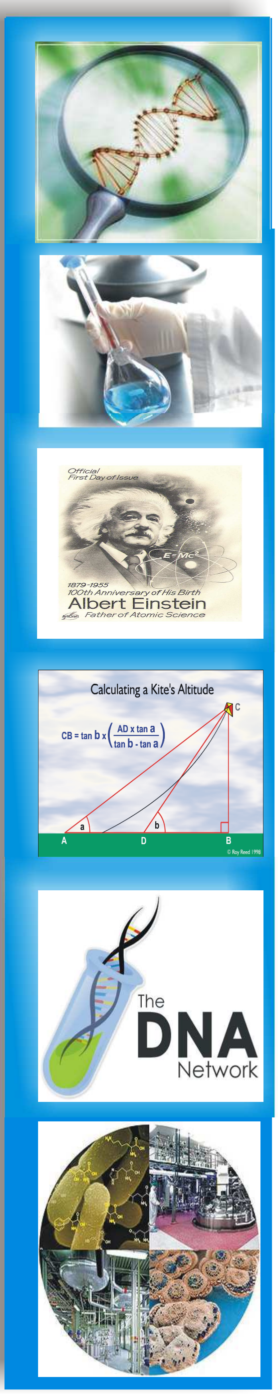

GATE - ELECTRICAL ENGINEERING

MOCK TEST PAPER

- *There are a total of 65 questions carrying 100 marks.*
- *Questions (1-25) will carry 1-mark each and questions (26-55) will carry 2-marks each.*
- *Questions (56-65) belongs to general aptitude (GA). Questions (56-60) will carry 1-mark each, and question (61-65) will carry 2-marks each*
- *For Q.1-25 and Q.56-60 1/3 mark will be deducted for each wrong answer.For Q.26-51 and Q. 61-65 2/3 mark will be deducted for each wrong answer. The question pairs (Q.52, Q.53) and (Q.54, Q.55) are linked questions.For Q.52 &54 2/3 mark will be deducted. There is no negative marking for Q.53 &Q.55.*
- *Q.48-51 are common data questions. If first question is attempted wrongly then answer of second question will not be evaluated.*
- *Pattern of questions : MCQs & Numerical*
- *Total marks : 100*
- *Duration of test : 3 Hours*

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Q 1-25 (1 MARK EACH)

1. A transformer operates most efficiently at 3/4th full load. Its iron (P_I) and copper loss (P_{Cu}) are related as:

(A) $P_I / P_{Cu} = 16/9$

(B) $P_I / P_{Cu} = 4/3$

(C) $P_I / P_{Cu} = 3/4$

(D) $P_I / P_{Cu} = 9/16$

2. For a 4 KVA, 200/400 V, 50 Hz, 1 – phase transformer, calculate the efficiency, when supplying a full – load secondary current at 0.8 lagging power factor. The following are the test results:

Open circuit with 200 V applied to the L.V. side: 0.8 A, 70 W. Short circuit with 20 V applied to the H.V. side: 10 A, 60 W.

(A) 96.1%

(B) 76.3%

(C) 59.2%

(D) 66.7%

3. The shaft output of a three-phase 60- Hz induction motor is 80 KW. The friction and windage losses are 920 W, the stator core loss is 4300 W and the stator copper loss is 2690 W. The rotor current and rotor resistance referred to stator are respectively 110 A and 0.15 □. If the slip is 3.8%, what is the percent efficiency?

(A) 66.7%

(B) 87.81%

(C) 96.1%

(D) 78.7%

4. A 2.2 kVA, 440 / 220 V, 50 Hz, step-down transformer has the following parameters referred to the primary side : R_{e1} = 3 ohms, X_{e1} = 4 ohms, R_{c1} = 2.5K ohms and =

2Kohms . The transformer is operating at full-load with a power-factor of 0.707 lagging. Determine the voltage regulation of the transformer.

(A) 11.25%

(B) 34.30%

(C) 22.50%

(D) None of these

5. A universal motor (ac–operated) has a 2-pole armature with 960 conductors. At a certain load the motor speed is 5000 rpm and the armature current is 4.6 Amps, the armature terminal voltage and input power are respectively 100 Volts and 300 Watts. Assuming an armature resistance of 3.5 ohm.Effective armature reactance is

(A) 16.48

(B) 46.18

(C) 18.64

(D) 14.86

6. A 3-phase induction motor has a starting torque of 100% and a maximum torque of 200% of full load torque. The Slip at maximum torque will be ________.

7. An unfinished moving iron voltmeter is used to measure the voltage in an a.c. circuit .If a stray d.c. magnetic field having a component along the axis of the meter coil appears, the meter reading would be

(A) unaffected

(B) decreased

(C) increased

(D) either decreased or increased depending on the direction of the d.c. field

8. The impulse response of an R - L circuit is a

(A) rising exponential function

(B) decaying exponential function

(C) step function

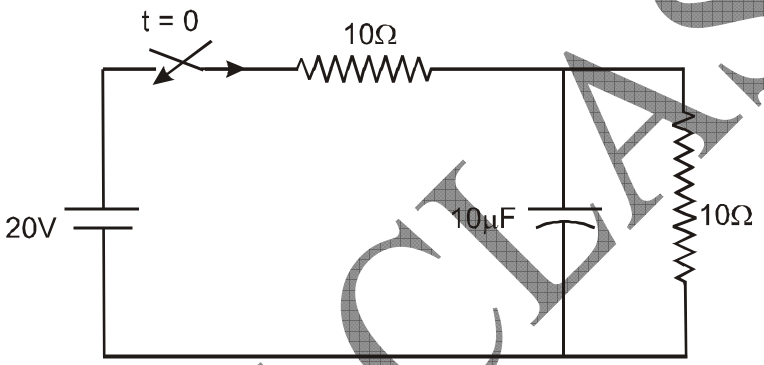
(D) parabolic function

9. Following are the value of a function

$y(x)$: $y(-1) = 5$, $y(0)$, $y(1) = 8$

$\frac{dy}{dx}$ at $x = 0$ as per Newton's central difference scheme is ________.

10. In the Figure given below, 4 the initial capacitor voltage is zero. The switch is closed at t = 0. The final steady - state voltage across the capacitor is



(A) 20V

(B) 10V

(C) 5V

(D) 0 V

11. If $S = \int_1^\infty x^{-3}dx$, then S has the value

(A) $\frac{-1}{3}$

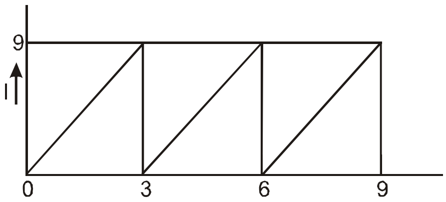
(B) $\frac{1}{4}$

(C) $\frac{1}{2}$

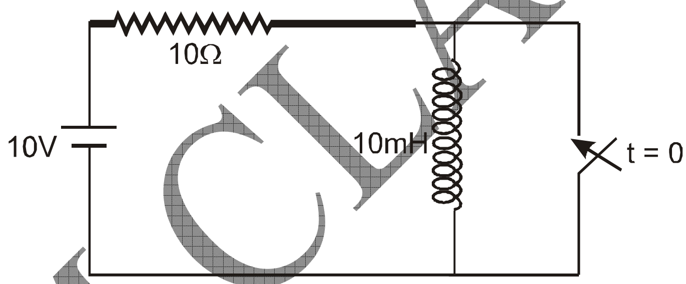
(D) 1

12. The energy stored in the magnetic field at a solenoid 30 cm long and 3 cm diameter wound with 1000 turns of wire carrying a current at 10 A, is _____ Joules.

13. The current wave from in a pure resistor at 10□ is shown in the given figure. Power dissipated in the resistor is ______ W.

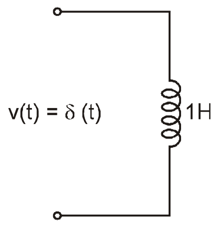


14. The circuit shown in the figure is in steady state, when the switch is closed at t = 0. Assuming that the inductance is ideal, the current through the inductor at $t = 0^+$ equals

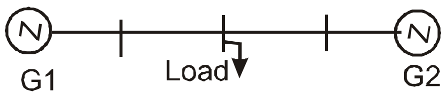


(A) 0 A
(B) 0.5 A
(C) 1 A
(D) 2 A

15. When a unit impulse voltage is applied to an inductor of 1 H, the energy supplied by the source is ________ J.



16. A load centre is at an equidistant from the two thermal generating stations G_1 and G_2 as shown in the figure. The fuel cost characteristics of the generating stations are given by



$F_1 = a + bP_1 + cP_1^2$ Rs/ hour

$F_2 = a + bP_2 + 2cP_2^2$ Rs/ hour

where P_1 and P_2, are the generation in MW of G_1 and G_2 respectively.

