GATE - 2013

EE : ELECTRICAL ENGINEERING

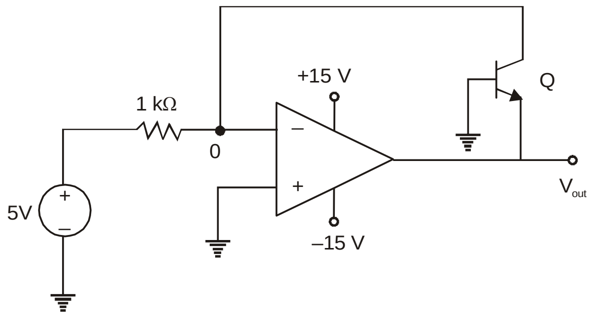
Duration : Three Hours | Maximum Marks : 100

Read the following instructions carefully.

1. All questions in this paper are of objective type.
2. There are a total of 65 questions carrying 100 marks.
3. Questions 1 through 25 are 1-mark questions, question 26 through 55 are 2-mark questions.
4. Questions 48 and 51 (2 pairs) common data questions and question pairs (Q. 52 and Q.53) and (Q. 54 and Q.55) are linked answer questions. The answer to the second question of the above pair depends on the answer to the first question of the pair. If the first question in the linked pair is wrongly answered or is un-attempted, then the answer to the second question in the pair will not be evaluated.
5. Questions 56 - 65 belong to general aptitude (GA). Questions 56 - 60 will carry 1-mark each, and questions 61-65 will carry 2-marks each. The GA questions will begin on a fresh page.
6. Un-attempted questions will carry zero marks.
7. Wrong answers will carry NEGATIVE marks. For Q.1 to Q.25 and Q.56 - Q.60, 1/3 mark will be deducted for each wrong answer. For Q. 26 to Q. 51, and Q.61 - Q.65, 2/3 mark will be deducted for each wrong answer. The question pairs (Q. 52, Q. 53) and (Q. 54, Q. 55) are questions with linked answers. There will be negative marks only for wrong answer to the first question of the linked answer question pair i.e. for Q. 52 and Q.54, 2/3 mark will be deducted for each wrong answer. There is no negative marking for Q. 53 and Q.55.

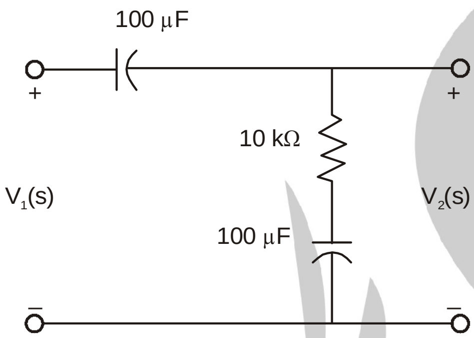
Q.1 to Q.25 carry one mark each.

1. In the circuit shown below what is the output voltage (V_{out}) in Volts if a silicon transistor Q and an ideal op-amp are used?



(a) - 15 (b) - 0.7
(c) +0.7 (d) +15

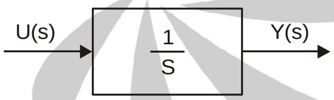
2. The transfer function $\frac{V_2(s)}{V_1(s)}$ of the circuit shown below is



(a) $\frac{0.5s+1}{s+1}$ (b) $\frac{3s+6}{s+2}$

(c) $\frac{s+2}{s+1}$ (d) $\frac{s+1}{s+2}$

3. Assuming zero initial condition, the response y(t) of the system given below to a unit step input u(t) is



(a) u(t) (b) t u(t)

(c) $\frac{t^2}{2}u(t)$ (d) $e^{-1}u(t)$

4. The impulse response of a system is h(t) = t u(t). For an input u(t - 1), the output is

(a) $\frac{t^2}{2}u(t)$ (b) $\frac{t(t-1)}{2}u(t-1)$

(c) $\frac{(t-1)^2}{2}u(t-1)$ (d) $\frac{t^2-1}{2}u(t-1)$

5. Which one of the following statements is NOT TRUE for a continuous time causal and stable LTI system?
(a) All the poles of the system must lie on the left side of the jω axis.
(b) Zeros of the system can lie anywhere in the s-plane.
(c) All the poles must lie within | s| = 1.
(d) All the roots of the characteristic equation must be located on the left side of the jω axis.

6. Two systems with impulse responses h_1 (t) and h_2(t) are connected in cascade. Then the overall impulse response of the cascaded system is given by
(a) product of h_1(t) and h_2(t)
(b) sum of h_1(t) and h_2(t)
(c) convolution of h_1(t) and h_2(t)
(d) subtraction of h_2(t) from h_1(t)

7. A source $v_s(t)$ =V cos 100πt has an internal impedance of (4 + j3)Ω. If a purely resistive load connected to this source has to extract the maximum power out of the source, its value in Ω should be
(a) 3 (b) 4
(c) 5 (d) 7

8. A single-phase load is supplied by a single-phase voltage source. If the current flowing from the load to the source is 10∠- 150°A and if the voltage at the load terminals is 100 ∠ 60°V, then the
(a) load absorbs real power and delivers reactive power.
(b) load absorbs real power and absorbs reactive power.
(c) load delivers real power and delivers reactive power.
(d) load delivers real power and absorbs reactive power.

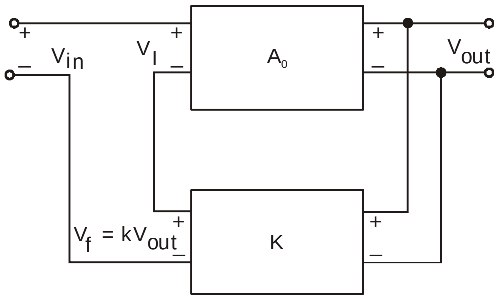
9. A single-phase transformer has no-load loss of 64 W, as obtained from an open-circuit test. When a short-circuit test is performed on it with 90% of the rated currents flowing in its both LV and HV windings, the measured loss is 81 W. The transformer has maximum efficiency when operated at
(a) 50.0% of the rated current.
(b) 64.0% of the rated current.
(c) 80.0% of the rated current.
(d) 88.8% of the rated current.

