Question 1 to 5 Carry One Mark Each

1. If we had taken the other road, we .... have arrived earlier.

(a) Would (b) Will (c) May (d) Should

2. A dishonest shopkeeper professes to sell his articles at cost price but he uses false weights with which he cheats by 10% while buying and 10% while selling. The percentage profit will be

(a) 11.11% (b) 33.33% (c) 22% (d) 22.22%

3. A and B, B and C do a work in 12 and 16 days. If A work for 5 days and B work for 7 days and C complete the remaining work in 13 days then, A would complete the work in how many days?

(a) 24 days (b) 48 days (c) $\frac{48}{3}$ days (d) $\frac{24}{7}$ days

4. Unless these differences will be resolved soon there will be an adverse effect on foreign investment.

(a) will resolved (b) will resolve (c) one resolved (d) shall be resolved

5. Fresh fruit contains 68% water and dry fruit contains 20% water. How many kg of dry fruits can be made from 75 kg of fresh fruits

(a) 75 kg (b) 25 kg (c) 30 kg (d) 60 kg

Question 6 to 10 Carry Two Mark Each

6. $\log\frac{16}{15}+5\log\frac{25}{24}+3\log\frac{81}{80}$ = log x, the value of x is

(a) 2 (b) 3 (c) 0 (d) None of these

7. The data given in the following table summaries the monthly budget of an average house hold :

Category	Amount (Rs.)
Food	5000
Medicine	1500
Savings	1800
Rent	3500
Other expenses	2200

The approximate percentage of the monthly budget NOT spent on savings is

(a) 85% (b) 85.24% (c) 85.50% (d) 84.23%

8. Swami Vivekanand had said, "So long as the millions live in hunger and ignorance I hold everyone traitor, who having been educated at their expenses pays not the least head to them.

As per Swami Vivekanand, which of the following will be the most appropriate definition of "traitor"?

(a) Educated people ignoring the starving and illiterate masses

(b) Millions who live in hunger and ignorance

(c) All those educated people who look after the massess

(d) All social workers who are duty bound

9. It is only by cultivating spirit of renunciation. Self sacrifice, contentment ands incere work that can really be happy. The stings of misfortune spare none but they will not cow such a person which of the following is similar in meaning as the word "cow" or used in the passage?

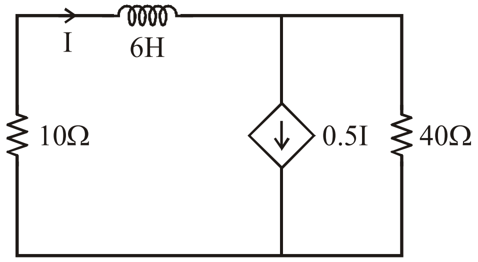
(a) spare (b) conquer (c) discard (d) Mould

10. A boatman goes 24 km downstream and 36 km upstream in 9 hours. While it takes $8\frac{1}{2}$ hours to go 36 km downstream and 24 km upstream, the speed of boat is

(a) 1 km/hr (b) 5 km/hr (c) 7 km/hr (d) 8 km/hr

Question 1 to 25 Carry One Mark Each

1. Consider the Network shown in below figure If I(0) = 6 Amp, I(t) (in Amp) for t > 0 will be



(a) $1.2\ e^{-5t}$ (b) $6e^{-5t}$ (c) $6e^{\frac{-25}{3}t}$ (d) $1.2e^{\frac{-25}{3}t}$

2. Consider a long two wire line composed of solid round-conductors. The radius of both conductors is 0.20 cm and the distance between their centres is 2m. If this distance is doubled, then the inductance per unit length.

(a) doubles (b) halves

(c) increase but does not double (d) decreases but does not halve

3. The fundamental time period of signal

$x(t) = \cos\left(\frac{\pi}{3}t\right) + \sin\left(\frac{\pi}{4}t\right)$ is ______ sec.

4 Solution of the differential equation

$y' = \tan(6x + 3y + 5) - 2$ is

(a) $Ae^{2x} + B\cos x$ (b) $\sin(6x + 3y + 5) - Ae^{3x} = 0$

(c) $A\cos 2x + B\sin 3x + Ce^{2x}$ (d) $\cot(6x + 3y + 5) - Ae^{2x} = 0$

5. The full load slip of a 3-phase squirrel cage induction motor is 0.05. The starting current is 5 times the rated current. The ratio of starting torque to full load torque is

______

6. If the characteristic polynomial is

$s^6+s^5+5s^4+3s^3+2s^2-4s - 8$. The number of poles lying in right hand side of s-plane is

______

7. The gate cathode characteristics of an SCR is given by $V_G = 0.5 + 8I_G$. The rectangular trigger pulse applied to the gate circuit has an amplitude of 12 V. The thyristor has average gate power loss of 0.5 watts. For a triggering of 400 Hz and duty cycle of 0.1 the value of resistance to be connected in series with the gate circuit is ______ Ω

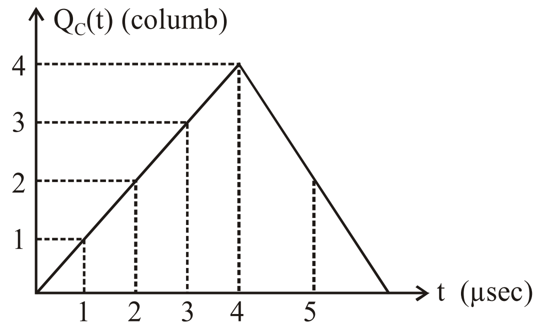
8. The black box in figure below consist of a minimum complexity circuit that uses only AND, OR & NOT gates. The function f(x, y, z) = 1 whenever x, y are different and 0 otherwise. Main conditions is the 3 inputs x, y, z have never all the same value

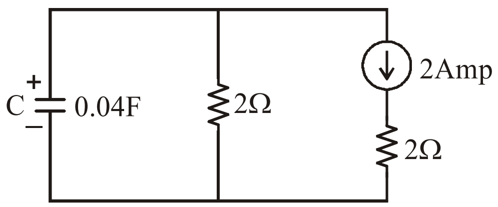
The manufacturing cost of the manufacture to design this black box when cost price of NOT, AND, OR Gates are respectively 2, 3, 4, is

9. A moving coil ammeter has a fixed shunt of 0.02 Ohm resistance. If the coil resistance of the meter is 1000 Ohms, a potential difference of 500 mV is required across it for full-scale deflection. Under this condition, the current in the shunt would be

(a) 2A (b) 10A (c) 25A (d) 2.5A

10. Charge flow the capacitor is shown in the graph below the power absorbed/delivered by the current source at t = 4 μsec is





(a) 204 watt (b) 198 watt (c) 192 watt (d) max than 204 watt

11. Which of the following statement is correct?

1. Precise instrument need not be accurate but an accurate instrument should be precise.

2. An accurate instrument need not be precise but precision instrument should be accurate.

3. Precision is pre-requisite to accuracy but it does not guarantee accuracy.

4. It is possible high precision with low accuracy but not high accuracy with low precision.

(a) 1, 3 and 4 only (b) 2, 3 and 4 only (c) 1 and 4 only (d) All are true

12. What is the total number of memory locations and input-output devices that can be addressed with a processor having 16-bits address bus, using memory mapped I/O?

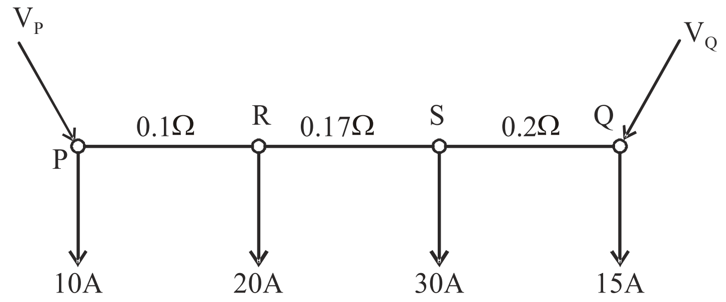
(a) 64K memory locations and 256 I/O devices

(b) 256 I/O devices and 65279 memory locations

(c) 64K memory locations and no I/O devices

(d) 64K memory locations or input-output devices

13. A DC distribution system is shown in figure with load currents as marked. The two ends of the feeder are fed by voltage sources such that $V_P - V_Q = 4$ V. The value of the voltage V_Q for a minimum voltage of 220 V at any point along the feeder is

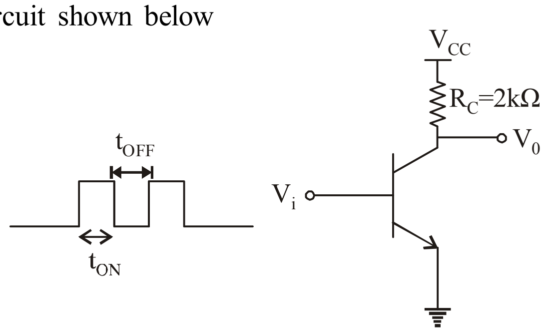


[ ] Volt

14 Real part of log[(1 + i) log i] is

(a) $\log\left(\frac{1+\pi}{\sqrt{2}}\right)$ (b) $\log\left(\frac{\pi}{\sqrt{2}}\right)+\frac{3\pi}{4}$ (c) $\log(\pi)+\sqrt{2}\pi$ (d) $\log(\sqrt{2})+\pi$

15. Consider the transistor circuit shown below



$V_{CC} = 7$ V ; $V_{CE(sat)} = 1$ V

$t_{ON} = 0.2$ msec. ; $t_{OFF} = 0.8$ msec.