For most economic generation to meet 300 MW of load, P_1 and P_2 , respectively, are

(A) 150, 150

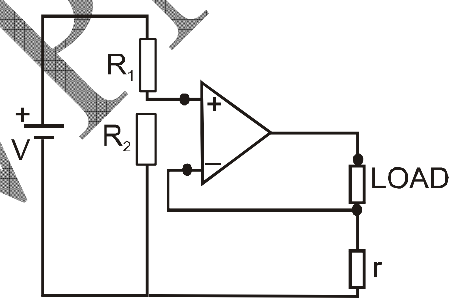
(B) 100, 200

(C) 200, 100

(D) 175, 125

17. The final value of $L^{-1}\dfrac{2s+1}{s^4+8s^3+16s^2+s}$ is _______.

18. The circuit shown in the figure is



(A) a voltage source with voltage $\frac{rV}{R_1 // R_2}$

(B) a voltage source with voltage $\frac{r // R_2}{R_1} V$

(C) a current source with current $\frac{r // R_2}{R_1 + R_2} \frac{V}{r}$

(D) a current source with current $\frac{R_2}{R_1 + R_2} \cdot \frac{V}{r}$

19. The resistance of a strip of copper of rectangular cross - section is 2Ω. A metal of resistivity twice that of copper is coated on its upper surface to a thickness equal to that of copper strip. The resistance of composite strip will be

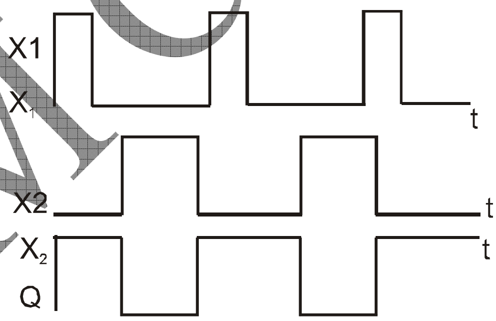
(A) 6 Ω

(B) 4/3 Ω

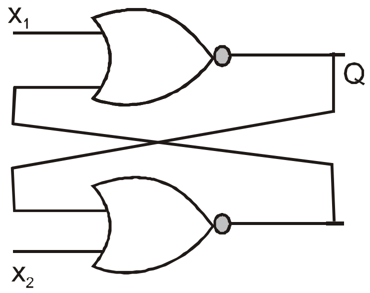
(C) 3/2 Ω

(D) 3/4 Ω

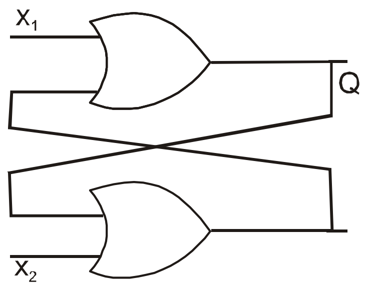
20. Select the circuit which will produce the given output Q for the input signals X1 and X2 given in the figure



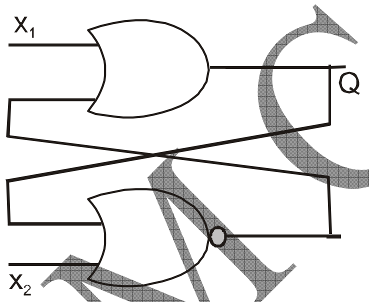
(A)



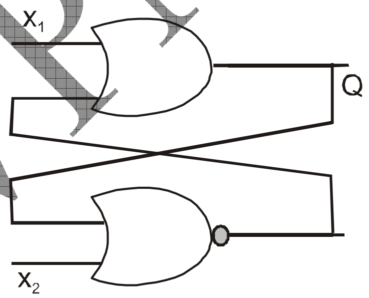
(B)



(C)



(D)



21. The current through an electrical conductor in 1 ampere when the temperature of the conductor is 0º C and 0.7 ampere when the temperature is 100ºC.The current when the temperature of the conductor is 1200º C must be

(A) 0.08 A

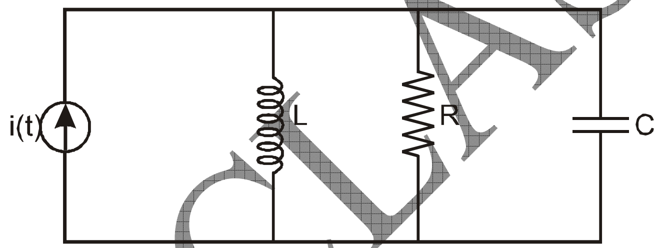
(B) 0.16 A

(C) 0.32 A

(D) 0.64 A

22. The circuit shown has i(t) = 10 sin (120 □ t). The power (time average power) dissipated in R is

$$L = \frac{1}{120}\pi H, C = \frac{1}{60}\pi H, R = 1 ohm.$$



(A) 25 watts

(B) 100 watts

(C) $\frac{10}{\sqrt{2}}$ watts

(D) 50 watts

23. The two windings of a transformer have an inductance of 2 Henrys each. If the mutual inductance between them is also 2 Henrys, then

(A) the transformer is an ideal transformer

(B) the turns ratio of the transformer is also two

(C) it is a perfect transformer

(D) none of these

24. A resistance R □and inductance of L H are connected across 240 V, Hz supply. Power dissipated in the circuit is 300 W and the voltage across R is 100 V. In order to improve the power factor to unity, the capacitor that is to be connected in series should have a value of

(A) 43.7 µF

(B) 4.37µF

(C) 437 µF

(D) 0.437 µF

25. If the product of matrix

$A = \begin{bmatrix} \cos^2\theta & \cos\theta\sin\theta \\ \cos\theta\sin\theta & \sin^2\theta \end{bmatrix}$ and

$B = \begin{bmatrix} \cos^2\phi & \cos\phi\sin\phi \\ \cos\phi\sin\phi & \sin^2\phi \end{bmatrix}$

is a null matrix , then □ and □ differ by

(A) an odd multiple of □

(B) an even multiple of □

(C) an odd multiple of □/2

(D) an even multiple of □/2

Q 26-55 (2 MARKS EACH)

26. The sum of the eigen values of the matrix $\begin{pmatrix} 3 & 4 \\ x & 1 \end{pmatrix}$ for real and negative values of x

(A) greater than zero

(B) less than zero

(C) zero

(D) dependent of the values of x

27. The value of $\int_0^{5\pi} (2-\sin x)\,dx$ is

(A) > 0

(B) 2

(C) 0

(D) undefined

28. Given $f(x, y) = x^2 + y^2$. Then $\nabla^2 f$ is

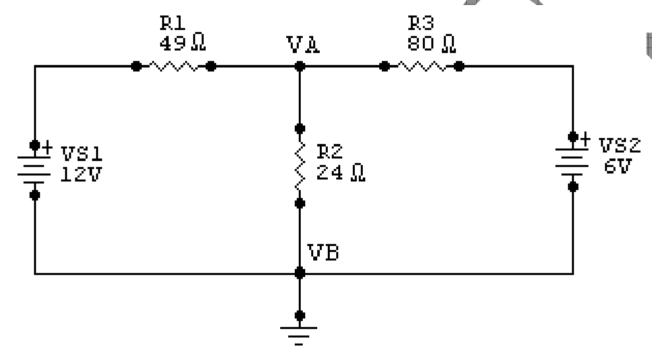
(A) 4

(B) 2

(C) 0

(D) $4(x+y)^2$

29. Find the node voltage V_A.



(A). 6 V

(B).12 V

(C). 4.28 V

(D). 3 V

30. The value of y as $t \to \infty$ for an initial value of y (1) = 0, for the differential equation $\left(4t^2+1\right)\frac{dy}{dt}+8yt-t=0$ is

(A) 1

(B) $\frac{1}{2}$

(C) $\frac{1}{4}$

(D) $\frac{1}{8}$

31. Taylor series expansion of the function,

$F(x) = \frac{x}{1+x}$ around $x = 0$ is

(A) $x + x^2 + x^3 + x^4$ ......

(B) $1 = x + x^2 + x^3 + x^4$ ....

(C) $2x + 4x^2 + 8x^3 + 16\,x^4$ ....

(D) $x - x^2 + x^3 - x^4$ ....

32. Three insulating materials with same maximum working stress and permittivities 2.5, 3.0, 4.0, are used in a single core cable. The location of the materials with respect to the core of the cable will be ____________.

33. The incremental generating costs of two generating units are given by

$IC_1 = 0.1\,X + 20$ Rs /MWhr.