10. The flux density at a point in space is given by B=4xa_x +2kya_y + 8a_z Wb/m^2. The value of Qconstant k must be equal to
(a) - 2 (b) - 0.5
(c) +0.5 (d) +2

11. A continuous random variable X has a probability density function f (x) = e^{-x}, 0 < x < ∞. Then P{X >1} is
(a) 0.368 (b) 0.5
(c) 0.632 (d) 1.0

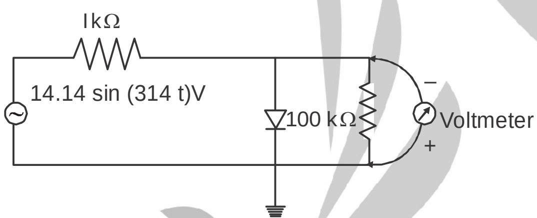
12. The curl of the gradient of the scalar field defined by $V = 2x^2y + 3y^2z + 4z^2x$ is
   (a) $4xya_x + 6yza_y + 8zxa_z$
   (b) $4a_x + 6a_y + 8a_z$
   (c) $(4xy + 4z^2)a_x + (2x^2 + 6yz)a_y + (3y^2 + 8zx)a_z$
   (d) 0

13. In the feedback network shown below, if the feedback factor k is increased, then the



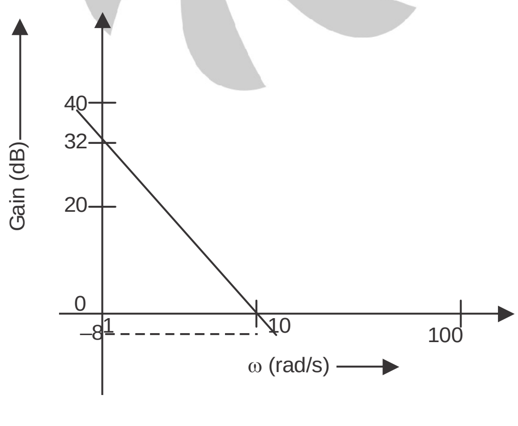
   (a) input impedance increases and output impedance decreases.
   (b) input impedance increases and output impedance also increases.
   (c) input impedance decreases and output impedance also decreases.
   (d) input impedance decreases and output impedance increases.

14. The input impedance of the permanent magnet moving coil (PMMC) voltmeter is infinite. Assuming that the diode shown in the figure below is ideal, the reading of the voltmeter in Volts is



   (a) 4.46
   (b) 3.15
   (c) 2.23
   (d) 0

15. The Bode plot of a transfer function G (s) is shown in the figure below.



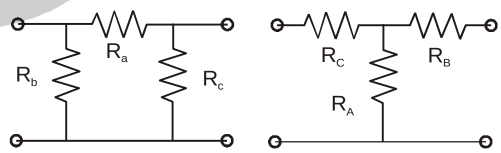
The gain (20 log| G(s)|) is 32 dB and - 8 dB at 1 rad/s and 10 rad/s respectively. The phase is negative for all ω. Then G(s) is
   (a) $\frac{39.8}{s}$
   (b) $\frac{39.8}{s^2}$
   (c) $\frac{32}{s}$
   (d) $\frac{32}{s^2}$

16. A bulb in a staircase has two switches, one switch being at the ground floor and the other one at the first floor. The bulb can be turned ON and also can be turned OFF by any one of the switches irrespective of the state of the other switch. The logic of switching of the bulb resembles
   (a) an AND gate
   (b) an OR gate
   (c) an XOR gate
   (d) a NAND gate

17. For a periodic signal $v(t) = 30 \sin 100 t + 10 \cos 300 t + 6 \sin (500 t + \pi/4)$, the fundamental frequency in rad/s is
   (a) 100
   (b) 300
   (c) 500
   (d) 1500

18. A band-limited signal with a maximum frequency of 5 kHz is to be sampled. According to the sampling theorem, the sampling frequency in kHz which is not valid is
   (a) 5
   (b) 12
   (c) 15
   (d) 20

19. Consider a delta connection of resistors and its equivalent star connection as shown below. If all elements of the delta connection are scaled by a factor k, k > 0, the elements of the corresponding star equivalent will be scaled by a factor of

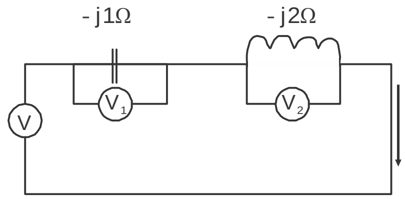


   (a) k^2
   (b) k
   (c) $1/k$
   (d) $\sqrt{k}$

20. The angle δ in the swing equation of a synchronous generator is the
   (a) angle between stator voltage and current.
   (b) anagular displacement of the rotor with respect to the stator.
   (c) angular displacement of the stator mmf with respect to a synchronously rotating axis.
   (d) angular displacement of an axis fixed to the rotor with respect to a synchronously rotating axis.

21. Leakage flux in an induction motor is
   (a) flux that leaks through the machine
   (b) flux that links both stator and rotor windings
   (c) flux that links none of the windings
   (d) flux that links the stator winding or the rotor winding but not both

22. Three moving iron type voltmeters are connected as shown below. Voltmeter readings are V, V_1 and V_2, as indicated. The correct relation among the voltmeter readings is



(a) $V = \frac{V_1}{\sqrt{2}} + \frac{V_2}{\sqrt{2}}$ (b) $V = V_1 + V_2$

(c) $V = V_1 V_2$ (d) $V = V_2 - V_1$

23. Square roots of - i, where $i = \sqrt{-1}$, are

(a) i, - i

(b) $\cos\left(-\frac{\pi}{4}\right) + i\sin\left(-\frac{\pi}{4}\right), \cos\left(\frac{3\pi}{4}\right) + i\sin\left(\frac{3\pi}{4}\right)$

(c) $\cos\left(\frac{\pi}{4}\right) + i\sin\left(\frac{3\pi}{4}\right), \cos\left(\frac{3\pi}{4}\right) + i\sin\left(\frac{\pi}{4}\right)$

(d) $\cos\left(\frac{3\pi}{4}\right) + i\sin\left(-\frac{3\pi}{4}\right), \cos\left(-\frac{3\pi}{4}\right) + i\sin\left(\frac{3\pi}{4}\right)$

24. Given a vector field $F = y^2 x a_x - yz a_y - x^2 a_z$, the line integral $\int F.dl$ evaluated along a segment on the x-axis from x = 1 to x = 2 is

(a) - 2.33

(b) 0

(c) 2.33

(d) 7

25. The equation $\begin{bmatrix} 2 & -2 \\ 1 & -1 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$ has

(a) no solution

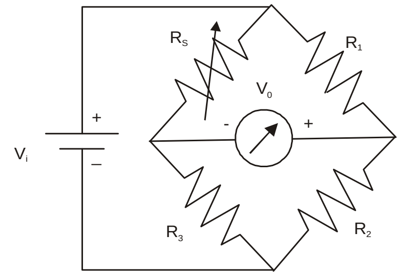
(b) only one solution $\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$

