = 10V$, $V_m = 30V$

rms value $= \dfrac{30}{\sqrt{3}} = 10\sqrt{3}$

Q.53 (D)
Q.54 (A)

$$V = L \frac{di'}{dt'} = \left(\frac{400}{\pi}m\right)\frac{dt}{dt}$$

$$\frac{dt}{dt} \text{ is max} \rightarrow 0 \rightarrow 5m\sec$$

$$V = \left(\frac{400}{\pi}m\right)\frac{10}{5m\sec}\left[\frac{800}{\pi}\right]V$$

If $i(t) = 10\sin(100\pi t)$

$$V = \left(\frac{400}{\pi}\right)^{mH}\frac{di(t)}{dt} = \left[\frac{40\cancel{0}}{\cancel{\pi}}\right]\cancel{pi} \times 10 \times \cos(100\pi t)$$

$$= 400\cos(100\pi t)$$

$$V_{max} = 400V$$

Q.55   (C)

$$\frac{dx_1(t)}{dt} = -3x_1(t) + x_2(t) + 2\mu(t)$$

$$\Rightarrow sx_1(s) = -3x_1(s) + x_2(s) + 2 \quad ---- [1]$$

$$\frac{dx_2(t)}{dt} = -2x_2(t) + \mu(t)$$

$$\Rightarrow sx_2(s) = -2x_2(s) + 1$$

$$(s+2)x_2 = 1$$

$$x_2 = \frac{1}{(s+2)}; \text{ From } [1], (s+3)x_1 = 2 + \frac{1}{s(s+2)}$$

$$x_1 = \frac{2s+5}{(s+2)(s+3)}$$

$$y(t) = x_1(t) \Rightarrow H(s) = \frac{y(s)}{X(s)} = \frac{2s+5}{(s+2)(s+3)} = \frac{2s+5}{s^2+5s+6}$$

Q.56   (B)

$$e^{At} = L^{-1}[\phi(s)]; \ \phi(s) = \left[[sI-A]^{-1}\right]$$

From given state equations

$$\dot{x}_1(t) = -3x_1(t) + x_2(t) + 2\mu(t)$$

$$\dot{x}_2(t) = -2x_2(t) + \mu(t)$$

$$\phi(s) = \left[\begin{bmatrix} s & 0 \\ 0 & s \end{bmatrix} - \begin{bmatrix} -3 & 1 \\ 0 & -2 \end{bmatrix}\right]^{-1} = \begin{bmatrix} s+3 & -1 \\ 0 & s+2 \end{bmatrix}^{-1}$$
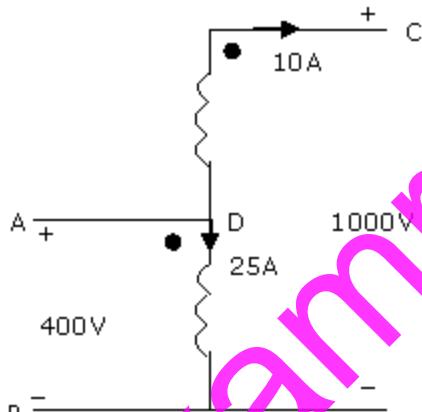
$$= \frac{1}{(s+2)(s+3)}\begin{bmatrix} s+2 & 1 \\ 0 & s+3 \end{bmatrix}$$

$$\phi(s) = \begin{bmatrix} \dfrac{1}{s+3} & \dfrac{1}{(s+2)(s+3)} \\ 0 & \dfrac{1}{(s+2)} \end{bmatrix}$$

$$e^{At} = L^{-1}\left[\phi(s)\right] = \begin{bmatrix} e^{-3t} & e^{-2t} - e^{-3t} \\ 0 & e^{-2t} \end{bmatrix}$$
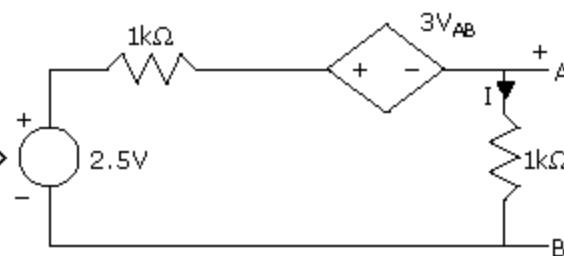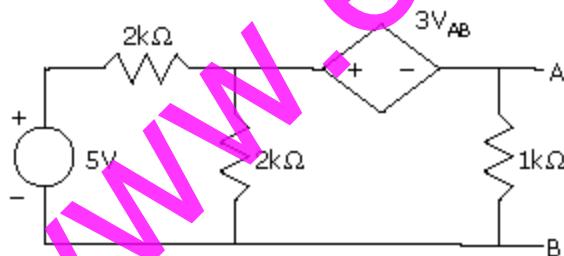
Q.57   (A)

Q.58   (A)

$$1000 = 25A + 400V = 10A \times 1000V$$

Q.59   (B)

$$\boxed{V_{OC} = V_{AB}}$$

$$2.5 = (1k\Omega)I + 3V_{AB} + V_{AB}$$

$$V_{AB} = (1k\Omega)I$$

$$\therefore 2.5 = V_{AB} + 3V_{AB} + V_{AB} = 5V_{AB}$$

$$V_{AB} = 0.5V$$

Apply short across AB: $V_{AB} = 0$, $3V_{AB} = 0$,

$$I_{sc} = \frac{2.5V}{1k\Omega} = 2.5mA$$

Q.60 (D)

$$R_{th} = \frac{V_{oc}}{I_{sc}} = \frac{0.5V}{2.5mA} = \frac{1000}{5} = 200\Omega = 0.2k\Omega$$