$IC_2 = 0.15\,Y + 18$ Rs/ MWhr.

Where X and Y are power (in MW) generated by the two units. For a total demand of 300 MW. The values (in MW) of X and Y will be respectively _________.

34. Solving $x^2 - 2 = 0$ by Newton Raphson technique, when initial guess $x_0 = 1.0$, then subsequent estimate of x (i.e. x_1) will be

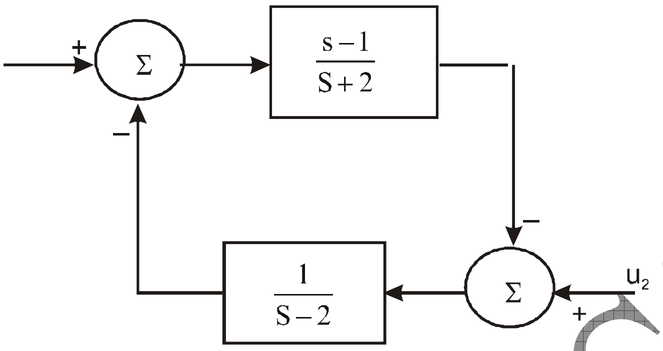
(A) 1.414

(B) 1.5

(C) 2.0

(D) none of these

35. The system shown in the figure is



(A) stable

(B) unstable

(C) conditionally stable

(D) Stable for input u_1, but unstable for input u_2

36. A single - phase fully controlled thyristor bridge ac - dc converter is operating at a firing angle 25° and an overlap angle 10° with constant dc output current of 20 A. The fundamental power factor (displacement factor) at input ac mains is

(A) 0.78

(B) 0.827

(C) 0.866

(D) 0.9

37. A three - phase , fully controlled thyristor bridge converter is used as line commutated inverter to feed 50 kW power at 420 V dc to a three - phase, 415 V (line), 50 Hz ac mains. Consider dc link current to be constant. The rms current of the thyristor is

(A) 119.05 A

(B) 79.37 A

(C) 68.73 A

(D) 39.68 A

38. In a transformer zero voltage regulation at full load is

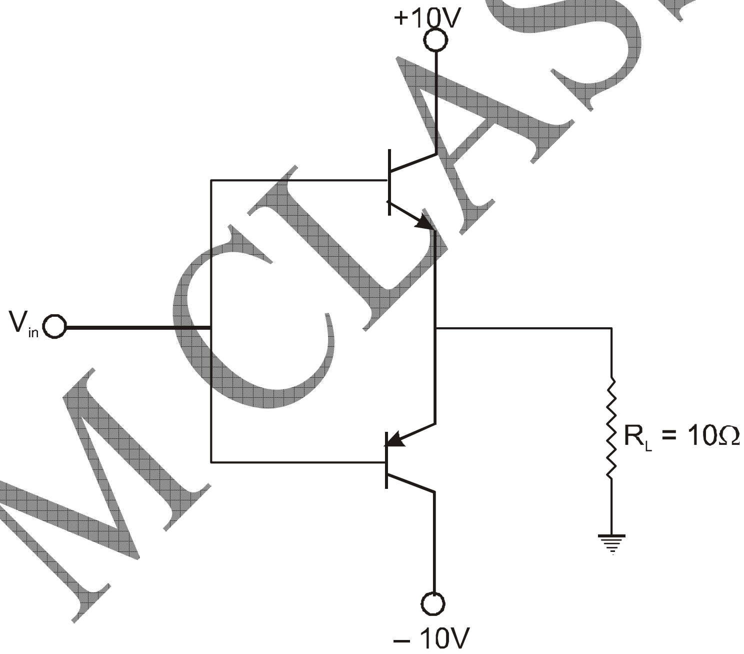
(A) not possible

(B) Possible at unity power factor load

(C) Possible at leading power factor load

(D) Possible at lagging without any controller, is

39. The input signal V_{in} shown in the figure is a 1kHz square wave voltage that alternates between + 7V and – 7V with a 50% duty cycle . Both transistors have the same current gain, which is large .The circuit delivers power to the load resistor R_L. What is the efficiency of this circuit for the given input ? Choose the closest answer.



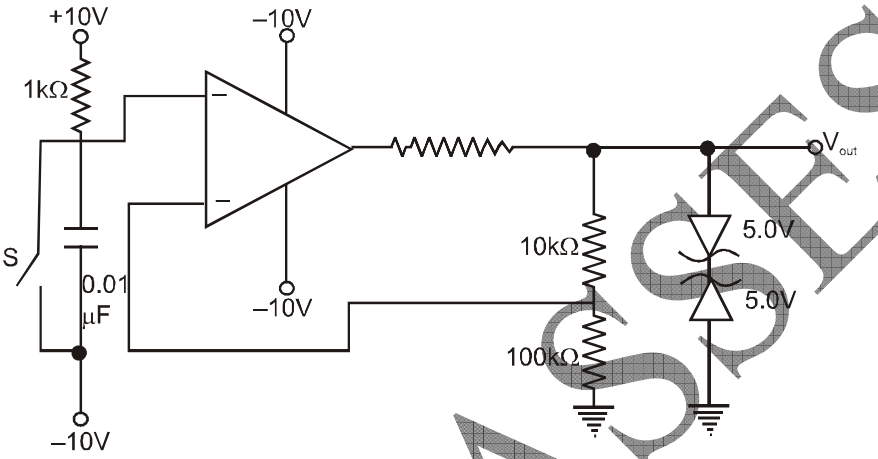
(A) 46%

(B) 55%

(C) 63 %

(D) 92%

40. The switch S is the circuit of the figure is initially closed . It is opened at time T = 0. You may neglect the Zener diode forward voltage drops. What is the behaviour of V_{out} for t > 0 ?



(A) It makes a transition from – 5V to + 5V at t = 12.98 □s.

(B) It makes a transition from – 5V to + 5V at t = 2.57 □s

(C) It makes a transition from + 5V to – 5V at t = 12.98 □s

(D) It makes a transition from + 5 V to – 5V at t = 2.57□s

41. A solid sphere made of insulating material has a radius R and has a total charge Q distributed uniformly in its volume . What is the magnitude of the electric field intensity ,E, at a distance r (0 < r < R) inside the sphere ?

(A) $\frac{1}{4\pi\varepsilon_0}\frac{Qr}{R^3}$

(B) $\frac{3}{4\pi\varepsilon_0}\frac{Qr}{R^3}$

(C) $\frac{1}{4\pi\varepsilon_0}\frac{Qr}{r^2}$

(D) $\frac{1}{4\pi\varepsilon_0}\frac{Qr}{r^3}$

42. Two wattmeters, which are connected to measure the total power on a three - phase system supplying a balanced load, read 10.5 kW and –2.5 kW, respectively, The power and the power factor, respectively, are

(A) 13.0 kW, 0.334

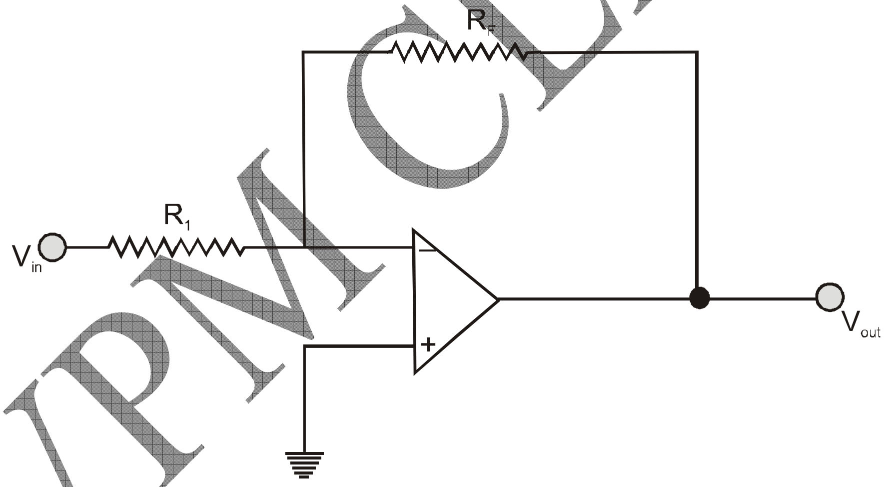
(B) 13.0 kW, 0.684

(C) 8.0kW, 0.52

(D) 8.0kW, 0.334

43. If a dc voltmeter is made from an ammeter having a full - scale deflection of 100 micro amperes, then its sensitivity (in k - ohm. (V) will be ________.