(c) non-zero unique solution

(d) multiple solutions

Q. 26 to Q.55 carry two marks each.

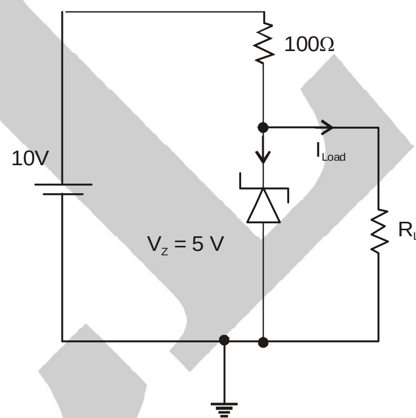
26. A strain gauge forms one arm of the bridge shown in the figure below and has a nominal resistance without any load as R_S = 300 Ω. Other bridge resistances are $R_1 = R_2 = R_3$ = 300 Ω. The maximum permissible current through the strain gauge is 20 mA. During certain measurement when the bridge is excited by maximum permissible voltage and the strain gauge resistance is increased by 1 % over the nominal value, the output voltage V_0 in mV is



(a) 56.02 (b) 40.83

(c) 29.85 (d) 10.02

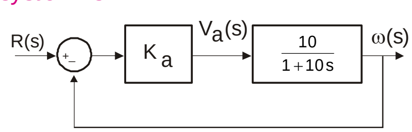
27. In the circuit shown below, the knee current of the ideal Zener diode is 10 mA. To maintain 5 V across R_L, the minimum value of R_L in Ω and the minimum power rating of the Zener diode in mW respectively are



(a) 125 and 125 (b) 125 and 250

(c) 250 and 125 (d) 250 and 250

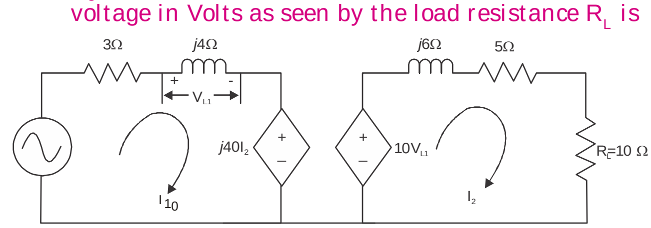
28. The open-loop transfer function of a dc motor is given as $\frac{\omega(s)}{V_a(s)} = \frac{10}{1+10s}$. When connected in feedback as shown below, the approximate value of K_a that will reduce the time constant of the closed loop system by one hundred times as compared to that of the open-loop system is



(a) 1 (b) 5

(c) 10 (d) 100

29. In the circuit shown below, if the source voltage $V_s = 100\angle 53.13°$ V then the Thevenin's equivalent voltage in Volts as seen by the load resistance R_L is

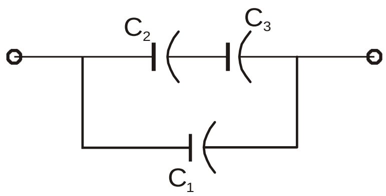


(a) 100 ∠ 90° (b) 800 ∠ 0°

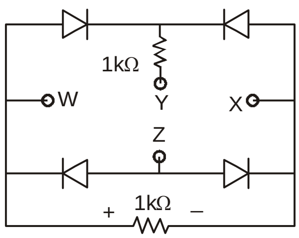
(c) 800 ∠ 90° (d) 100 ∠ 60°

30. Three capacitors C_1, C_2, and C_3, whose values are 10μF, 5μF, and. 2μF respectively, have breakdown voltages of 10V, 5V, and 2V respectively. For the interconnection shown, the maximum safe voltage in Volts that can be applied across the combination and the corresponding total charge in μC stored in the effective capacitance across the terminals are respectively

(a) 2.8 and 36
(b) 7 and 119
(c) 2.8 and 32
(d) 7 and 80

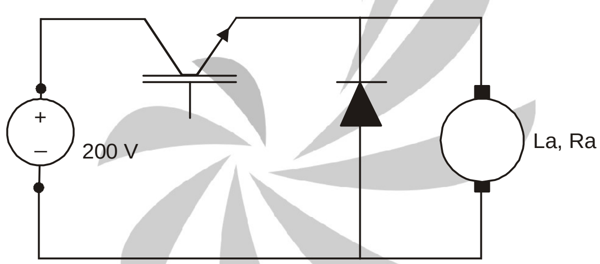


31. A voltage 1000 sin ωt Volts is applied across YZ. Assuming ideal diodes, the voltage measured across WX in Volts is



(a) sin ωt
(b) (sin ωt + | sin ωt|) / 2
(c) (sin ωt - | sin ωt|) / 2
(d) 0 for all t

32. The separately excited dc motor in the figure below has a rated armature current of 20 A and a rated armature voltage of 150 V. An ideal chopper switching at 5 kHz is used to control the armature voltage. If L_a = 0.1 mH, R_a = 1 Ω, neglecting armature reaction, the duty ratio of the chopper to obtain 50% of the rated torque at the rated speed and the rated field current is



(a) 0.4
(b) 0.5
(c) 0.6
(d) 0.7

33. For a power system network with n nodes, Z_{33} of its bus impedance matrix is j0.5 per unit. The voltage at node 3 is 1.3 ∠- 10° per unit. If a capacitor having reactance of - j3.5 per unit is now added to the network between node 3 and the reference node, the current drawn by the capacitor per unit is

(a) 0.325 ∠- 100°
(b) 0.325 ∠80°
(c) 0.371 ∠- 100°
(d) 0.433 ∠80°

34. A dielectric slab with 500 mm × 500 mm cross-section is 0.4 m long. The slab is subjected to a uniform electric field of E = $6a_x + 8a_y$ kV/mm. The relative permittivity of the dielectric material is equal to 2. The value of constant ε_0 is 8.85×10^{-12} F/m. The energy stored in the dielectric in Joules is

(a) 8.85×10^{-11}
(b) 8.85×10^{-5}
(c) 88.5
(d) 885

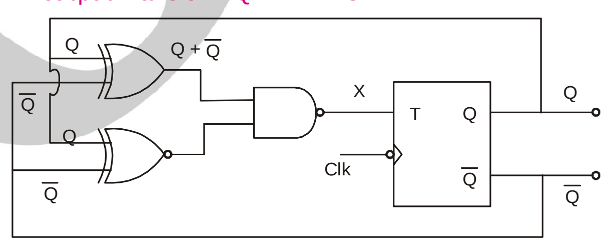
35. A matrix has eigenvalues - 1 and - 2. The corresponding eigenvectors are $\begin{bmatrix}1\\-1\end{bmatrix}$ and $\begin{bmatrix}1\\-2\end{bmatrix}$ respectively. The matrix is

(a) $\begin{bmatrix}1 & 1\\-1 & -2\end{bmatrix}$
(b) $\begin{bmatrix}1 & 2\\-2 & -4\end{bmatrix}$
(c) $\begin{bmatrix}-1 & 0\\0 & -2\end{bmatrix}$
(d) $\begin{bmatrix}0 & 1\\-2 & -3\end{bmatrix}$

36. $\oint \frac{z^2-4}{z^2+4}dz$ evaluated anticlockwise around the circle $|z - i| = 2$, where $i = \sqrt{-1}$, is