The average power dissipated for one cycle of operation is

(a) 0.3 mW (b) 0.6 mW (c) 0.9 mW (d) 1.2 mW

16. When a balanced 3-phase distributed type armature winding in an induction machine is carrying 3-phase balanced currents, the strength of the resultant rotating magnetic field is

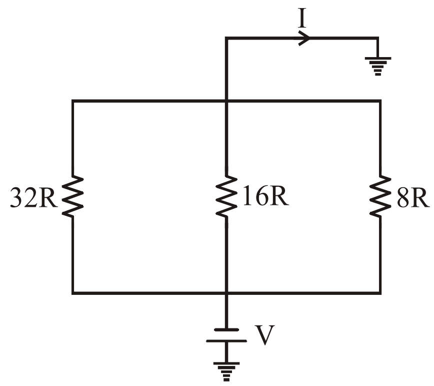
(a) three times the amplitude of each constituent pulsating magnetic field.

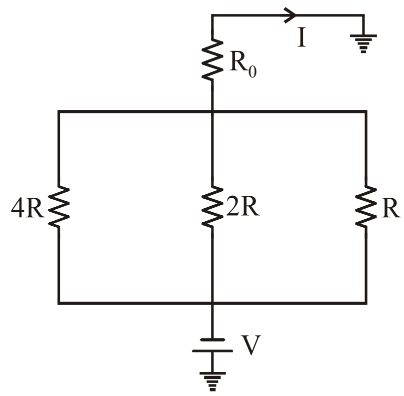
(b) equal to the amplitude of each constituent pulsating magnetic field.

(c) half the amplitude of each constituent pulsating magnetic field.

(d) one and a half times the amplitude of each constituent pulsating magnetic field.

17. For the circuit shown below. If I is same in both of the figure then find the value of R_0 (in Ω) is





(a) 2R (b) 3R (c) 4R (d) None of these

18. A d.c. potentiometer is designed to measure up to about 2 V with a slide wire of 800 mm. A standard cell of emf 1.18 V obtains balance at 600 mm. A test cell is seen to obtain balance at 680 mm. The emf of the test cell is

(a) 1.00 V (b) 1.34 V (c) 1.50 V (d) 1.70 V

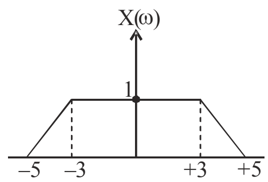
19. A transformer is rated at 11 kV/0.4 kV, 500 kVA, 5% reactance. The short circuit MVA of the transformer when connected to an infinite bus is

[ ] MVA.

20. Directional derivative of $\phi(x, y, z) = xy^2 + 4xyz + z^2$ at point (1, 2, 3) in the direction of $3\hat{i} + 4\hat{j} - 5\hat{k}$ is

(a) $\frac{11}{\sqrt{3}}$ (b) 11 (c) $\frac{\sqrt{3}}{11}$ (d) $\sqrt{\frac{11}{3}}$

21. Consider a time domain signal x(t) whose fourier transform is X(ω). If X(ω) is as shown below.



The value of signal x(t) at t = 0 is

[ ]

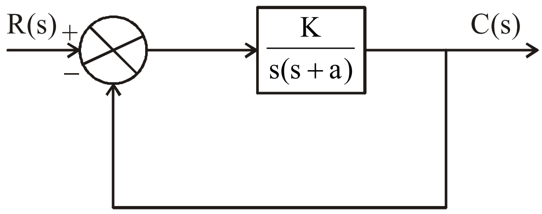
22. Solution of the integral $\int_0^\infty x^{1/3}e^{-x^2}dx$ is

(a) $2\left|\overline{\frac{1}{3}}\right.$ (b) $\left|\overline{\frac{1}{4}}\right.\left|\overline{\frac{3}{4}}\right.$ (c) $\frac{1}{2}\left|\overline{\frac{2}{3}}\right.$ (d) $\frac{3}{4}\left|\overline{\frac{1}{4}}\right.$

23. The four arms of bridge network has $Z_{AB} = Z_{BC} = 100\angle{-30°}\Omega$, $Z_{CD} = 50\angle{-60°}\Omega$ and an unknown impedance is connected between D and A. Then unknown impedance Z_{DA} is

(a) $50\angle 0°\Omega$ (b) $100\angle 0°\Omega$ (c) $50\angle -120°\Omega$ (d) $200\angle 60°\Omega$

24. The value of 'K' and 'a' to satisfy the frequency domain specification $M_r = 1.04$ and $\omega_r = 11.55$ rad/sec is respectively



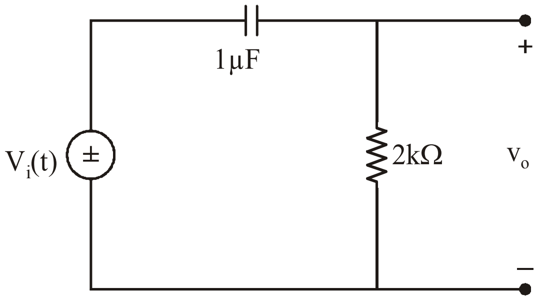
(a) 663, 32.55 (b) 25.75, 32.55 (c) 663, 16.28 (d) 25.75, 16.28

25. Particular integral of $y'' + y' - 6y = 5e^{-3x}$ is

(a) xe^{-x} (b) $-xe^{-x}$ (c) xe^{-3x} (d) $-xe^{-3x}$

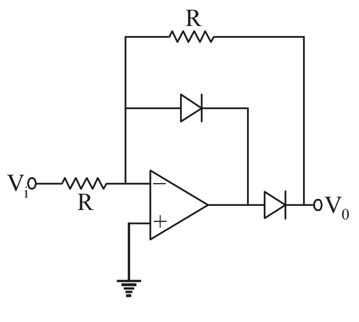
Question 26 to 55 Carry Two Marks Each

26 Consider the network shown in figure

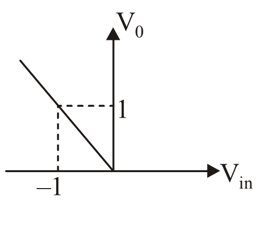


It a unit ramp input $V_i(t)$ is applied, then the steady state value of the output will be ________ (in volts).

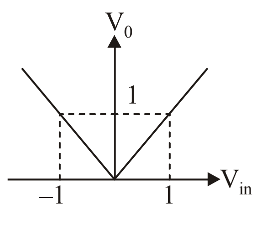
27. Consider the circuit shown given below. The transfer characteristics of circuit is repersented by which of the following option.

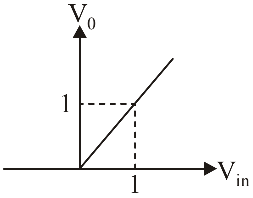


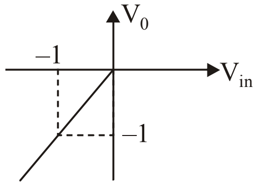
(a)



(b)



(c) 

(d) 

28. In the four bit carry look ahead carry adder, the ExOR gate has a propagation delay of 10 ns and that the AND and OR gates have a propagation delay of 5ns. The sum will appear after

29. A 3-phase synchronous generator delivers 10 MVA at a voltage of 10.5 kV. The line impedance is 5 Ω. Use the reference base as 12 MVA at 11 kV. The voltage drop in the line (in per unit) is

30. Two similar 200 kVA, 1–ϕ transformers gave the following results when tested by the back to back method. W_1 in the supply line give reading of 4 kW . W_2 in the primary series circuit, when full load current circulated through secondaries give reading of 6 kW. The efficiency of each transformer is

%.

31. If two 300V full scale voltmeters V_1 and V_2 having sensitivities of 100 kΩ/V and 150 kΩ/V are connected in series to measure 500 V, then

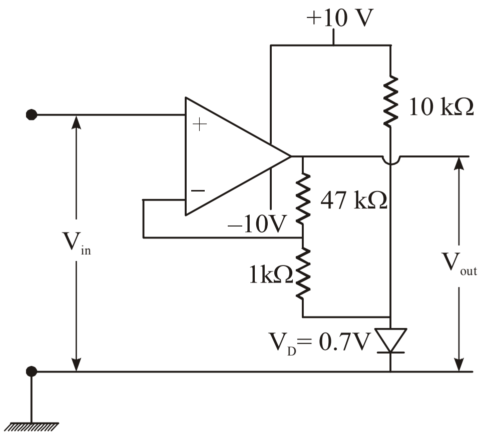
(a) V_1 and V_2 will read 0 V each

(b) V_1 will read 200 V and V_2 will read 300 V

(c) V_1 will read 300 V and V_2 will read 200 V

(d) V_1 and V_2 will read 250 V each

32. The Schmitt trigger circuit is shown in the below figure. If V_{sat} = ± 10 V, the tripping point for the increasing input voltage will be



Volt.