44. Consider the inverting amplifier, using an ideal operational amplifier shown in the figure. The designer wishes to realize the input resistance seen by the small - signal source to be as large as possible, while keeping the voltage gain between - 10 and – 25 . The upper limit on R_F is 1 M□. The value of R_1 should be



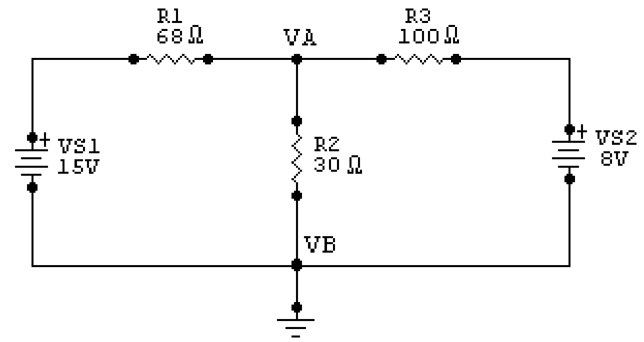
(A) Infinity

(B) 1 M□

(C) 100 k□

(D) 40 k□

45. What is the current through R_2?



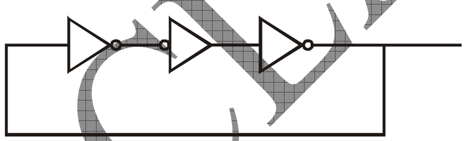
(A) 3.19 A

(B) 319 mA

(C) 1.73 A

(D) 172 mA

46. The circuit shown in the figure



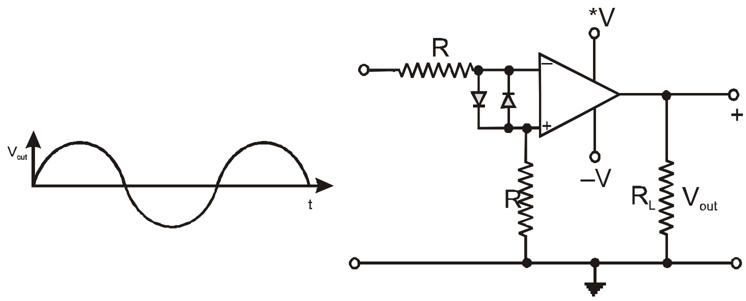
(A) is an oscillating circuit and its output is a square wave

(B) is one hose output remains stable in ‘1’ state

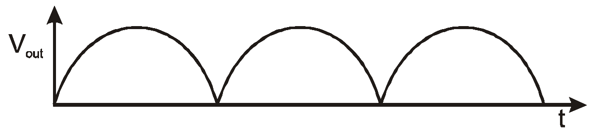
(C) is one having output remains stable in ‘0’ state

(D) having a single pulse of 3 time propagation delay.

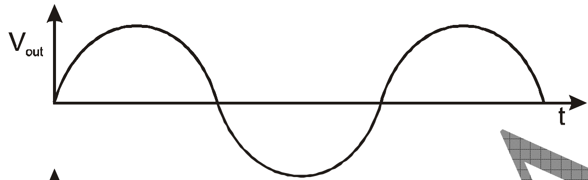
47. In the given figure, if the input is a sinusoidal signal, the output will appear as shown in



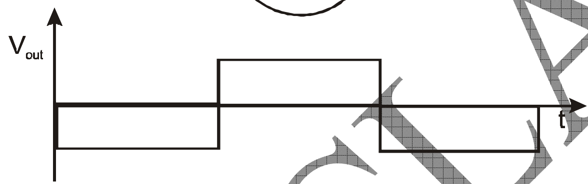
(a)



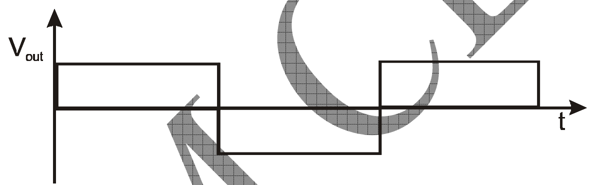
(b)



(c)

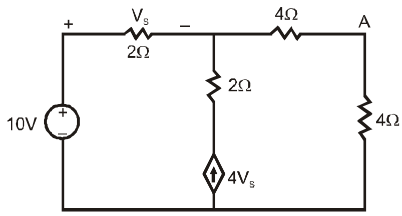


(d)



COMMON DATA QUES. (48-49)

Consider the circuit,



48. The value of I_{SC} is_______.

49. Value of R_{Th}' by applying 1A source is -

(A) $\frac{38}{9}$ W

(B) $\frac{58}{9}$ W

(C) $\frac{48}{9}$ W

(D) $\frac{28}{9}$ W

Common Data Ques.(50 - 51)

A universal motor (a.c. operated) has a 2-pole armature with 960 conductors. At a certain load the motor speed is 5000 r.p.m. and the armature current is 4.6A. The armature terminal voltage and input are respectively 100 V and 300 W. Compute the following, assuming an armature resistance of 3.5

50. Effective armature reactance

(A) 3.58

(B) 16.48

(C) 14.93

(D) 12.64

51. Max. value of useful flux per pole -

(A) 1.048×10^{-3} wb

(B) 2.096×10^{-3} wb

(C) 3.056×10^{-3} wb

(D) None of these

Statement for Linked Answer Questions 52 and 53

A state variable system X(t) = $\begin{bmatrix} 0 & 1 \\ 0 & -3 \end{bmatrix} X(t) + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u(t)$ with the initial condition X (0) [–1 3]^T and the unit step input u (t) has

52. The state transition matrix

(A) $\begin{bmatrix} 1 & \frac{1}{3}\left(1-e^{-3t}\right) \\ 0 & e^{-3t} \end{bmatrix}$

(B) $\begin{bmatrix} 1 & \frac{1}{3}\left(e^{-t}-e^{-3t}\right) \\ 0 & e^{-t} \end{bmatrix}$

(C) $\begin{bmatrix} 1 & \frac{1}{3}\left(e^{-t}-e^{-3t}\right) \\ 0 & e^{-3t} \end{bmatrix}$

(D) $\begin{bmatrix} 1 & \left(1-e^{-t}\right) \\ 0 & e^{-t} \end{bmatrix}$

53. The state transition equation

(A) $X(t) = \begin{bmatrix} t-e^{-t} \\ e^{-t} \end{bmatrix}$

(B) $X(t) = \begin{bmatrix} t-e^{-t} \\ 3e^{-3t} \end{bmatrix}$

(C) $X(t) = \begin{bmatrix} t-e^{-3t} \\ 3e^{-3t} \end{bmatrix}$

(D) $X(t) = \begin{bmatrix} t-e^{-3t} \\ e^{-t} \end{bmatrix}$

Statement for Linked Answer Questions 54 and 55.

A 1000 kVA, 6.6 kV, 3 - phase star connected cylindrical pole synchronous generator has a synchronous reactance of 20. Neglect the armature resistance and consider operation at full load and unity power factor.

54. The induced emf (line - to - line) is close to

(A) 5.5 kV

(B) 7.2 kV

(C) 9.6 kV

(D) 12.5 kV

55. The power (or torque) angle is close to

(A) 13.9°

(B) 18.3°

(C) 24.6°

(D) 33.0°

GENERAL APTITUDE

Q 56-60 (1 MARK EACH)

56. REASON : SFBTPO :: THINK : ?

(A) SGHMJ

(B) UIJOL

(C) UHNKI

(D) UJKPM

57. The Antonym of MORTAL is

(A) Divine

(B) Immortal

(C) Spiritual

(D) Eternal

58. The Synonym of ALERT is

(A) Energetic

(B) Observant

(C) Intelligent

(D) Watchful

59. A shopkeeper expects a gain of 22.5% on his cost price. If in a week, his sale was of Rs. 392, what was his profit?

(A) Rs. 18.20

(B) Rs. 70

(C) Rs. 72

(D) Rs. 88.25

60. IF '+' stands for '-' , '-' stands for 'x', 'x' stands for '÷'and '÷'stands for '+'then what is the value of 56x7÷13-11+15-8÷2-7?