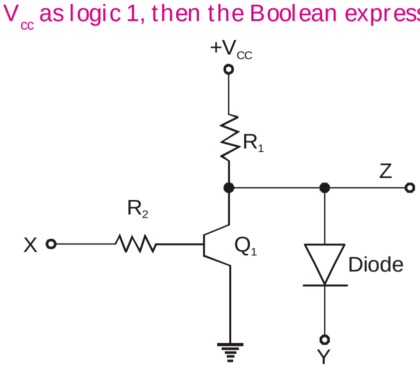
(a) - 4π
(b) 0
(c) 2 + π
(d) 2 + 2i

37. The clock frequency applied to the digital circuit shown in the figure below is 1 kHz. If the initial state of the output Q of the flip-flop is '0', then the frequency of the output wave orm Q in kHz is



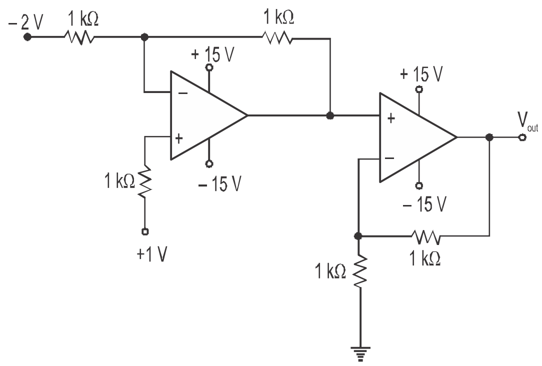
(a) 0.25
(b) 0.5
(c) 1
(d) 2

38. In the circuit shown below, Q_1 has negligible collector-to-emitter saturation voltage and the diode drops negligible voltage across it under forward bias. If V_{cc}, is + 5 V, X and Y are digital signals with 0 V as logic 0 and V_{cc} as logic 1, then the Boolean expression for Z is



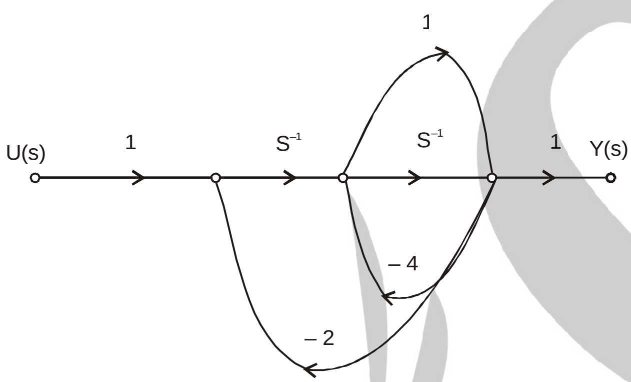
(a) X Y
(b) $\overline{X}Y$
(c) $X\overline{Y}$
(d) $\overline{XY}$

39. In the circuit shown below the op-amps are ideal. Then V_{out} in Volts is



(a) 4 (b) 6
(c) 8 (d) 10

40. The signal flow graph for a system is given below. The transfer function $\frac{Y(s)}{U(s)}$ for this system is



(a) $\frac{s+1}{5s^2+6s+2}$ (b) $\frac{s+1}{s^2+6s+2}$

(c) $\frac{s+1}{s^2+4s+2}$ (d) $\frac{1}{5s^2+6s+2}$

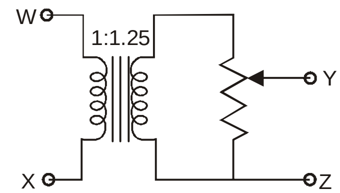
41. The impulse response of a continuous time system is given by $h(t) = \delta(t-1) + \delta(t-3)$. The value of the step response at t = 2 is

(a) 0 (b) 1
(c) 2 (d) 3

42. Two magnetically uncoupled inductive coils have Q factors q_1 and q_2 at the chosen operating frequency. Their respective resistances are R_1 and R_2. When connected in series, their effective Q factor at the same operating frequency is

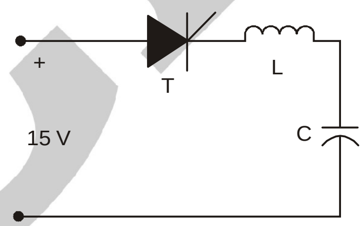
(a) $q_1R_1 + q_2R_2$
(b) $q_1/R_1 + q_2/R_2$
(c) $(q_1R_1 + q_2R_2) / (R_1 + R_2)$
(d) $q_1R_2 + q_2R_1$

43. The following arrangement consists of an ideal transformer and an attenuator which attenuates by a factor of 0.8. An ac voltage V_{wx1} = l00V is applied across WX to get an open circuit voltage V_{yz1}, across YZ. Next, an ac voltage V_{yz2} = 100V is applied across YZ to get an open circuit voltage V_{wx2} across WX. Then, V_{yz1} V_{wx1}/ V_{WX2} / V_{YZ2} are respectively.



(a) 125/100 and 80/100
(b) 100/100 and 80/100
(c) 100/100 and 100/100
(d) 80/100 and 80/100

44. Thyristor T in the figure below is initially off and is triggered with a single pulse of width 10 μs. It is given that $L = \left(\frac{100}{\pi}\right)\mu H$ and $C = \left(\frac{100}{\pi}\right)\mu F$. Assuming latching and holding currents of the thyristor are both zero and the initial charge on C is zero, T conducts for



(a) 10 μs (b) 50 μs
(c) 100 μs (d) 200 μs

45. A 4-pole induction motor, supplied by a slightly unbalanced three-phase 50 Hz source, is rotating at 1440 rpm. The electrical frequency in Hz of the induced negative sequence current in the rotor is

(a) 100 (b) 98
(c) 52 (d) 48

46. A function $y = 5x^2 + 10x$ is defined over an open interval x = (1, 2). At least at one point in this interval, $\frac{dy}{dx}$ is exactly.

(a) 20 (b) 25
(c) 30 (d) 35

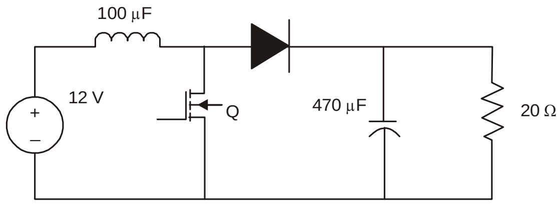
47. When the Newton-Raphson method is applied to solve the equation $f(x) = x^3 + 2x - 1 = 0$, the solution at the end of the first iteration with the initial guess value as $x_0 = 1.2$ is

(a) - 0.82 (b) 0.49
(c) 0.705 (d) 1.69

COMMON DATA QUESTIONS

Common Data for Questions 48 and 49:

In the figure shown below, the chopper feeds a resistive load from a battery source. MOSFET Q is switched at 250 kHz, with a duty ratio of 0.4. All elements of the circuit are assumed to be ideal.