33. Residue of $f(z) = \dfrac{z^2}{z^2 - 2z + 2}$ at it's one of the singularity is ☐

34. In a certain conducting region,

$H = -4y^3\hat{a}_x$ A/m. The current through a square of side 1 m, with the corner at the origin and the sides coinciding with the positive x and y axes is

☐ (in Amp)

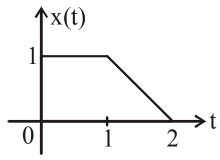
35. A 400V/100V, 10 kVA two winding transformer is reconnected as an autotransformer across a suitable voltage. The maximum rating of such a transformer could be (in kVA)

☐

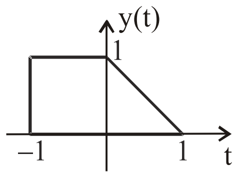
36. The reading of the wattmeter connected to measure the reactive power in a 3-phase circuit is given by zero when the line voltage is 400 volts and the line current is 15 Amps. Then the power factor of the circuit is

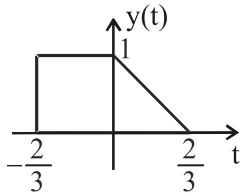
(a) zero (b) 0.6 (c) 0.8 (d) unity

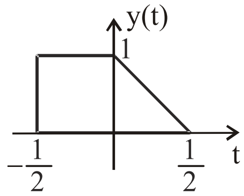
37. The signal x(t) is shown below



The signal $y(t) = x\left(\frac{3}{2}t + 1\right)$ will be

(a) 

(b) 

(c) 

(d) None of these

38. The rank of matrix $\begin{bmatrix} 1 & 2 & 3 & 4 \\ 2 & 1 & 4 & 5 \\ 1 & 5 & 5 & 7 \\ 8 & 1 & 14 & 17 \end{bmatrix}$ is

☐

39. The general solution of $2x^2y'' + 3xy' - 3y = x^3$ is

(a) $Ae^x + Be^{-x}$ (b) $Ae^x + Be^{2x}$ (c) $Ax + \frac{B}{x} + x^3$ (d) $Ax + \frac{B}{x\sqrt{x}} + \frac{x^3}{18}$

40. The resistances of two coils of a wattmeter are 0.01 ohm and 1000 ohms respectively and both are non-inductive. The load current is 20 A and the voltage across the load is 30 V. In one of the two way of connecting the voltage coil, the error in the reading would be

(a) 0.1% too high (b) 0.2% too high (c) 0.15% too high (d) zero

41. A 6 pulse thyristor converter is connected to the main through a transformer of 6% reactance. If the rms value of the voltage at the secondary of the transformer is 415 V The voltage regulation, (neglect resistance in converter) when the full load DC current is 200 A is

(a) 0.143 (b) 0.0212 (c) 0.0134 (d) 0.165

42. The voltage applied to the primary winding of an unloaded single phase transformer is given by $V = 400 \cos\omega t + 100 \cos 3\omega t$. The primary has 500 turns and frequency of the fundamental componant of the applied voltage is 50 Hz. The maximum value of the flux is

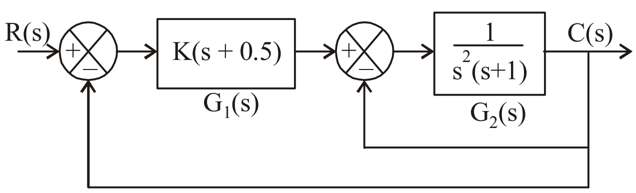
(a) 2.43 mWb (b) 2.33 mWb (c) 3.43 mWb (d) 3.34 mWb

43. In the complex function $f(z) = \frac{e^z}{z - \sin z}$, $z = 0$ is

(a) Simple pole (b) pole of order 3

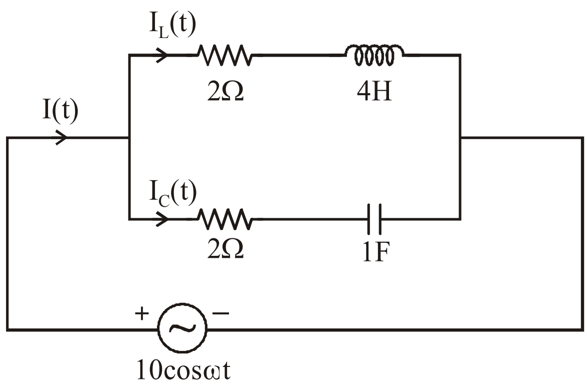
(c) Essential singularity (d) Removable singularity

44. Consider the control system shown in figure the system involves two loops. The range of gain K for stability of the system by the use of the Nyquist stability criterion is (The gain K is positive)



(a) $0 < K < 2$ (b) $2 < K$ (c) $K < -1$ (d) $K > -1$

45 The avrage power dissipated in circuit at resonance.



(a) 10 W (b) 15 W (c) 20 W (d) 25 W

46.

```
        MVI   A, 05 H
        MVI   B, 02 H
RAM:    ADD   B
        DCR   B
        JZ    RAM;
        ANI   04 H
        HLT
```

How many times loop will excess?

(a) 0 time (b) 1time (c) 2 times (d) can't say

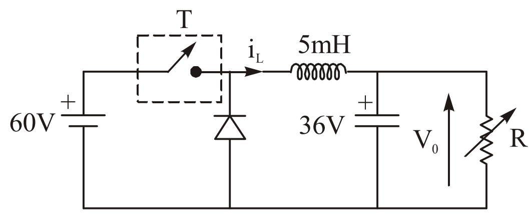
47. The value of $\iint_S \vec{A}\cdot\overrightarrow{ds}$, where $\vec{A}=x^3\hat{i}+y^3\hat{j}+z^3\hat{k}$ and S is the surface of the sphere $x^2+y^2+z^2=a^2$ is

(a) $\frac{7\pi}{5}a^3$ (b) $\frac{32\pi}{5}a^5$ (c) $\frac{9\pi}{5}a^3$ (d) $\frac{12\pi}{5}a^5$

48. A 400 MW, 22 kV, 50 Hz, 3-phase 4-pole synchronous generator having a rated pf = 0.8, has a moment of inertia 27.5×10^3 kg/m^2. The inertia constant (H) will be

(a) 2.44 MJ/MVA (b) 0.678 MJ/MVA (c) 678 MJ/MVA (d) 244 MJ/MVA

49. A buck converter feeding a variable resistive load is shown in the figure. The switching frequency of the switch S is 100 kHz and the duty ratio is 0.6. The output voltage V_0 is 36 V. Assume that all the components are ideal, and that the output voltage is ripple free. The value of R (in ohm) that will make the inductor current (i_L) just continuous is

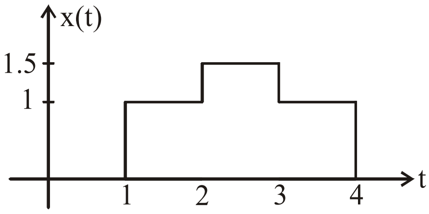


50. A double cage rotor induction motor whose impedances of the rotor of the inner and outer cages at stand still conditions are (0.02+j0.6) Ω and (0.06+j0.2) Ω respectively. Assume that the stator impedance is negligible. The ratio of the torque due to the two cages at the time of starting is

(a) 22.5 (b) 26.6 (c) 24.8 (d) 25.6

51. A 230 V single phase full converter is feeding a RLE load R = 15 Ω, L = 100 mH, and E = 70 V. If the average load current is 5 A, then the firing angle delay is (in degree)

52. The Fourier transform of the signal x(t) is



(a) $e^{-j\frac{5\omega}{2}}\left\{\dfrac{\sin\left(\frac{\omega}{2}\right)+2\sin\left(3\frac{\omega}{2}\right)}{\omega}\right\}$

(b) $\left\{\dfrac{\sin\left(\frac{\omega}{2}\right)+2\sin\left(3\frac{\omega}{2}\right)}{\omega}\right\}$

(c) $e^{j\frac{5\omega}{2}}\left\{\dfrac{\sin\left(\frac{\omega}{2}\right)+2\sin\left(3\frac{\omega}{2}\right)}{\omega}\right\}$

(d) None of these

53. Box A contain 6 red, 4 blue balls. Box B contain 3 red & 7 Blue balls. Two balls are drawn at random been box A and placed in box B. Now, a box is selected at random from box B. The probability that it is a blue ball is

(a) 0.5 (b) 0.45 (c) 0.65 (d) 0.75

54. A 3-phase, star-connected, 50 Hz synchronous generator has direct-axis synchronous reactance of 0.6 pu and quadrature-axis synchronous reactance of 0.45 pu. The generator delivers rated kVA at rated voltage. If resistive drop at full-load is 0.015 pu then voltage regulation will be

(a) 44.8 % (b) 46 % (c) 49 % (d) 50%

55. Find value of 'K' for GM of 5 for a unity feedback system having open loop transfer function as

$$G(j\omega) = \frac{K}{j\omega(1+0.2j\omega)(1+0.05j\omega)}$$

❍❍❍

ANSWERS KEY

1. ***Ans. (a)***

2. ***Ans. (d)***

Let

1000 gm in = 1000 Rs.