(A)30

(B)45

(C)60

(D)90

Q 61-65 (2 MARKS EACH)

61. ‘Captain’ is related to ‘Soldier’ in the same way as ‘Leader’ is related to

(A) Chair

(B) Followers

(C) Party

(D) Minister

62. PORK:PIG

(A) rooster:chicken

(B) mutton:sheep

(C) steer:beef

(D) lobster:crustacean

63. My uncle decided to take ...... and my sister to the market.

(A) I

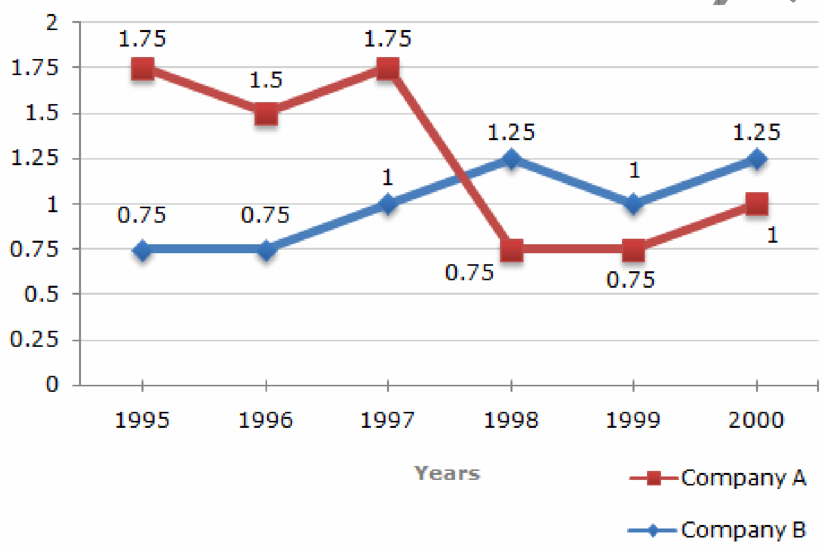
(B) mine

(C) me

(D) myself

64. Answer the question based on the given line graph.

Ratio of Exports to Imports (in terms of money in Rs. crores) of Two Companies Over the Years



In how many of the given years were the exports more than the imports for Company A?

(A) 2

(B) 3

(C) 4

(D) 5

65. Look at this series: 58, 52, 46, 40, 34, ... What number should come next?

(A)26

(B)28

(C) 30

(D) 32

Answer Key

Question	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Answer	D	A	B	C	A	0.2679	D	B	1.5	B	C	0.15	270	C	0.5	C	1	D	B	B
Question	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Answer	B	A	C	A	C	A	A	A	C	D	D	4.0,3.0 2.5	128	C	D	A	D	C	D	D
Question	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Answer	A	D	10	C	D	A	D	9/2V	A	B	A	A	C	B	C	B	B	D	C	B
Question	61	62	63	64	65															
Answer	B	B	C	B	B															

Hints and Solution

1.(D) If P_{Cu} is the Cu loss at full load, its value at 75% of full load is

P_{Cu} x $(0.75)^2$ = 9/16 P_{Cu}

At maximum efficiency, it equals the iron loss P_I which remains constant through out. Hence max. efficiency at

P_I = 9/16 P_{Cu}

Or P_I / P_{Cu} = 9/16

2.(A) The transformer is supplying full-load secondary current at 0.8 lagging power factor

Full load secondary current = $\frac{4KVA}{400V} = \frac{4000VA}{400V}$ = 10A

From the open circuit test, core losses = 70W

From the S.C. test, full load copper losses = 60W

Efficiency

$$\eta = \left(\frac{V_2 I_2 \cos\theta}{V_2 I_2 \cos\theta + \text{core losses} + \text{full load copper losses}}\right)\times 100 = \left(\frac{4000\times 0.8}{4000\times 0.8 + 70 + 60}\right)\times 100$$

$$= \left(\frac{3200}{3300}\right)\times 100 = 96.1\%$$

3.(B) P_m =output = 80 KW

Windage and Friction losses = 920W

Stator core loss = 4300 W

Stator copper loss = 2690W

Slip = 3.8%

Gross mech output = P_m + windage and friction losses

= 80 KW + 920 W

= 80.92KW

rotor input / rotor gross output = 1/(1–s)

rotor input = rotor gross output / (1–s) = 80.92 KW /(1–0.038) = 84.11 KW

we know that ;

stator input = rotor input + stator core loss + stator Cu loss

= 84.11 KW +4300 W + 2690 W = 91.1 KW

% □ = (rotor output / stator input) x 100

= (80/91.1) x 100 KW

= 87.81 %

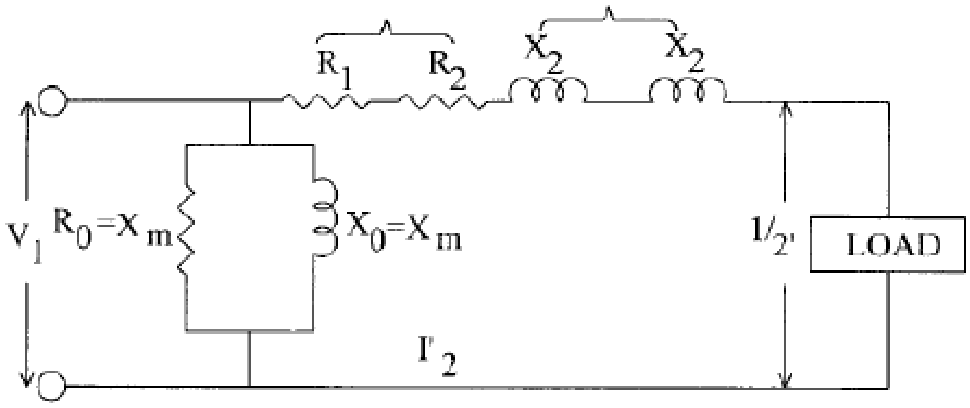
4.(C) Given : P_0 = 2.2 kVA , 440/220 V , 50 Hz

R_{01} = 3□ , X_{01} = 4□ , R_m = 2.5k□ , X_m = X_0 = 2k□

cos□ = 0.707 lagging

Therefore sin□ = 0.707

Voltage regulation



cos□ = 0.707 ; therefore □ = 45^o

(Voltage drop) = I_2 (R_{01} cos□ + X_{01} sin□)

and I_2 = P_0/ V_2 cos□

= 2.2 x 103 x 0.707 / 220 x 0.707

= 1 x 10

I_2 = 10A

Voltage drop = 10 (3 x 0.707 + 4 x 0.707)

= 10 (4.950)

= 49.50 Volts

Therefore, Voltage regulation = (voltage drop /V_2) x 100

= (49.50 / 220) x 100 = 22.50%

5.(A) P = 2; Z = 960; N= 5000

I_i =I_a= 4.6 amp ; V_1 =100 volts

P_i =300W find X_a and □$_m$ = ?

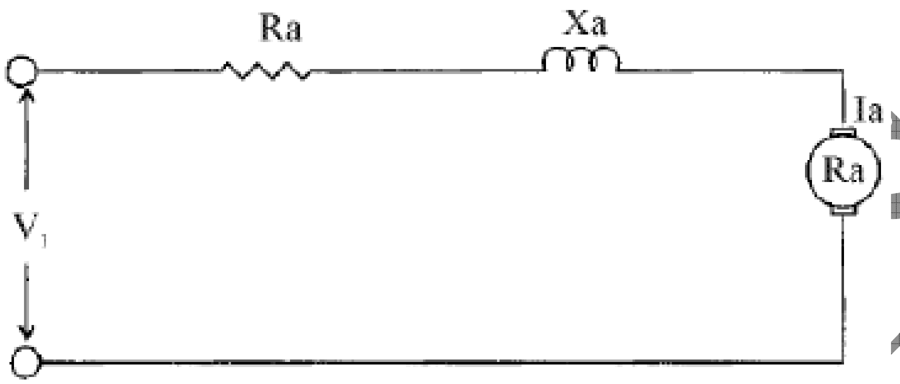
P_1 = $V_1 I_1$cos □

□ cos □ = P_1 / $V_1 I_1$ = 300/ 100 x 4.6 = 0.652

E_{bdc} = V - $I_a R_a$ or (N□PZ / 60A)

= 100 - 4.6 x 3.5

$= 100 - 16.1 = 83.9$ volts



$E_{bac} = V\cos□ - I_a R_a$

$= 100 \times 0.652 - 4.6 \times 3.5 = 49.11$ volts

And $V^2 = ((E_{bac} + I_a R_a)^2 + (I_a X_a)^2$

$(4.6 X_a)^2 = 100^2 - (65-2)^2$

$21.16 X_a^2 = 5749$

$X_a = 16.48$ ohms

6. **0.2679**

Given : $(T_{st} / T_f) = 1$ & $(T_{max} / T_f) = 2$

□ $(T_{st} / T_{max}) = 1/2 = 0.5$

let $a = R_2 / X_2$

□ $(T_{st} / T_{max}) = 2a/(1+a^2) = 0.5/1$

$2a/(1+a^2) = 1/2$

$4a = 1 + a^2$

$a^2 - 4a + 1 = 0$

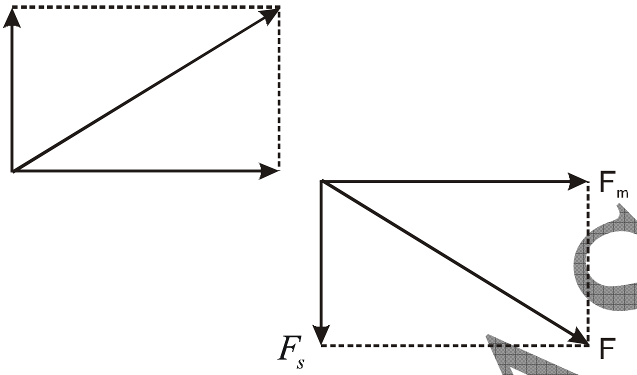
$a = \dfrac{4 \pm \sqrt{16 - 4 \times 1 \times 1}}{2}$

$$a = \frac{4 \pm \sqrt{12}}{2}$$

a = 3.73 or 0 .2679

a = slip at max torque = 0.2679

7.(D) The meter reading will either decrease or increase depending upon the direction of flux.