48. The average source current in Amps in steady-state is

(a) 3/2 (b) 5/3
(c) 5/2 (d) 15/4

49. The PEAK-TO-PEAK source current ripple in Amps is

(a) 0.96 (b) 0.144
(c) 0.192 (d) 0.288

Common Data for Questions 50 and 51:

The state variable formulation of a system is given as

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix} = \begin{bmatrix}-2 & 0\\ 0 & -1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} + \begin{bmatrix}1\\ 1\end{bmatrix}u,$$

$x_1(0) = 0$

$x_2(0) = 0$

and $y = \begin{bmatrix}1 & 0\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}$

50. The system is

(a) controllable but not observable
(b) not controllable but observable
(c) both controllable and observable
(d) both not controllable and not obser- vable

51. The response y(t) to a unit step input is

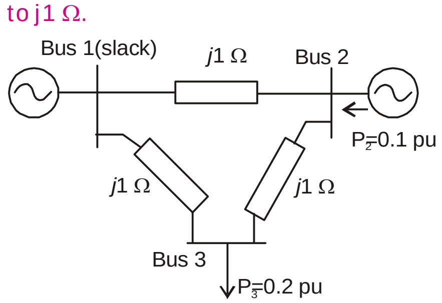
(a) $\frac{1}{2} - \frac{1}{2}e^{-2t}$ (b) $1 - \frac{1}{2}e^{-2t} - \frac{1}{2}e^{-t}$

(c) $e^{-2t} - e^{-t}$ (d) $1 - e^{t}$

LINKED ANSWER QUESTIONS

Statement for Linked Answer Questions 52 and 53:

In the following network, the voltage magnitudes at all buses are equal to 1 p.u., the voltage phase angles are very small, and the line resistances are negligible. All the line reactances are equal to j1 Ω.



52. The voltage phase angles in rad at buses 2 and 3 are

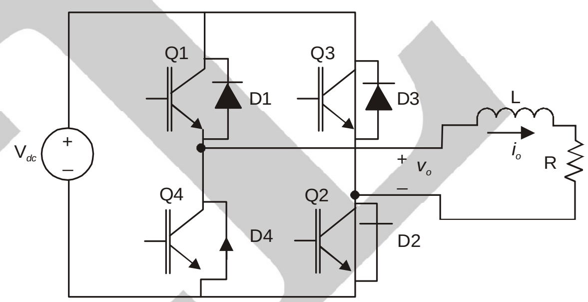
(a) $\theta_2 = -0.1, \theta_3 = -0.2$ (b) $\theta_2 = 0, \theta_3 = -0.1$
(c) $\theta_2 = 0.1, \theta_3 = 0.1$ (d) $\theta_2 = 0.1, \theta_3 = 0.2$

53. If the base impedance and the line-to-line base voltage are 100Ω and 100 kV, respectively, then the real power in MW delivered by the generator connected at the slack bus is

(a) - 10 (b) 0
(c) 10 (d) 20

Statement for Linked Answer Questions 54 and 55:

The Voltage Source Inverter (VSI) shown in the figure below is switched to provide a 50 Hz, square-wave ac output voltage (v_0) across an R-L load. Reference polarity of v_0 and reference direction of the output current i_0 are indicated in the figure. It is given that R = 3 Ω, L = 9.55 mH.



54. In the interval when $v_0 < 0$ and $i_0 > 0$ the pair of devices which conducts the load current is

(a) Q1, Q2 (b) Q3, Q4
(c) D1, D2 (d) D3, D4

55. Appropriate transition i.e., Zero Voltage Switching (ZVS)/Zero Current Switching (ZCS) of the IGBTs during turn-on/turn-off is

(a) ZVS during turn-off
(b) ZVS during turn-on
(c) ZCS during turn-off
(d) ZCS during turn-on

GENERAL APTITUDE (GA) QUESTIONS

Q.56 to Q.60 carry one mark each.

56. They were requested not to quarrel with others.

Which one of the following options is the closest in meaning to the word quarrel?

(a) make out (b) call out
(c) dig out (d) fall out

57. In the summer of 2012, in New Delhi, the mean temperature of Monday to Wednesday was 41°C and of Tuesday to Thursday was 43°C. If the temperature on Thursday was 15% higher than that of Monday, then the temperature in °C on Thursday was

(a) 40 (b) 43
(c) 46 (d) 49

58. Complete the sentence:

Dare _________ mistakes.

(a) commit (b) to commit

(c) committed (d) committing

59. Choose the grammatically CORRECT sentence:

(a) Two and two add four.

(b) Two and two become four.

(c) Two and two are four.

(d) Two and two make four.

60. Statement: You can always give me a ring whenever you need.

Which one of the following is the best inference from the above statement?

(a) Because I have a nice caller tune.

(b) Because I have a better telephone facility.

(c) Because a friend in need is a friend indeed.

(d) Because you need not pay towards the telephone bills when you give me a ring.

Q.61 to Q.65 carry two marks each.

61. What is the chance that a leap year, selected at random, will contain 53 Saturdays?

(a) 2/7 (b) 3/7

(c) 1/7 (d) 5/7

62. Statement: There were different streams of freedom movements in colonial India carried out by the moderates, liberals, radicals, socialists, and so on.

Which one of the following is the best inference from the above statement?

(a) The emergence of nationalism in colonial India led to our Independence.

(b) Nationalism in India emerged in the context of colonialism.

(c) Nationalism in India is homogeneous.

(d) Nationalism in India is heterogeneous.

63. The set of values of p for which the roots of the equation $3x^2 + 2x + p(p - 1) = 0$ are of opposite sign is

(a) $(-\infty, 0)$ (b) $(0, 1)$

(c) $(1, \infty)$ (d) $(0, \infty)$

64. A car travels 8 km in the first quarter of an hour, 6 km in the second quarter and 16 km in the third quarter. The average speed of the car in km per hour over the entire journey is

(a) 30 (b) 36

(c) 40 (d) 24

65. Find the sum to n terms of the series 10 + 84 + 734 + ...

(a) $\frac{9(9^n+1)}{10}+1$ (b) $\frac{9(9^n-1)}{8}+1$

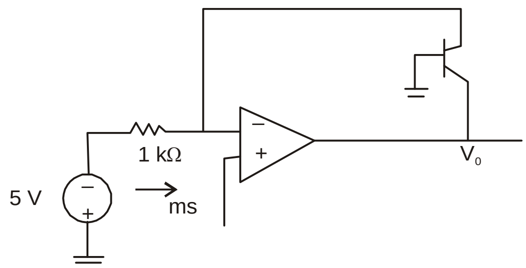
(c) $\frac{9(9^n-1)}{8}+n$ (d) $\frac{9(9^n-1)}{8}+n^2$

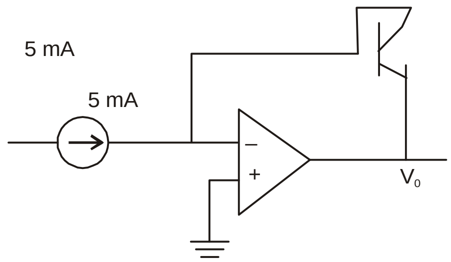
ANSWERS

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

EXPLANATIONS

1.