–10% (1000 gm → 900 gm) + 10% (1000 Rs. → 1100 Rs.)

900 gm 1100 Rs.

200

$$p\% = \frac{200}{900}\times 100 = 22.22\%$$

3. ***Ans. (c)***

		1 day work	Total work
A + B	12	4	48
B + C	16	3	

A + B = 5 days (5 × 4) = 20

B + C = 2 days (2 × 3) = 6

Remaining work,

48 – 26 = 22

$$C = \frac{22}{11} = 2 \text{ (Efficiency of C)}$$

Efficiency of A = 3

$$A = \frac{48}{3} \text{ days}$$

4. ***Ans. (c)***

5. ***Ans. (c)***

	w : pulp
Fresh	17 : 8
Dry	1 × 2 : 4 × 2
Dry	2 : 8

17 + 8 = 25 unit = 75

1 unit = 3

then 10 unit

= 10 × 3

= 30 kg

6. ***Ans. (d)***

$$x = \left(\frac{16}{15}\right)\times\left(\frac{25}{24}\right)^5\times\left(\frac{81}{80}\right)^3$$

7. ***Ans. (b)***

Total expenses are = 12200

Total expenses excluding saving

12200 – 1800 = 10400

$$\text{Hence required percentage} = \frac{10400}{12200}\times 100$$

= 85.24%

8. ***Ans. (a)***

9. ***Ans. (d)***

10. ***Ans. (c)***

$$\frac{24}{B+W}+\frac{36}{B-W} = 9 \quad ...(1)$$

$$\frac{36}{B+W}+\frac{24}{B-W} = \frac{17}{2} \quad ...(2)$$

Equation (1) × 3 and equation (2) × 2

$$\frac{72}{B+W}+\frac{108}{B-W} = 27 \quad ...(3)$$

$$\frac{72}{B+W}+\frac{48}{B-W} = 17 \quad ...(4)$$

(3) – (4)

$$\frac{60}{B-W} = 10$$

B – W = 6

B + W = 8

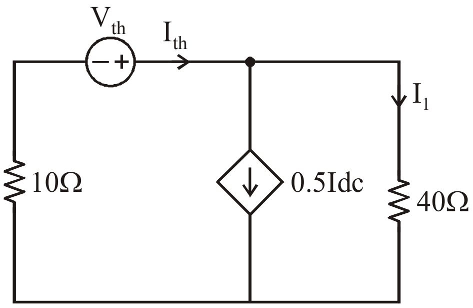
B = 7 km/hr

00000000000000

1. ***Ans.*** **(b)**

$I(0) = 6\text{Amp}$, $I_L(\infty) = 0$

for R_{eq}



Applying KCL

$I_{dc} = 0.5\ I_{dc} + I_1$

$I_1 = 0.5\ I_{dc}$

Apply KVL

$-V_{dc} + 0.5\ I_{dc} \times 40 + I_{dc} \times 10 = 0$

$$\frac{V_{dc}}{I_{dc}} = 30\ \Omega$$

$R_{th} = 30\ \Omega$

$$\tau = \frac{L}{R_{th}} = \frac{6}{30} = \frac{1}{5}\text{sec}$$

$$I_L(t) = I_L(\infty) - [I_1(\infty) - I_1(0)]\, e^{-\frac{t}{\tau}}$$

$$I_L(t) = 6e^{-5t}\text{Amp}$$

2. ***Ans. (c)***

$$\text{Inductance per unit length} = 2\times10^{-7}\, ln\left(\frac{d}{r'}\right)$$

μ = Permeability of material

D = Distance between their centres

If d is double, L will increase but does not double.

3. ***Ans. (24)***

$x(t) = x_1(t) + x_2(t)$

$$T_1 = \frac{2\pi}{\frac{\pi}{3}} = 6,\ T_2 = \frac{2\pi}{\frac{\pi}{4}} = 8$$

$$\frac{T_1}{T_2} = \frac{6}{8} = \frac{3}{4}\ \text{Rational number}$$

x(t) is periodic, fundamental period

$T_0 = 4T_1 = 3T_2 = 24$ sec

4. ***Ans.*** **(b)**

$$\frac{dy}{dx} = \tan(6x + 3y + 5) - 2$$

Put $6x + 3y + 5 = t$

$$\Rightarrow\ 6 + \frac{3dy}{dx} = \frac{dt}{dx}$$

$$\frac{dt}{dx} = 3\tan(t)$$

$$\int \cot(t)dt = \int 3dx$$

$\ln[\sin t] = 3x + c$

$\ln[\sin(6x + 3y +5)] = 3x + c$

$\sin(6x + 3y + 5) = e^c e^{3x} = Ae^{3x}$

5. ***Ans. (1.20 to 1.30)***

$$\frac{\text{Starting torque}}{\text{Full load torque}} = \left(\frac{I_{st}}{I_{fl}}\right)^2 s_{fl}$$

$$= 5^2 \times 0.05 = 1.25$$

6. ***Ans.*** **(1)**

S^6	1	5	2	–8
S^5	1	3	-4	
S^4	2	6	-8	
S^3	8	12	Auxiliary eq $=\frac{d}{ds}(2s^4+6s^2-8)=8s^3+12s$	
S^2	3	-8		
S^1	$\frac{100}{3}$			
S^0	-8	⟶ Single pole in RHS.		

7. ***Ans (44 to 45)***

Gate pulse width is given as

$$T = \frac{\text{Duty cycle}}{\text{Triggering frequency}}$$

$$T = \frac{0.1}{400} = 250\ \mu s$$

As T > 100 μs So, D.C. data is given

$$V_G I_G = 0.5 \text{ watt}$$

$$(0.5 + 8 I_G)I_G = 0.5$$

$$8 I_G^2 + 0.5 I_G - 0.5 = 0$$

$$\boxed{I_G = 0.22 \text{ Amp}}$$

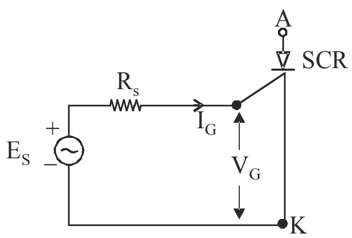
During the pulse –ON period

$$E_S = R_S I_G + V_G$$

$$12 = R_S I_G + (0.5 + 8I_G)$$

$$12 = R_S I_G + (0.5 + 8 \times 0.22)$$

$$12 = R_S \times 0.22 + 2.26$$



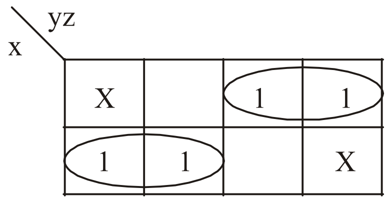
(a) Circuit Diagram

$$R_S = \frac{12 - 2.26}{0.22} = \frac{9.74}{0.22}$$

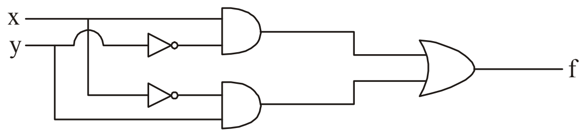
$$R_S = 44.27\ \Omega.$$

8. ***Ans. (14)***

x	y	z	f
0	0	0	x
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	x



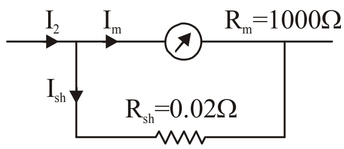
$$f = x\bar{y} + \bar{x}y$$



$$\text{Total price} = 2 \times 2 + 3 \times 2 + 4$$

$$= 14 \text{ Rs}$$

9. ***Ans. (c)***



$$V_m = V_{sh}$$

$$V_m = 500\text{mV}$$

$$I_{sh} = \frac{V_m}{R_{sh}} = \frac{500 \times 10^{-3}}{0.02}$$

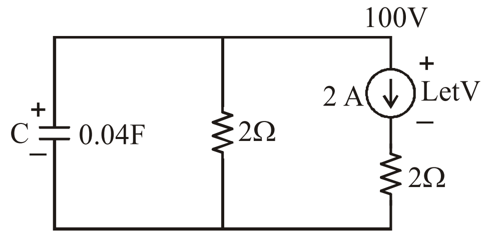
$$I_{sh} = 25\text{A}$$

10. ***Ans.* (c)**

From the graph it is given that at t = 4 μsec charge Q = 4 coulomb.

$$\because \quad Q = CV$$

$$V = \frac{Q}{C} = \frac{4}{0.04} = 100 \text{ V}$$



$$-100 + V + 2 \times 2 = 0$$

$$-96 + V = 0$$

$$V = 96 \text{ Volt}$$

Power absorb = 96×2

= 192 watt

11. ***Ans. (a)***

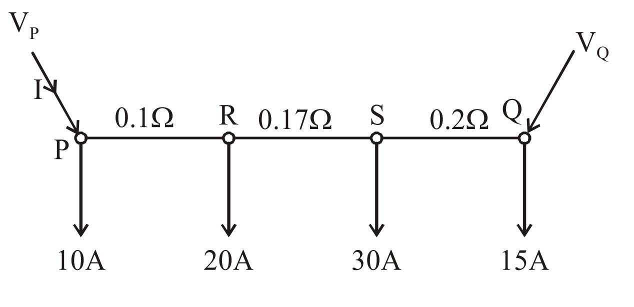
12. ***Ans. (d)***

In case of memory mapped I/O → I/O devices are treated as memory locations having 16 bit address.