As shown in figure let F_m be the flux due to meter coil and F_S is due to stray magnetic field, then resultant will be F. Similarly when F is in opposite direction. Thus the reading will either increase or decrease.

8.(B) $I(s) = \frac{V(s)}{Z(s)}; Z(s) = R + Ls$

$I(s) = \frac{V(s)}{R+Ls}$; also $V(s) = 1$

$I(s) = \frac{1}{R+Ls}$

□ $I(t) = \left(\frac{1}{L}\right) e^{-\frac{Rt}{L}}$

a decaying exponential function

9. **1.5**

$$\left(\frac{dy}{dx}\right)_{at\,x=0} = \frac{y_2 - y_1}{x_2 - x_1}$$

$$=\frac{y(1)-y(-1)}{1-(-1)}=\frac{8-5}{2}=1.5$$

10.(B) At, t = 0^+, capacitor is uncharged

At steady state condition, capacitor is open circuited

$$V_C(\infty)=\frac{20}{10+10}\times 10=10\text{volts}$$

11.(C) $S=\int_1^\infty x^{-3}dx=\left[\frac{x^{-2}}{-2}\right]_1^\infty=\frac{1}{2}$

12. 0.15

$$L=\frac{N^2\mu_0 A}{l}=\frac{10^6\times 4\pi\times 10^{-7}\times\frac{\pi}{4}\times\left(9\times 10^{-4}\right)}{0.3}$$

$$=\frac{9\pi^2\times 10^{-5}}{0.3}$$

 Energy = $\frac{1}{2}LI^2$ = 0.148 or 0.15 Joules

13. 270

$$I_{rms}^2=\frac{1}{3}\int_0^3\left(\frac{9}{3}t\right)^2.dt=\left[\frac{1}{3}\times 9\times\frac{t^3}{3}\right]_0^3=27A^2$$

 Power = I^2R = 27 × 10 = 270 W

14.(C) At steady state, current,

$$I=\frac{10}{10}=1\text{Amp}$$

By Lenz's law at t = 0^+ , current through inductor, I = 1 Amp

15. 0.5

Current that flows is given by,

V(s) = sL1I (s)

$I = s\, I(s)\; I(s) = \frac{1}{s} = u(t) = 1$ A.

Energy supplied $= \frac{1}{2} \times 1 \times 1 = \frac{1}{2} = 0.5J.$

16.(C) For economic generation $\frac{\partial F_1}{\partial P_1} = \frac{\partial F_2}{\partial P_2}$

$b + 2CP_1 = b + 4CP_2$

$P_1 = 2P_2$

$p_1 + P_2 = 300,$

$P_1 = 200$ MW , and $P_2 =$ **100 MW**

17. 1

$$\underset{s\to\infty}{\text{Lim}} f(t) = \underset{s\to 0}{\text{Lim}}\, sF(s) = \underset{s\to 0}{\text{Lim}} \frac{s(2s+1)}{s^4 + 8s^3 + 16s^2 + s}$$

$$= \underset{s\to 0}{\text{Lim}} \frac{2s+1}{s^3 + 8s^2 + 16s + s} = 1$$

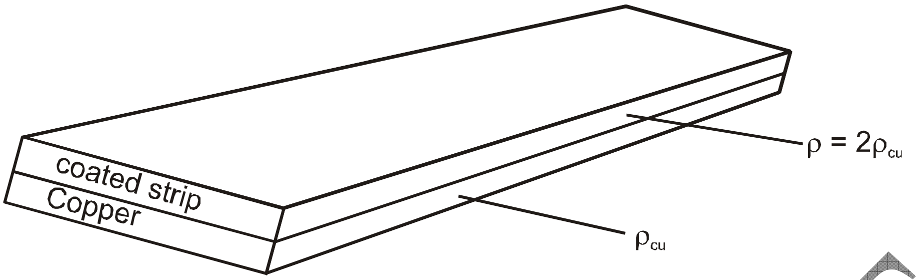
18.(D) It behaves as a current source

$$I_0 = \frac{\eta V}{r} = \frac{R_2}{R_1 + R_2} - \frac{V}{r}$$

$$\eta = \frac{R_2}{R_1 + R_2}$$

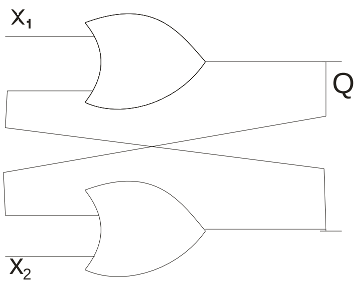
$$I_0 = \frac{R_2}{R_1 + R_2} \times \frac{V}{r}$$

19.(B) Copper and coated metal strips have resistance 2 ohms respectively. These two strips are in parallel.



 Resistance of composite strip $= \frac{2 \times 4}{2+4} = \frac{4}{3}$ ohms

20.(B)



Truth table of the above figure

X_1	X_2	X_3
1	0	1
0	0	1
0	1	0

21.(B) Let a be the temperature coefficient, then

$R_t = R_0 (1 + \alpha t)$

where R_t is resistance at t_0 C and R_0 is resistance at 0º C.

Assuming that for a given potential difference, I is proportional to $\frac{1}{R}$,

$$\frac{1\text{amp}}{0.7\text{amp}} = \frac{R_0(1+\alpha t)}{R_0} = 1 + \alpha.100$$

  = 0.0043 per ºC

current, I at 1200ºC is given by

$$\frac{1}{T} = \frac{R_0(1+\alpha.1200)}{R_0} = 1+\alpha.1200$$

$\therefore$ $I = -\frac{1}{6.16} = 0.16$ amp.

22.(A) Using the addition of admittances in parallel, s

$Y = Y_L + Y_R + Y_C = \frac{1}{j\omega L} + j\omega C = 1 + j$

The phasor voltage becomes $V = \frac{1}{Y}$

Using phasors in polar format,

$I = 10\, e^{-j\pi/2}$

$Y = \sqrt{2}\, e^{-j\pi/4}$

The power (time average power) dissipated in R,

$P = \frac{1}{2}\text{Re}\frac{(VV^*)}{R} = 25$

$v(t) = \frac{10}{\sqrt{2}}\cos\left(\omega t - \frac{3\pi}{4}\right)$

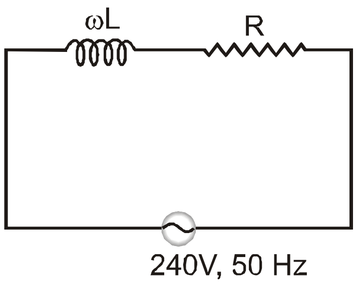
From which, P $(\pi)^2$ (t) = 25 watts.

23.(C) As, $K = \frac{M}{\sqrt{L_1L_2}} = \frac{2}{\sqrt{2\times 2}} = 1$

Hence it is a perfect transformer.

24.(A) $\frac{V^2}{R} = 300$, or $R = \frac{100^2}{300} = \frac{100}{3}\Omega$

and IR = V = 100 V or $I = \frac{100}{\left(\frac{100}{3}\right)} = 3\text{amp.}$



For the p.f. to be equal to unity,

$$I(\omega L) = I\left(\frac{1}{\omega C}\right) = V_L$$

or $$\frac{1}{\omega C} = \sqrt{240^2 - 100^2} = 218.17\text{Volt}$$

or $$C = \frac{3}{2\pi \times 50 \times 218.17}$$

$= 43.7 \times 10^{-6} = 43.7\mu F.$

25.(C) $AB = \begin{bmatrix} \cos\theta.\cos\phi\cos(\theta-\phi) & \cos\theta.\sin\phi.\cos(\theta-\phi) \\ \cos\phi\sin\theta.\cos(\theta-\phi) & \sin\theta.\sin\phi\cos(\theta-\phi) \end{bmatrix}$

= A null matrix, when $\cos(\theta - \phi) = 0$

i.e. if $(\theta - \phi)$ is an odd multiple of $\left(\frac{\pi}{2}\right)$.