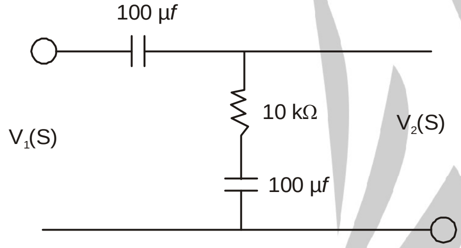
$I = I, e\ I = I_0 e^{\frac{V_{RE}}{V_T}}$

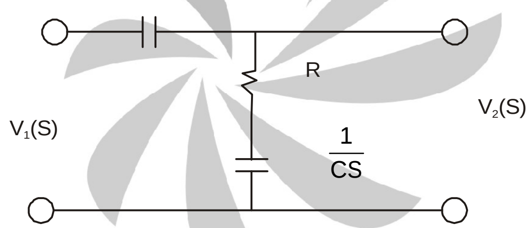
$I = I_0 e^{-\frac{V_0}{V_T}}$

$-V_0 = V_T \left(\ln \frac{I}{I_0} \right) = V_T \ln \left(\frac{I_3 ms}{I_s} \right)$

$V_0 = -0.7$

2.





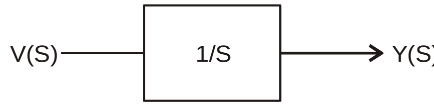
By voltage division rule

$$v_2(s) = \frac{R + \frac{1}{cs}}{R + \frac{1}{cs} + \frac{1}{cs}} V_1(s)$$

$$\frac{v_2(s)}{v_1(s)} = \frac{10\times10^3 + \frac{1}{100\times10^{-6}s}}{10\times10^3 + \frac{2}{100\times10^{-6}s}} = \frac{10^4 + \frac{10^4}{s}}{10^4 + 11}$$

$$\frac{v_2(s)}{v_1(s)} = \frac{(s+1)}{(s+2)}$$

3.



$$\frac{y(s)}{v(s)} = \frac{1}{s}$$

$$y(s) = \frac{1}{s} \times u(s)$$

For unit step 3/P

$$v(s) = \frac{1}{s}$$

$$y(s) = \frac{1}{s^2}$$

$$y(t) = t\,u(t)$$

4. $h(t) = t\,u(t)$

$$h(s) = \frac{1}{s^z}$$

Hence $\frac{y(s)}{v(s)} = \frac{1}{s^z}$

$$y(s) = \frac{1}{s^z} v(s)$$

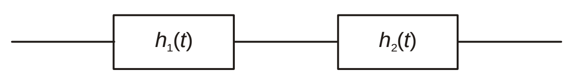
5. Continue time casual and stable LTI system.

A system is casual if only and if y(to) output of a system at time constant (to) depends only on x(y) for $y \le$ to

$x(y) \rightarrow$ input to the system

for stability all poles of the system lie on the left side of jw axis or splan axis. Poles are nothing but roots of the characterstic equation.

6. Tow systems with impulse responses $(h_1)(t)$ and $h_2(t)$ are connected in cascade



Then the overall impulse response of the Cascaded system in given by convolution $h_1(t)$ and $h_2(t)$

Overall Impulse Respone = Convolution of $(h_i(+1)), h_2(+)$

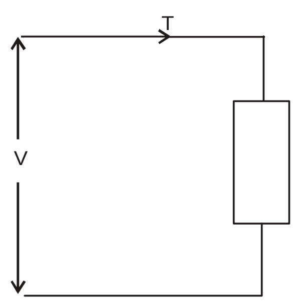
= Product of $H_1(s)$, $H_2(s)$

Where $H_1(s)$, $H_2(s)$ are transfer function is S domain.

7. For max power

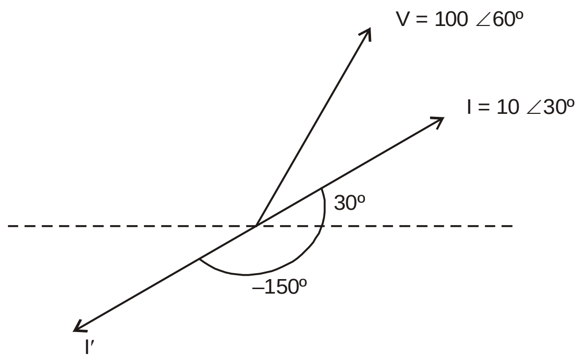
$$R_L = \sqrt{R_s^2 + X_s^2} = \sqrt{4^2 + 3^2} = 5$$

8 .



$V = 100 \angle 60^o$

$I = -10 \angle -150^o$ (source to load current)



P complex power

$= V_I^* = 100\angle 60° \; 10\angle -30° = 1000 \angle 30°$

$= 1000 \cos 30° + J\, 1000 \sin 30°$

Hence load absorbs both active and reactive power.

9. $P_0 = 64$ watt

$P_{cu} = 81$ watt at 90% of rated load

$81 = (0.9\ {}^sf_l^2)R$

$${}^sf_l^2\, R = \frac{81}{(0.9)^2} = 100$$

P_{cu} fl = 100 w

For maximum efficiency

$$I = {}^sf_l \sqrt{\frac{P_0}{P_{cufl}}} = \sqrt{\frac{64}{100}} \text{ if}$$

$I = 0.81\ I_{fl}$

10. $B = 4_x \hat{a}_x + 2k_y \hat{a}_y + 8\hat{a}_3$

Divergence of magnetic flux density is zero

That is $\cup \cdot B = 0$

$$\frac{\partial}{\partial x}(4x) + \frac{\partial}{\partial y}(2ky) + \frac{\partial}{\partial f} \cdot 8 = 0$$

$\Rightarrow \quad 4 + 2x + 0 = 0 \quad \Rightarrow k = -2$

$\therefore$ Option A.