So microprocessor having 16 bit address line can address 2^{16} memory location and I/O devices.

2^{16} memory locations = $2^6 \times 2^{10}$ = 64 K memory locations.

13. ***Ans. (225 to 226)***



Let, V_D be the drop of voltage in line.

Applying kVL

$$V_P - V_D - V_Q = 0$$

$$V_p - V_Q = V_D$$

or $V_D = V_P - V_Q = 4 \text{ V}$

But $V_D = (I - 10)\ 0.1 + (I - 30)\ 0.17 + (I - 60)\ 0.2$

$$4 = 0.47\ I - 18.1$$

or $22.1 = 0.47I$

or $I = \dfrac{22.1}{0.47} = 47.02 \text{ A}$

$\therefore$ $V_D = (37.02 \times 0.1) + (17.02 \times 0.17) + (12.98 \times 0.2)$

$V_D = 9.19 \text{ V}$

$\therefore$ $V_p = 220 + 9.19 = 229.19 \text{ V}$

$\therefore$ $V_Q = V_P - 4 = 229.19 - 4 = 225.19 \text{ V}$

14. ***Ans. (b)***

$\log[(1 + i)\log i]$

$\because$ $\log(x + iy) = \log\left(\sqrt{x^2 + y^2}\right) + i\tan^{-1}\left(\dfrac{y}{x}\right)$

$$= \log\left[(1+i)\left\{\log(1) + i\tan^{-1}\left(\frac{1}{0}\right)\right\}\right]$$

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

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

$$= \log\left[i\frac{\pi}{2} - \frac{\pi}{2}\right]$$

$$= \log\left[\sqrt{\frac{\pi^2}{4} + \frac{\pi^2}{4}}\right] + i\tan^{-1}\left(\frac{\frac{\pi}{2}}{-\frac{\pi}{2}}\right)$$

$$= \log\left(\frac{\pi}{\sqrt{2}}\right) + \left(\pi - \frac{\pi}{4}\right)$$

$$= \log\left(\frac{\pi}{\sqrt{2}}\right) + \frac{3\pi}{4}$$

15. ***Ans. (b)***

$$I_{c(sat)} = \frac{V_{cc} - V_{sat}}{R_c} = \frac{7-1}{2k} = 3\text{ mA}$$

$$P_V = I_{c(sat)} V_{CE(sat)} \times \frac{T_{ON}}{T}$$

$T_{ON} = 0.2$ msec.

time period T = 1 msec.

$$= 1 \times 3 \times \frac{0.2}{1} = 0.6\text{ m Watt}$$

16. ***Ans. (d)***

When a balanced 3-Phase distributed type armature winding is carrying 3-phase balanced currents, then the pulsating mmf produced in each phase is.

$F_a = F_m(\cos\alpha\cos\omega t)$

$F_b = F_m \cos(\alpha - 120°)\cos(\omega t - 120°)$

$F_c = F_m \cos(\alpha - 240°)\cos(\omega t - 240°)$

Then resultant mmf is given

$$F_R = F_a + F_b + F_c = \frac{3}{2}F_m \cos(\alpha - wt)$$

So the strength of the resultant rotating magnetic field is one and a half $\left(1\frac{1}{2} = \frac{3}{2}\right)$ times the amplitude (F_m) of each constituent pulsating magnetic field.

17. ***Ans.*** **(c)**

$$\frac{1}{R_{eq}} = \frac{1}{32R} + \frac{1}{16R} + \frac{1}{8R}$$

$$R_{eq} = \frac{32R}{7}\ \Omega \qquad \ldots(1)$$

Equivalent resistance of figure (2)

$$\frac{1}{R_{eq_2}} = \frac{1}{4R} + \frac{1}{2R} + \frac{1}{R}$$

$$\frac{1}{R_{eq_2}} = \frac{7}{4R}$$

$$R_{eq_2} = \frac{4R}{7}\ \Omega$$

$$R_{eq_2} = R_0 + \frac{4R}{7}\ \Omega$$

…(2)

Since the current is both figure is some and voltage source is same hence equivalent resistance must be same

$$R_0 + \frac{4R}{7} = \frac{32R}{7}$$

$$R_0 = 4R\Omega$$

18. ***Ans. (b)***

Standard cell e.m.f = 1.18V

And balanced at 600 mm

∴ Working current

$$I_w = \frac{1.18V}{600 \times 10^{-3}}$$

I_w = 1.967 × 10–3 A

Test cell balanced at 680 mm

680 × I_w = test cell voltage (v).

∴ $V = 680 \times 1.96 \times 10^{-3} = 1.34V$

19. ***Ans. (10)***

Since the transformer is connected to an infinite bus, the p.u. impedance of the circuit will be 0.05. i.e. the p.u. impedance offered by the transformer and voltage is also 1 pu.

$$\text{Short circuit MVA} = \frac{1}{X_{pu}} \times \text{System MVA}$$

$$\text{Short circuit MVA} = \frac{0.5}{0.05}$$

= 10 MVA

20. ***Ans. (b)***

$$\phi = xy^2 + 4xyz + z^2$$

$$\nabla\phi = (y^2 + 4yz)\hat{i} + (2xy + 4xz)\hat{j} + (4xy + 2z)\hat{k}$$

$$(\nabla\phi)_{1,2,3} = 28\hat{i} + 16\hat{j} + 14\hat{k}$$

$$\text{D.D.} = (\nabla\phi)\cdot\hat{a} = (\nabla\phi)\cdot\frac{\vec{a}}{|\vec{a}|}$$

$$= (28\hat{i} + 16\hat{j} + 14\hat{k})\cdot\frac{(3\hat{i} + 4\hat{j} - 5\hat{k})}{\sqrt{3^2 + 4^2 + 5^2}}$$

$$= \frac{78}{7.071} = 11.03$$

21. ***Ans.*** **[4.5 to 5.0]**

$$x(t) = \frac{1}{2\pi}\int_{-\infty}^{\infty} X(j\omega)e^{j\omega t}d\omega$$

$$x(t)_{t=0} = \frac{\text{Area}}{2\pi}$$

$$= \frac{\text{sum of parallel sides} \times \text{height}}{2 \times 2\pi}$$

$$= \frac{6 \times 10}{2 \times 2\pi} = \frac{15}{\pi}$$

22. ***Ans.*** **(c)**

$$I = \int_0^{\infty} x^{1/3}e^{-x^2}dx$$

Put $\quad x^2 = y \text{ or } x = y^{1/2}$

$$dx = \frac{1}{2}y^{-\frac{1}{2}}dx$$

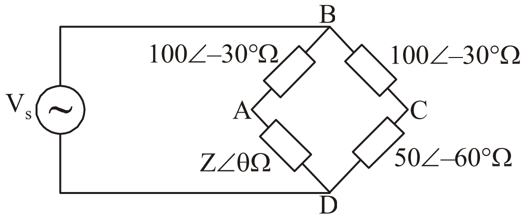
$$I = \frac{1}{2}\int_0^{\infty} y^{\frac{1}{6}}y^{-\frac{1}{2}}e^{-y}dy$$

$$I = \frac{1}{2}\int_0^{\infty} y^{-\frac{1}{3}}e^{-y}dy$$

$$= \frac{1}{2}\int_0^{\infty} y^{\frac{2}{3}-1}e^{-y}dy$$

$$= \frac{1}{2}\Gamma\left(\frac{2}{3}\right)$$

23. ***Ans.*** ***(a)***



$$Z_{DA} \times 100\angle{-30} = 100\angle 30 \times 50\angle{-60}$$

$$Z_{DA} = \frac{100\angle 30 \times 50\angle -60}{100\angle -30}$$

$$Z_{DA} = 50\angle 0^\circ\Omega$$

24. ***Ans.*** ***(a)***

$$\frac{C(s)}{R(s)} = \frac{G(s)}{1 + G(s)H(s)}$$

$$= \frac{k}{s^2 + as + k}$$

$$\omega_n = \sqrt{k}$$

and $\quad 2\xi\omega_n = a$

or $\quad \xi = \frac{a}{2\sqrt{k}}$

$$M_r = \frac{1}{2\xi\sqrt{1-\xi^2}}$$

$$1.04 = \frac{1}{2\xi\sqrt{1-\xi^2}}$$

$$\xi = 0.77 \text{ or } 0.632$$

If $\xi > 0.77$, there is no resonant peak, therefore $\xi = 0.77$ is neglected.