26.(A) Eigen values are given by the solution of equation,

$$\begin{vmatrix} 3-\lambda & 4 \\ x & 1-\lambda \end{vmatrix} = 0$$

Since x is real and negative, put x = -k, where k is positive constant

$\Rightarrow \quad (3 - \lambda)(1 - \lambda) + 4k = 0$

$\Rightarrow \quad \lambda^2 - 4\lambda + 3 + 4k = 0$

If λ_1 and λ_2 be the solutions of the above equation, then λ_1 and λ_2 are eigen values.

Now, Sum of eigen values = Sum of roots of the above equation

i.e. $$\lambda_1 + \lambda_2 = \frac{-(-4)}{1} = 4(>0)$$

27.(A) $\int_0^{5\pi}(2-\sin x)\,dx = [2x+\cos x]_0^{5\pi}$

= 10□ - 1- 1 = 10□ - 2 > 0

28.(A) f(x, y) = $x^2 + y^2$

$$\nabla^2 f = \vec{\nabla}.\vec{\nabla} = \left(\vec{i}\frac{\partial}{\partial x}+\vec{j}\frac{\partial}{\partial y}\right).\left(\vec{i}\frac{\partial}{\partial x}+\vec{j}\frac{\partial}{\partial y}\right)\left[x^2+y^2\right]$$

$$= \frac{\partial}{\partial x^2}\left(x^2\right)+\frac{\partial^2}{\partial x^2}\left(y^2\right)=4$$

29.(C) $((V_a-12)/49)+(V_a/24)+((V_a-6)/80)=0$

$((V_a-12)(1920)+(V_a)(3920)+(V_a-6)(1176))/94080=0$

$V_a(7016)-30096=0$

$V_a=30096/7016$

$V_a=4.28$

30.(D) Given, $\left(4t^2+1\right)\frac{dy}{dt}+8yt-t=0$

□ $\frac{dy}{dt}+\frac{8t}{4t^2+1}y=\frac{t}{4t^2+1}$ ....(i)

□ I.F. = $e^{\int 8t/\left(4t^2+1\right)} = \left(4t^2+1\right)$

Hence solution of equation (i) is

$$y\left(4t^2+1\right)=\int\frac{t}{\left(4t^2+1\right)}.\left(4t^2+1\right)dt+C=\frac{t^2}{2}+C$$

□ $y = \frac{t^2}{2\left(4t^2+1\right)}+\frac{C}{\left(4t^2+1\right)}$ ....(ii)

But y (1) = 0, therefore $0 = \frac{1}{10}+\frac{C}{5}$

□ $C = -\frac{1}{2}$

From equation (ii), we have $y = \dfrac{t^2}{2(4t^2+1)} - \dfrac{1}{2(4t^2+1)}$

$\therefore \qquad y|_{t\to\infty} = \underset{t\to\infty}{\text{Lt}} \dfrac{1}{2(4+1/t^2)} - \dfrac{1}{2(4t^2+1)} = \dfrac{1}{2(4+0)} - 0 = \dfrac{1}{8}$

31.(D) $f(x) = \dfrac{x}{1+x}$

f(x) = f(0)

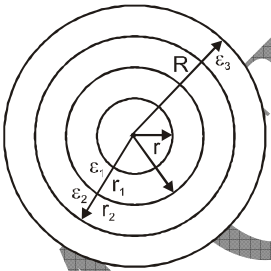
$= f'(0)(x-0) + \dfrac{f''(0)}{\lfloor 2}(x-a)^2 + \dfrac{f'''(0)}{\lfloor 3}x^3 + ...$

$= 0 + x + (-x^2) + x^3 + ...$

$= x - x^2 + x^3 + ...$

32. **4.0 3.0, 2.5**

When all the three materials are subjected to the same maximum stress,



$g_{max} = \dfrac{\lambda}{2\pi\varepsilon_1 r} = \dfrac{\lambda}{2\pi\varepsilon_2 r_2} = \dfrac{\lambda}{2\pi\varepsilon_3 r_2}$

or $\qquad \varepsilon_1 r = \varepsilon_2 r_1 = \varepsilon_3 r_2$

Since $r < r_1 < r_2$,

Therefore $\qquad \varepsilon_1 > \varepsilon_2 > \varepsilon_3$

Thus, the dielectric material with highest permittivity should be placed near the conductor and other layer in the descending order.

33. **128**

For most economic load sharing

$I\,C_1 = IC_2$

We have $X + Y = 300$ MW

and $0.1\times + 20 = 0.15\,Y + 18$

$= 0.15\,(300 - X) + 18$

$= 45 - 0.15 + 18$

□ $025\,X = 43$

or $X = 172$ MW

□ $Y = 300 - 172 = 128$ MW

34.(C) $x^2 - 2 = 0$

$$x_1 = x_0 - \frac{f(x_0)}{f(x_0)} = 1 + \frac{1}{2} = 1.5$$

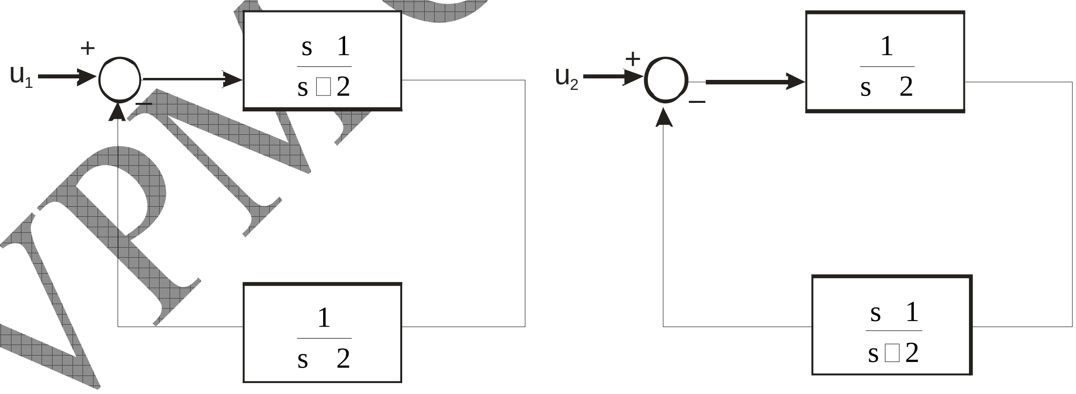
$f(x_0) = 12 - 2 = -1$

$f\,(x_0) = 2x$

$f(x_0) = 2x_0 = 2(1) = 2$

35.(D) Transfer function for u_1

$$TF_1 = \frac{(s-1)/(s+2)}{1+\left(\frac{s-1}{s+2}\right).\left(\frac{1}{s-1}\right)} = \frac{(s-2)}{(s+3)}$$



Hence stable.

Transfer function for u_2

$$TF_2 = \frac{\left(\frac{1}{s-1}\right)}{1+\left(\frac{1}{s-1}\right)\left(\frac{s-1}{s+2}\right)} = \frac{1}{(s+3)(s-1)}$$

hence unstable , as it has pole at right side of s - plane.

36.(A) $$I_0 = \frac{V_m}{\omega L_s}\left[\cos\alpha - \cos(\alpha+\mu)\right]$$

$$20 = \frac{230\times\sqrt{2}}{2\times\pi\times100L_s}\left[\cos 25° - \cos(25+10)\right]$$

L_S = .0045 Henery

$$V_0 = \frac{2\times\sqrt{2}\times230}{\pi}$$

$$\text{Cos } 25° - \frac{2\times\pi\times50\times0.0045}{\pi}\times20 = 178.65$$

$$\text{Displacement factor} = \frac{V_o I_0}{V_s I_s}$$

$$= \frac{178.65}{230}\times\frac{20}{20} = 0.78$$

37.(D) $P = V_d \times I_d$

$50 \times 1000 = 420 \times I_d$

$I_d = 119.05$

rms current of the thyristor = $\frac{19.05}{3} = 39.68$

38.(C) Zero voltage regulation at full load is possible at leading power factor load

$= V_R \cos \square - V_R \sin \square$

$\square = 45°$

Hence voltage regulation is zero.

39.(D) Efficiency of the given circuit is 92% because it is a class c amplifier and usually its efficiency is high all the four options containing 46%, 55%, 63%, 92%. and among the four options the 92% is highest. The answer would be 92%.