11 . $f(n) = e^{-n}$

$0 \angle n \angle \infty$

$P(n > 1)\ (n) = e^{-n} = 1 - P(x \le 1)$

$$P(x \le 1) = \int_{-\infty}^{1} f(x)dn = \int_{-\infty}^{1} -e^n dn$$

$$= \left|\frac{-e^{-x}}{-1}\right|_{-\infty}^{1} = e^{-1} - 0 = 0.367$$

Thus $= 1 - P(x \le 1)$

$= 1 - 0.367 = 0.6321$

Alternative

$$P(x > 1) = \int_1^\infty e^{-x}dx = -\left[e^{-x}\right]_1^\infty$$

$$= -\left[e^{-\infty} - e^{-1}\right] = \left[0 - \frac{1}{e}\right]$$

$$= \frac{1}{e} = 0.368 = 1 - (0.368) = \underline{0.632}$$

12. $v = 2x^2 y + 3y^2 z + 4z^2 x$

Curl of gradient of scalar field 'v' is

$\rightarrow \nabla \times (4xy + 4z^2)\ \hat{a}_x + (2x^2 + 6yz)\ \hat{a}_y + (3y^2 + 8zx)\ \hat{a}_z$

$$= \begin{vmatrix} \hat{a}_x & \hat{a}_y & \hat{a}_z \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ (4xy + yz^2) & (2x^2 + 6yz) & (3y^2 + 8zx) \end{vmatrix}$$

$$= \hat{a}_x(6y - 6y) - \hat{a}_y(8z - 8z) + \hat{a}_z(4x - 4x)$$

13. As the feed back some shunt - As the feed back is increased by feats x

$Z_{in}^1 = Z_i(1 + kB)$

$Z_{out} = Z_{out}(1 + kB)$

so input impedance increases and output impedance increases.

14. $V = 2x^2y + 3y^2z + 4z^2x$

Curl (grad v) = $\nabla \times \nabla$ v

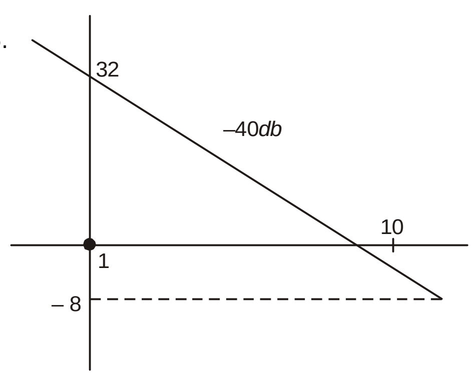
$$\nabla v = i\frac{\partial}{m}(2x^2y + 3y^2z + 4z^2x) + \hat{j}\frac{\partial}{\partial y}(2x^2y + 3y^2z + 4z^2x) + k\frac{\partial}{\partial z}(2x^2y + 3y^2z + 4z^2x)$$

$$\nabla v = i\left[4xy + 4z^2\right] + \hat{j}\left[2x^2 + 6yz\right] + k\left[3y^2 + 8zx\right]$$

$$\nabla \times \nabla v = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \frac{\partial}{m} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ 4xy + 4z^2 & 2x^2 + 6yz & 3y^2 + 8zu \end{vmatrix}$$

$$= i(6y - 6y) - \hat{j}(8z - 8z) + \hat{k}\ (4x - 4x) = 0$$

15.



$\Rightarrow \quad 20 \log k = 32$

$k = 10^{1.6} = 39.8$

$\Rightarrow$ As slope is - 40db/decode so two pols at ons'm

$$\text{so } t(s) = \frac{39.8}{32}$$

16.

0	1	1
1	0	1
0	0	0
1	1	0

so - suitch is EXOR GATE

17. v(t) =30 sin 100 t + 10 cos 3 cot + 6 sin (500 t + $^{\pi}/_{4}$)

Hence fundamental freq in real, = 100

18. (A) As f_{max} = 5 kHz

f sampling $\geq$ 2 f_{max} = 2 f_{max} = 10 kHz

Not 12, 15, 20 kHz a valid samply frequency so sampling frequency f_s, such is not valid sampling frequency,

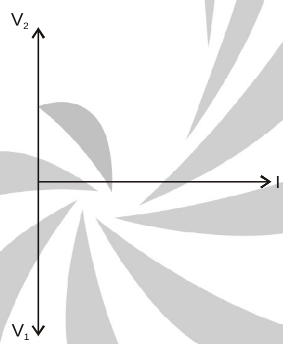
19.
$$z_y = \frac{Z_\Delta}{3}$$
$$Z_y' = \frac{kZ_\Delta}{3}$$
$$Z_y' = kZ_y$$

Hence scall factor is K

20. In swing equation δ is the angular displacement of an axis fixed to the rotor with respect to a synchronously rotating axis.

21. In two invtually coupled coil leakage flux is the flux that links with one coil only.

22.



$v_2 > v_1$ and phase difference is 180 and hence Ms voltmeter will read

$$v = v_2 - v_1$$

23. Let a + ib = $\sqrt{-i}$

Sequencing both the sides, we get

$$a^2 - b^2 + 2ab\, i = - i$$

Equating real and imaginary parts

$$a^2 - b^2 = 0 \Rightarrow a = \pm b$$
$$2ab = -1$$

when a =b $\Rightarrow 2b^2 = -1$ $\quad b^2 = -\frac{1}{2}$

$$b = \pm \frac{i}{\sqrt{2}}$$

when $\quad b = \frac{i}{\sqrt{2}} \quad a = \frac{i}{\sqrt{2}}$

$$a + ib = \frac{i}{\sqrt{2}} + \left(\frac{1}{\sqrt{2}}\right) = -\frac{1}{2} + \frac{i}{\sqrt{2}}$$

when $\quad b = \frac{-i}{\sqrt{2}} \quad a = \frac{-i}{\sqrt{2}}$

then $\quad a + ib = \frac{-i}{\sqrt{2}} + i\left(\frac{-i}{\sqrt{2}}\right) = \frac{-i}{\sqrt{2}} + \frac{1}{\sqrt{2}}$

$$= \frac{1}{\sqrt{2}} - {}^{i}/_{\sqrt{2}} = \cos {}^{\pi}/_{4} + i\ln\left(-{}^{\pi}/_{4}\right)$$

$$\text{or } \cos\left(-{}^{\pi}/_{4}\right) + i\ln\left(-{}^{\pi}/_{4}\right)$$

24. B.F $= y^2x\, a_x - yz\, a_y - x^2\, a_z$

$$l = xi + yj + z\hat{k}$$
$$dl = dx\, i + dyj + dz\, \hat{k}$$
$$F = y^2x\, i - yzj - x^2\hat{k}$$
$$\int F.dl = \int y^2x\, dx - yz\, dy - x^2 dz$$

along x-axis, y = 0, z = 0 The integral reduces to zero.

25. $\begin{bmatrix} 2 & -2 \\ 1 & -1 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$

$$P_2 - P_2 - \frac{1}{2}P_1$$

$$\begin{bmatrix} 2 & -2 \\ 0 & 0 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix} \text{ rank} = 1$$

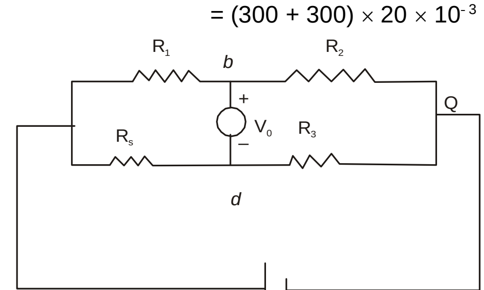
no of linearly independent

$$2x_1 - 2x_2 = 0$$

Therefore infinite sol.