Also $\quad \omega_r = \omega_n\sqrt{1 - 2\xi^2}$

$$11.55 = \omega_n\sqrt{1 - 2 \times 0.632^2}$$

$$\omega_n = 25.75 \text{ rad/sec}$$

$$\omega_n = \sqrt{k}$$

$\therefore \quad 25.75 = \sqrt{k}$

or $\quad k = 663$

$$a = 2\,\xi\,\omega_n$$
$$= 2 \times 0.632 \times 25.75$$
$$= 32.55$$

25. ***Ans.* (d)**

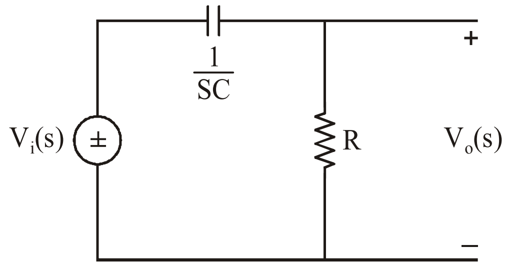
$$(D^2 + D - 6)y = 5e^{-3x}$$

$$\text{P.I.} = \frac{1}{f(D)}Q = \frac{1}{(D^2 + D - 6)}(5e^{-3x})$$

$$= \frac{x}{(2D+1)}5e^{-3x}$$

$$= -xe^{-3x}$$

26. ***Ans.* (.002)**



$$V_0(s) = \frac{R}{R + \frac{1}{SC}} \cdot V_i(s)$$

$$V_0(s) = \frac{R}{\frac{RSC+1}{SC}} \cdot V_i(s)$$

$$V_0(s) = \frac{RSC}{RSC+1} \cdot \frac{1}{S^2}$$

$$V_0(s) = \frac{RS}{(RSC+1)} \cdot \frac{1}{S}$$

$$V_0(s) = \frac{1}{\left[S + \frac{1}{RC}\right]} \cdot \frac{1}{S}$$

$$V_0(s) = \frac{1}{S\left[S + \frac{1}{RC}\right]} = \frac{a_0}{S} + \frac{a_1}{\frac{1}{RC}}$$

$$a_0 = \left.\frac{1}{S + \frac{1}{RC}}\right|_{S=0} = RC$$

$$a_1 = \left.\frac{1}{S}\right|_{S=\frac{-1}{RC}} = -RC$$

$$V_0(s) = \frac{RC}{S} + \frac{-RC}{\left[S + \frac{1}{RC}\right]}$$

Taking inverse laplace

$$V_0(t) = RCV(t) - RCe^{-\frac{1}{RC}\cdot t} \cdot V(t)$$

$$V_0(t) = RC\left(1 - e^{-\frac{t}{RC}}\right)V(t)$$

Steady state $t \to \infty$

$$V_0(t = \infty) = RC = 2 \times 10^3 \times 1 \times 10^{-6}$$
$$= 0.002 \text{ V}$$

27. ***Ans.* *(a)***

V_i is positive, output of OPAMP is negative, D_2 is off and D_1 is ON

$$V_0 = 0$$

V_i is negative, output of OPAMP is positive D_1 is off, D_2 is ON

$$V_0 = V_{in}$$

28. ***Ans.* *(30)***

In look ahead carry, sum appear after 4 logic gate delay (2 Ex–OR gate delay, 1 AND gate delay and 1 OR gate delay)

$\therefore$ Total delay = 10 + 10 + 5 + 5

= 30 msec

29. ***Ans. (0.42 to 0.48)***

By per unit method

$$S_b = 10 \text{ MVA}, \ V_b = 11 \text{ kV}$$

$$V_{pu} = \frac{V_1}{V_b} = \frac{10.5}{11}$$

$$S_{pu} = \frac{S_{3\phi}}{(S_b)_{3\phi}} = \frac{10}{12}$$

Current in per wait, $I_{pu} = \frac{S_{pu}}{V_{pu}} = \frac{10}{12} \times \frac{11}{10.5}$

= 0.8730158

Per unit impedance of the line,

$$Z_{pu} = Z_{\Omega} \frac{[(\text{MVA})_b]_{3\phi}}{(\text{kV})_b^2}$$

$$= Z_{\Omega} \frac{(S_b)_{3\phi}}{V_b^2} = 5 \times \frac{12}{(11)^2}$$

= 0.4958677

Voltage drop in the line per phase in per unit

$V_{pu} = Z_{pu} \times I_{pu}$ = 0.4958677 × 0.8730158

= 0.4329 pu

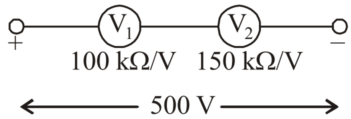
30. ***Ans.*** **(*97.30 to 97.70*)**

Iron loss of each transformer $W_{(i)}$ = 2 kW

Full load copper losses of each transformer $W_{cu} = 3$ kW

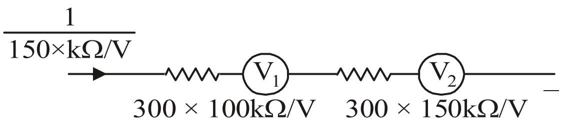
$$\therefore \ \eta = \frac{200\text{k} \times 1}{200\text{k} \times 1 + 2\text{k} + 3\text{k}} \times 100 = 97.56\%$$

31. ***Ans. (b)***



In series current should be same, minimum meter full scale reading should be allowed,

$\therefore$ meter having 150 kΩ/V will have small full scale reading $\left(I \propto \frac{1}{\text{sensitivity}}\right)$ so, meter V_2 will read 300V, and remaining voltage will be read by vi.i.e., V_1 = 200V



V_1 = 200 V, V_2 = 300 V

32. ***Ans. (0.85 to 0.90)***

for the increasing input voltage; $(V_0 = +10\text{V})$

$\therefore$ Triggering voltage using superposition theorem

$$= \frac{47}{48} \times 0.7 + \frac{1}{48} \times 10 = 0.893 \text{ V}$$

33. ***Ans.*** **(1)**

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

It has singularities at $z = \frac{2 \pm \sqrt{4-8}}{2}$

$$z = \frac{2 \pm 2i}{2} = 1 \pm i$$

$$\text{Res}[f(z)]_{z=i+i} = \lim_{z \to (1+i)} [(z-1-i)]f(z)]$$

$$= \lim_{z\to(1+i)}\left[\frac{z^2}{z-1+i}\right] = \frac{(1+i)^2}{2i}$$

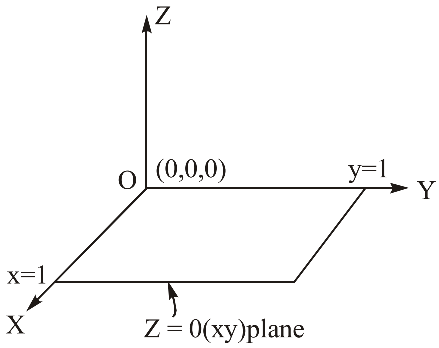
$$\text{Res}[f(z)]_{z=1-e} = \lim_{z\to(1-i)}[(z-1+i)f(z)]$$

$$= \lim_{z\to(1-e)}\left[\frac{z^2}{z-1-i}\right] = \frac{(i-e)^2}{-2i} = 1$$

$$\text{Res}[f(z)]_{z=i+i} = \text{Res}[f(z)]_{z=1-i} = 1$$

34. ***Ans. (4)***

Magnetic field intensity, $\vec{H} = -4y^3\hat{a}_x$ A/m As per the given data closed path (open surface) is defined in Z = 0 plane, is shown in fig.



Current, I passing through Z = 0 (xy) plane is given by $I = \int_S \vec{J}\cdot d\vec{s}$

$$d\vec{s} = dxdy\hat{a}_z \quad (\because Z = 0 \text{ plane})$$

$$\vec{J} = \Delta\times\vec{H}$$

$$= \begin{vmatrix} \hat{a}_x & \hat{a}_y & \hat{a}_z \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ -4y^3 & 0 & 0 \end{vmatrix} = 12y^2\hat{a}_z \text{A/m}^2$$

$\therefore$ Current passing through the plane is given by

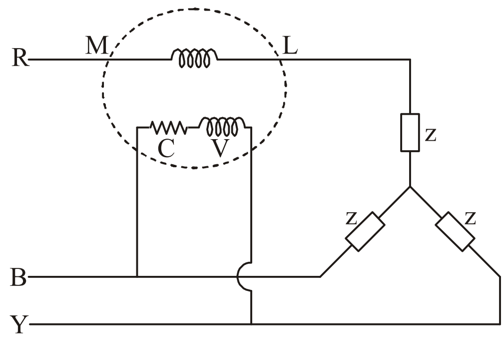
$$I = \int_{x=0}^{1}\int_{y=0}^{1} 12y^2 dxdy = 12\left.\frac{y^3}{3}\right|_0^1 \left.x\right|_0^1$$

$$= \frac{12}{3} = 4\,\text{Amp}$$

35. ***Ans. (50)***

36. ***Ans. (d)***

Reactive power measurement



$$Q = V_{BY}I_R\cos[I_R \;\&\; V_{BY}]$$

$$Q = \sqrt{3}\,V_{ph}I_{Ph}\cos[90-\phi]$$

$$= \sqrt{3}\,V_{th}I_{th}\sin\phi$$

Given $\quad Q = 0$

$\therefore \quad \sin\phi = 0$

Power factor = $\cos\phi$ = 1

37. ***Ans. (b)***

38. ***Ans.* (2)**

$$A = \begin{bmatrix} 1 & 2 & 3 & 4 \\ 2 & 1 & 4 & 5 \\ 1 & 5 & 5 & 7 \\ 8 & 1 & 14 & 17 \end{bmatrix}$$