40.(D) It is a limited circuit

It makes a transition from + 5V to – 5V

$$20\left(1-e^{-t/RC}\right)=5\times\frac{10}{110} = \text{Voltage across } 100\text{ k}\Omega$$

RC = 0.01 × $10^{-6}\times 10^{3}$

t = 2.57 μs

41.(A) By Gauss's theorem

$$\int_s \vec{E}.\vec{ds}=\frac{Q_{enc}}{\varepsilon_0}$$

where , Q_{enc} = charge enclosed in radius r

$$\int_s \vec{E}.\vec{ds}=\frac{Q}{\frac{4}{3}\pi R^3}.\frac{4}{3}\pi r^3$$

or $E(4\pi r^2) = \dfrac{Qr^3}{R^3}$

or $E=\dfrac{Qr}{4\pi\varepsilon_0 R^3}$

42.(D) Total power = 10.5 – 2.5 = 8 kW

$$\tan\phi = \sqrt{3}\times\frac{13}{8}$$

cos φ = 0.334

43. 10

$$\text{Sensitivity}=\frac{\text{Total of resistance of the inst}}{\text{Full scale current figure}}\text{ohm./V}$$

$$=\frac{1}{10\times10^{-6}}=10\text{K}-\text{ohm/V}$$

44.(C) If gain = – 25 , then $-25 = -\dfrac{1\times10^{3}}{R_1}$

Now $\dfrac{V_0}{V_{in}}=-\dfrac{R_f}{R_1}$

$\therefore \quad R_1 = \frac{1000}{25} k\Omega = 10k\Omega$

If gain = –10, then R_1 = 100 kΩ

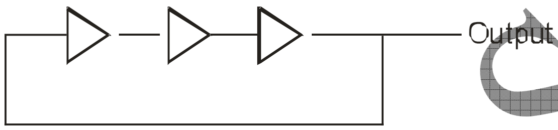
45.(D) Applying KCL at node A and taking node B as reference:

$(15-V_a)/68-V_a/30-(V_a-8)/100=0$

V_a=5.1689V;

Ir_2=va/30=5.1689/30=0.172A=172mA;

46.(A) The circuit shown in the figure



is an oscillating circuit and its output is a square wave

47.(D) Output will appear 180° out of phase to the input.So the option (D) is correct.

48. $\frac{9}{2}$ V

$10 + 2\,(4\,V_S - I_{SC}) - 4\,I_{SC} = 0$

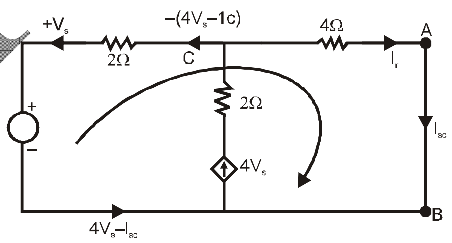
$$10 + 8\,V_S = 6\,I_{SC}$$

$$V_S = -2\,(4\,V_S - I_{SC})$$

$$9\,V_S = 2\,I_{SC}$$

or $\quad I_{SC} = \frac{9}{2} \qquad V_S = \frac{90}{38}$

Since $\quad 19\,V_S = 10$



49.(A) To determine R_{Th}' apply 1A source

$$V_s = -2(1 + 4V_s)$$

$$= -\frac{2}{9}$$

$$V = \frac{2}{9} + 4 = \frac{38}{9}$$

$$R_{Th} = \frac{38}{9}\,W$$

□ $V_{Th} = R_{Th}\, I_{sc} = 10$ V

50.(B) Given: P=2 ; Z =960 ; N_1 =5000 rpm ; I_{a1} = 4.6 amp

$V_a = 100v = I_{a1}R_a$

P_i = 300 watt

R_a = 3.5 ohms

Find X_a = ?

$□_m$ / pole = ?

P_i = VI cos □

□ cos □ = P_i / VI = 300 / 100 x 4.6 = 300 / 460

= 0.652

Now E_{bac} = V cos □ - I_aR_a = 100 x 0.652 – 4.6 x 3.5

= 49.1 volts

and $V^2 = (E_{bac} + I_aR_a)^2 + (I_aX_a)^2$

$100^2 = (49.1 + 4.6 \times 3.5)^2 + (4.6X_a)^2$

$(4.6X_a)^2 = 100^2 - (49 + 16.1)^2 = 10000 - (65.2)^2$

= 10,000 – 4251.04 = 5748.96

$21.16\, X_a^2 = 5748.96$

 X_a = 5748.96 / 21.16

= 16.48

51.(A) $E_{bdc} = V - I_aR_a = 100 - 4.6 \times 3.5 = 83.9$ V

and $E_{bdc} = N\phi_m PZ / 60A$

$83.9 = 5000\ \phi_m \times 2 \times 960 / 60 \times 2$

$\phi_m = 83.9 / 8.0 \times 10^4 = 1.048 \times 10^{-3}$ wb

52.(A) $$(sI-A)^{-1} = \begin{bmatrix} s & 1 \\ 0 & s+3 \end{bmatrix} = \frac{\text{Adj}(sI-A)}{|sI-A|} = \frac{\begin{bmatrix} s+3 & 0 \\ -1 & s \end{bmatrix}}{\begin{bmatrix} s & 1 \\ 0 & s+3 \end{bmatrix}} = \frac{\begin{bmatrix} s+3 & -1 \\ 0 & s \end{bmatrix}}{s(s+3)} = \begin{bmatrix} \frac{1}{s} & \frac{-1}{s(s+3)} \\ 0 & \frac{1}{s+3} \end{bmatrix}$$

$f(t) = L^{-1}(sI - A)^{-1}$

$$= \begin{bmatrix} 1 & \frac{1}{3}\left(1-e^{-3t}\right) \\ 0 & e^{-3t} \end{bmatrix}$$

53.(C) Zero state response = $L^{-1}\phi(s)B\,U(S)$

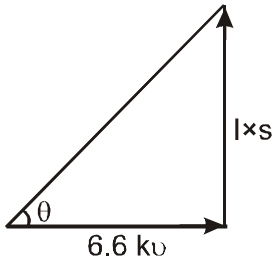
$$L^{-1}\begin{bmatrix} \frac{1}{s} & \frac{-1}{s(s+3)} \\ 0 & \frac{1}{s+3} \end{bmatrix}\begin{bmatrix} 1 \\ 0 \end{bmatrix}\frac{1}{s} = L^{-1}\begin{bmatrix} \frac{1}{s^2} \\ 0 \end{bmatrix} = \begin{bmatrix} t \\ 0 \end{bmatrix}$$

State transition equation = zero input response + zero state response.

$x(t) = \phi(X)\,X(0) + t$

$$= \begin{bmatrix} -1+1-e^{-3t} \\ 0+3e^{-3t} \end{bmatrix} + \begin{bmatrix} t \\ 0 \end{bmatrix} = \begin{bmatrix} t-e^{-3t} \\ 3e^{-3t} \end{bmatrix}$$

54.(B) $I = \frac{1000}{6.6} = 151.51A$



I × R = 151.51 × 20 = 3.03 kV

$$E_{end} = \sqrt{6.6^2 + 3.03^2} = 7.2\text{kV}$$

55.(C) Torque angle, □ = tan $^{-1}\frac{3.03}{6.6} = 24.6°$

56.(B)

As

$R \xrightarrow{+1} S$

$E \xrightarrow{+1} F$

$A \xrightarrow{+1} B$

$S \xrightarrow{+1} T$

$O \xrightarrow{+1} P$

$N \xrightarrow{+1} O$

Similarly

$T \xrightarrow{+1} U$

$H \xrightarrow{+1} I$

$I \xrightarrow{+1} J$

$N \xrightarrow{+1} O$

$K \xrightarrow{+1} L$

57.(B) The Antonym of MORTAL is Immortal

58.(D) The Synonym of ALERT is Watchful

59.(C) C.P. = Rs. $\left(\frac{100}{122.5}\times 392\right) = \text{Rs}\left(\frac{1000}{1225}\times 392\right) = 320\text{Rs}$

Profit = Rs. (392 - 320) = Rs. 72.

60.(B) Changing the symbols as given in the problem the above expression is

56÷7+13x11-15x8+2x7

Solving the BODMAS rule, we get 8+143-120+14=165-120=45

61.(B) ‘Captain’ is supposed to lead the battalian of ‘Soldiers’ int he same way as ‘Leader’ is supposed to lead the ‘Followers’.

62.(B) mutton:sheep

63.(C) My uncle decided to take me and my sister to the market.

64.(B) The exports are more than imports in those years for which the exports to imports ratio are more than For Company A, such years are 1995, 1996 and 1997.

Thus, during these 3 years, the exports are more than the imports for Company A.

65.(B) This is a simple subtraction series. Each number is 6 less than the previous number.