$R_2 \to R_2 - 2R_1$

$R_3 \to R_3 - R_1$

$R_4 \to R_4 - 8R_1$

$$\approx \begin{bmatrix} 1 & 2 & 3 & 4 \\ 0 & -3 & -2 & -3 \\ 0 & 3 & 2 & 3 \\ 0 & -15 & -10 & -15 \end{bmatrix}$$

$R_3 \to R_3 + R_2$

$R_4 \to R_4 - 5R_2$

$$\approx \begin{bmatrix} 1 & 2 & 3 & 4 \\ 0 & -3 & -2 & -3 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

Above matrix is in echelon form.

Hence $\rho(A)$ = Total no. of non-zero rows in echelon form = 2

39. ***Ans.* (d)**

$2x^2 y'' + 3xy' - 3y = x^3$

Let $D = \dfrac{d}{dx}$

Then, $(2x^2 D^2 + 3xD - 3)y = x^3$ …(1)

Put, $x = e^z$ or $z = \ln x$

$xD = D_1$

$x^2D^2 = D_1 (D_1 - 1)$

Where, $D_1 = \dfrac{d}{dz}$

Equation (1) can be written as

$(2D_1(D_1 - 1) + 3D_1 - 3)y = e^{3z}$

$(2D_1^2 + D_1 - 3)y = e^{3z}$

Auxilary equation is

$2m^2 + m - 3 = 0$

$(m - 1)(2m + 3) = 0$

$m = 1, -\dfrac{3}{2}$

C.F. $= Ae^z + Be^{-3z/2}$

P.I. $= \dfrac{1}{2D_1^2 + D_1 - 3}(e^{3z}) = \dfrac{e^{3z}}{18}$

y = C.F. + P.I.

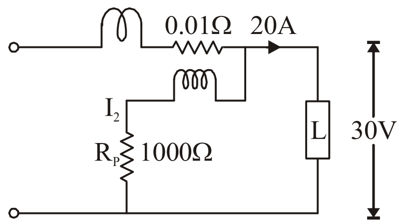
$= Ae^z + Be^{-3z/2} + \dfrac{e^{3z}}{18}$

$= Ax + \dfrac{B}{x\sqrt{x}} + \dfrac{x^3}{18}$

40. ***Ans.* (*c*)**

Generally, Wattmeters are M.C short.

For L-C short the circuit is,



The error in the wattmeter $= \dfrac{V^2}{R_p}$

$= \dfrac{30^2}{1000} \Rightarrow 0.9$ W

The true power = 30 × 20 = 600 W

The percentage error

$= \dfrac{0.9}{600} \times 100 = 0.15\%$ too high

41. ***Ans.* (*b*)**

P = 6 Transformer reactance X = 6%

$V_s = 415$ V, $I_0 = 200$ A

Voltage regulation = $\frac{2\pi f L_s I_0}{V_{m\ell}.\cos\alpha}$

$$= \left(\frac{\omega L_s}{V_{m\ell}}\right).\frac{I_0}{\cos\alpha}$$

$$= \frac{X}{V_{m\ell}}.\frac{I_0}{\cos\alpha}$$

$$= \frac{0.06\times 200}{\sqrt{2}\times 415\times 1} = 0.0212$$

42. ***Ans.* (*b*)**

The applied voltage

$$V = e = N\frac{d\phi}{dt}$$

$$d\phi = \frac{1}{N}(Vdt)$$

But V = $400\cos\omega t + 100\cos 3t$

$$\phi = \frac{1}{500}\int(400\cos\omega t + 100\cos 3\omega t)dt$$

$$= \frac{100}{500}\left[\frac{4}{\omega}\sin\omega t + \frac{1}{3\omega}\sin 3\omega t\right]$$

$$= \frac{1}{5(2\pi\times 50)}\left[4\sin\omega t + \frac{1}{3}\sin 3\omega t\right]$$

$$\phi = \frac{1000}{500\pi}\left[4\sin\omega t + \frac{1}{3}\sin 3\omega t\right]\text{mWb}$$

A plot of ϕ, as given by above equation, will indicate that the flux wave is flat topped.

Maximum value of ϕ occurs at $\omega t = 90^0$

$\therefore$ Maximum value of flux,

$$\phi_m = \frac{2}{\pi}(4\sin 90° + \frac{1}{3}\sin 270°)$$

$$\phi_m = \frac{2}{\pi}\left(4 - \frac{1}{3}\right) = 2.334 \text{ mWb}$$

43. ***Ans.* (b)**

$$f(z) = \frac{e^z}{z - \sin z}$$

$$e^z = 1 + z + \frac{z^2}{\lfloor 2} + \frac{z^3}{\lfloor 3} + \ldots\ldots$$

$$\sin z = z - \frac{z^3}{\lfloor 3} + \frac{z^5}{\lfloor 5}\ldots\ldots$$

$$z - \sin z = \frac{z^3}{\lfloor 3} - \frac{z^5}{\lfloor 5} + \ldots\ldots$$

$$= \frac{z^3}{\lfloor 3}\left(1 - \frac{z^2}{20} + \ldots\ldots\right)$$

$$\frac{e^z}{z - \sin z} = \left(1 + z + \frac{z^2}{\lfloor 2} + \ldots\right)\frac{6}{z^3}\left(1 - \frac{z^2}{20} + \ldots\right)^{-1}$$

$$= \frac{6}{z^3}\left(1 + z + \frac{z^2}{2} + \frac{z^3}{6} + \ldots\right)\left(1 + \frac{z^2}{20} + \ldots\right)$$

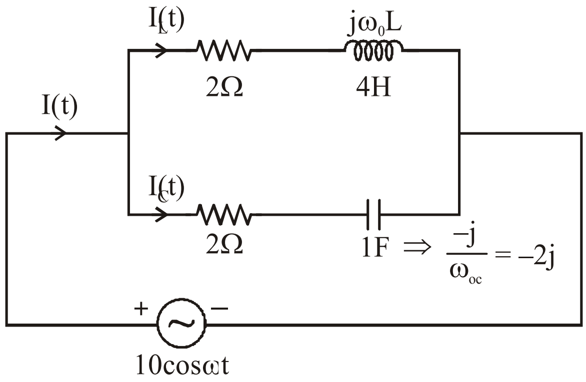
$$= \frac{6}{z^3}\left(1 + z + \frac{11z^2}{20} + \frac{13z^3}{60} + \ldots\right)$$

$$f(z) = \underbrace{\frac{6}{z^3} + \frac{6}{z^2} + \frac{33}{10z}}_{\text{Principal Part}} + \underbrace{\frac{13}{10} + \ldots\ldots}_{\text{analytic part}}$$

$\Rightarrow$ z = 0 is pole of order "3"

44. ***Ans.* (*b*)**

45. ***Ans.* (d)**



Here $R^2 = \frac{L}{C} \Rightarrow (2)^2 = \frac{4}{1}$

$4 = 4$

ω_0 is independent

$$\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{4\times1}} = 0.5 \text{ Rad/sec.}$$

$V_0 = \frac{1}{R}$ and $Z_0 = R = 2\Omega$

$$I(t) = \frac{V(t)}{Z} = \frac{10\cos\omega_0 t}{2}$$

$$I(t) = 5\cos 0.5t$$

$$I(t) = 5\cos\frac{t}{2}$$

$$I_L(t) = \frac{I(t)(2-2j)}{2-\cancel{2j}+2+\cancel{2j}} \text{ By using}$$

$$I_L(t) = \frac{(1-j)}{2} I(t)$$

$$I_L(t) = \frac{\sqrt{1+1}}{2}\angle -45^\circ I(t)$$

$$I_L(t) = \frac{1}{\sqrt{2}}\angle -45^\circ \times I(t)$$

$$I_L(t) = \frac{1}{\sqrt{2}}\angle -45^\circ \times 5\cos\frac{t}{2}$$

$$I_L(t) = \frac{5}{\sqrt{2}}\cos\left(\frac{t}{2} - 45^\circ\right)$$

Similarly

$$I_L(t) = \frac{5}{\sqrt{2}}\cos\left(\frac{t}{2} + 45^\circ\right)$$

$$P_{total} = I_L^2(t)_{rms}.R + I_L(t)^2_{rms}R$$

$$= \left(\frac{5}{\sqrt{2}\times\sqrt{2}}\right)^2 \cdot 2 + \left(\frac{5}{\sqrt{2}\times\sqrt{2}}\right)^2 \times 2$$

$$= \frac{25}{4}\times 2 + \frac{25}{4}\times 2$$

$$= \frac{25}{2} + \frac{25}{2} = \frac{50}{2} = 25 \text{ W}$$

$$P_{total} = 50 \text{ W}$$

46. ***Ans. (a)***

A = 05 H
B = 02 H
A + B = 07 H
B = B − 1 = 01 H
Z = 0

Loop execute if Z = 1 (Set)
0 time loop will be execute

47. ***Ans.*** **(d)**

S is a surface of the sphere, enclosing a volume therefore Gauss divergence theorem is applicable.

$$\iint_S \vec{A}\cdot\vec{ds} = \iiint_V \left(\text{div}\vec{A}\right)dV$$

$$\Rightarrow \iiint_V \left(\frac{\hat{i}\partial}{\partial x} + \frac{\hat{j}\partial}{\partial y} + \frac{\hat{k}\partial}{\partial z}\right)\left(x^3\hat{i} + y^3\hat{j} + z^3\hat{k}\right)dV$$

$$\Rightarrow \iiint_V \left(3x^2+3y^2+3z^2\right)dV$$

$$\Rightarrow 3\iiint \left(x^2+y^2+z^2\right)dV$$

In spherical system

$$x = r\sin\theta\cos\phi\,;\; y = r\sin\theta\sin\phi$$

$$z = r\cos\theta$$

$$dV = r^2\sin\theta\, dr\, d\theta\, d\phi$$

$3\iiint_V r^2\left(r^2\sin\theta\, dr\, d\theta\, d\phi\right)$ [Breaking the whole volume into 8 octant]

$$\Rightarrow 3\times 8\int_0^{\pi/2} d\phi\cdot\int_0^{\pi/2}\sin\theta\, d\theta\int_0^a r^4\cdot dr$$

$$\Rightarrow 24\times\frac{\pi}{2}\cdot\left(\cos\theta\right)\Big|_0^{\pi/2}\cdot\frac{r^5}{5}\Big|_0^a = \frac{12\pi}{5}a^5$$

48. ***Ans. (b)***

Inertia constant (H)

$$= \frac{\text{KE stored in rotor (MJ)}}{\text{MVA rating of alternator (s)}}$$

$$\text{kE stored in rotor} = \frac{1}{2}J\omega^2$$

$$\omega = \frac{2\pi N_s}{60}$$

$$\omega = \frac{2\pi\times 1500}{60}$$

$$= 157.07 \text{ rad/sec}$$

$$\text{K.E.} = \frac{1}{2}\times 27.5\times 10^3\times(157.07)^2$$

$$= 339.267 \text{ MJ}$$

$$H = \frac{339.267}{\left(\frac{400}{0.8}\right)} = 0.678\,\text{MJ/MVA}$$

49. ***Ans. (2500)***

For just continous

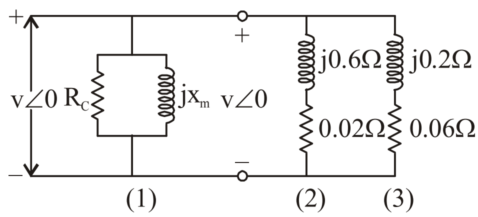
$$L = \left(\frac{1-\alpha}{2f}\right)\times R$$

$$5\times 10^{-3} = \left(\frac{1-0.6}{2\times 100\times 10^3}\right)\times R$$

$$R = 2500\,\Omega$$

50. ***Ans. (c)***

Equivalent - circuit (per ph) of the double cage motor is as shown.



(1): Magnetizing current & core losses branch.

(2): Low resistance, High reactance, inner cage.

(3): High resistance, low reactance, outer cage.

At starting, torque due to inner cage

$$T_i = \frac{3V^2(0.02)}{\omega_\delta\left[0.02^2+0.6^2\right]}$$

Torque due to outer cage

$$T_0 = \frac{3V^2(0.06)}{\omega_\delta\left[0.06^2+0.2^2\right]}$$

$$\frac{\text{Torque due to outer cage}}{\text{Torque due to inner cage}} = \frac{0.06(0.02^2+0.6^2)}{(0.06^2+0.2^2)(0.02)}$$

$$= 3\times\frac{0.3604}{0.0436}$$

$$= 24.8$$

51. ***Ans. (45 to 46)***

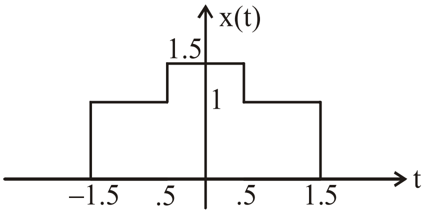
For 1-ϕ, full converter

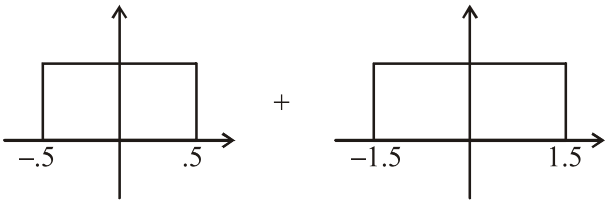
Output voltage (V_0) = $\frac{2V_m}{\pi}\cos\alpha = E + I_0R$

$$\frac{2\times\sqrt{2}\times 230}{\pi}\cos\alpha = 70 + (5 \times 15)$$

$$\alpha = 45.55°$$

52. ***Ans. (a)***





$$X_1(\omega) = \left(2\sin\frac{\omega}{2} + 2\sin 3\frac{\omega}{2}\right)$$

$$X(\omega) = X_1(\omega)e^{-\frac{j5\omega}{2}}$$

$$= e^{-j\omega 5/2}\left[\sin\frac{\omega}{2} + 2\sin\frac{3\omega}{2}\right]$$

53. ***Ans. (c)***

Two balls are down from box A

i.e. (2 red) or (2 blue) or (1 red & 1 blue)

Let E_1 = event of drawing 2 red balls from box A

E_2 = event of drawing 2 blue balls from box A

E_3 = event of drawing 1 red & 1 blue balls from A

$$P(E_1) = \frac{6_{C_2}}{10_{C_2}} = \frac{1}{3}$$

$$P(E_2) = \frac{4_{C_2}}{10_{C_2}} = \frac{2}{15}$$

$$P(E_3) = \frac{6_{C_1}\times 4_{C_1}}{10_{C_2}} = \frac{8}{15}$$

Let B = event of drawing blue ball from box B.

$P(B) = P(B\cap E_1) + P(B\cap E_2) + P(B\cap E_3)$

$$= P(E_1)P\left(\frac{B}{E_1}\right) + P(E_2)P\left(\frac{B}{E_2}\right) + P(E_3)P\left(\frac{B}{E_3}\right)$$

$$= \left(\frac{1}{3}\times\frac{7}{12}\right) + \left(\frac{2}{15}\times\frac{9}{12}\right) + \left(\frac{8}{15}\times\frac{8}{12}\right) = 0.65$$

54. ***Ans. (a)***

$$\tan\psi = \frac{V\sin\phi + I_aX_q}{V\cos\phi + I_aR_a}$$

$$= \frac{1\times 0.6 + 1\times 0.45}{1\times 0.8 + 1\times 0.015} = 1.288\ ;$$

$$\psi = 52.2°$$

$$\delta = \psi - \phi = 52.2° - 36.9° = 15.3°$$

$$I_d = I_a\sin\psi = 1\times 0.79 = 0.79A$$

$$I_q = I_a\cos\psi = 1\times 0.61 = 0.61A$$

$$E_o = V\cos\delta + I_qR_a + I_dX_d$$

$$= 1\times 0.965 + 0.61\times 0.015 + 0.79\times 0.6$$

$$= 1.448 \text{ pu}$$

$$= \%\text{ regulation} = \frac{1.448 - 1}{1}\times 100 = 44.8\%$$

55. ***Ans.*** **(5)**

$$GM = 5$$

$$\Rightarrow |G(j\omega)|_{\omega pc} = \frac{1}{5}$$

at ω_{pc}

$$\angle G(j\omega)_{\omega pc} = -180°$$

$$= -90° - \tan^{-1}(0.2\omega) - \tan^{-1}(0.05\omega)$$

$$\Rightarrow \tan^{-1}(0.2\omega) + \tan^{-1}(0.05\omega) = 90$$

Taking 'tan' of above equation

$$\frac{0.2\omega + 0.05\omega}{1 - 0.2\omega \times 0.05\omega} = \infty$$

$$= 1 - \frac{\omega^2 \times 10}{1000} = 0$$

$$\Rightarrow \omega^2 = 100$$

$$\omega = 10 \text{ rad/sec}$$

$$|G(j\omega)|_{\omega pc} = \frac{k}{10 \times \sqrt{\left[1^2 + 2^2\right]} \times \sqrt{1^2 + (0.5)^2}}$$

$$k = 5$$

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