26. Maximum permissible voltage

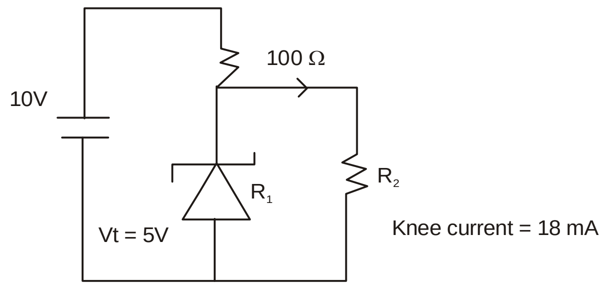
$$= (300 + 300) \times 20 \times 10^{-3} = 12V$$



when R_s is increased by 1% new value of

$$R_e' = 303\ \Omega$$
$$v_0 = v_0 - v_1 = v_{mm} - v$$
$$= 6 - \frac{300}{603} \times 12 = (6 - 5.97)v$$
$$= 0.03 \text{ v} = 30\text{mv}$$

27.



$R_L \text{ min} = \dfrac{5}{I_{L\max}}$

$I_{100} = \dfrac{10-5}{100} = \dfrac{5}{100} = 50 \text{ mA}$

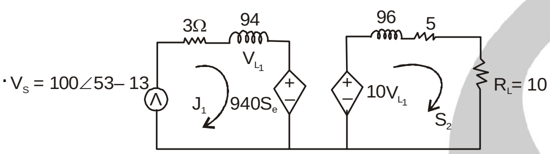
$I_{L\max} = I_{100} - I_{knee} = 40 \text{ mA}$

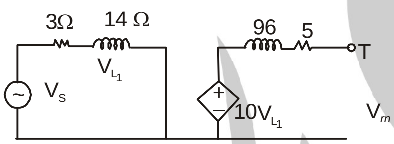
$RL \text{ min} = \dfrac{5}{40} \times 1000 = 125\ \Omega$

minimum power rating of zener should

$= 50\text{mA} \times 5\text{V} = 250 \text{ mw}$

29.



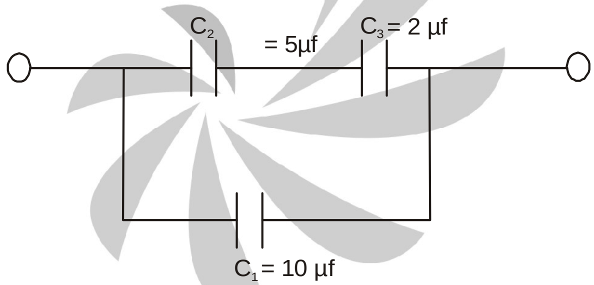


$V_{\tau n} = 10\ V_{L1} = 10 \times \left(\dfrac{4\angle 90^o}{30 + 4\angle 90^o}\right) 100\angle 53^\circ$

$= 10 \times \dfrac{4\angle 90}{5\angle 53.13} \times 100\angle 53.13$

$= 800\ \angle 90^\circ$

30.



Let applied voltage be v

$V_{c_1} = v$

$V_{c_2} = \dfrac{c_3}{c_3 + c_2} v = \dfrac{2}{7} v$

$V_{c_3} = \dfrac{5}{7} v$

If v = 7 as per options

$V_{c_3} = 5$ v · > Breakdown voltage of C_3

and hence $v = 2.8v$

$q = C_{eq}.\ V = 32$ Columb

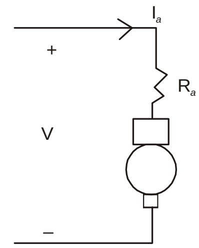
31. During +ve half cycle all the diodes are off and hence $V_{wx} = 0$

During - ve half cycle all the diodes are ON and hence $V_{wx} = 0$

32. I_a rated = 20A

Vrated = 150V.

$R_a = 1i$



$V = I_a R_a + E_b$

$150 = 20 + 6$

$E_b = 130V$

Rated torque $T = K_a\ \phi\ I_a$., $T \alpha\ I_a$

'ϕ' is constant, as it is seperately excited D.C. motor & armature reaction is also neglated.

Hence for obtaining 50% of roted torque I_a should be dropped by 50% i.e. $\dfrac{I_a}{2}$ so $I_{an} = \dfrac{20}{2} = 10A$

speed should be constant so

$V_N = 130 + 10$

$= 140V$

It is step down chopper

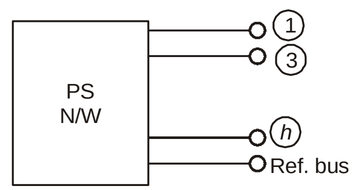
$V_0 = Vs\delta$

δ = duty ratio

$140 = 2006$

$\delta = 0.7$

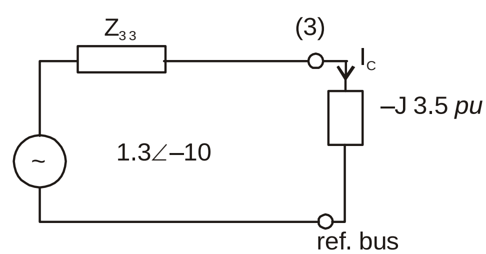
33.



Thevenin's equivalent impedance between bus (3) and ref. bus is Z_{33}

$Z_{33} = 10.5$ pu

Thevenin's equivalent voltage between bus (3) and ref. bus = $1.3 \angle -10°$



$$I_C = \frac{13\angle -10}{j0.5 - j3.5}$$

$$= \frac{1.3\angle -10}{-j3.0} = 0.433\angle 80°$$

34. $E = 1 \in E^2 \times Av$

$$= \frac{1}{2} \times 8.85 \times 10^{-12} \times 10^{2} \times 10^{12} \times .5 \times .5 \times .4 = 88.57$$

36. Poles are given by

$z^2 + 4 = 0$

$z = \pm 2i$

Both poles lies inside a circle

Resdiue at $z = 2i = 4 (z - 2i) (z^2 - 4)$

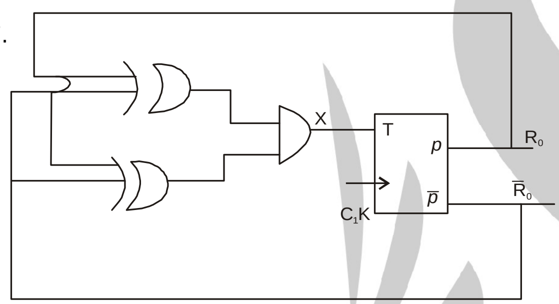
Residue at $z = - 2_1$

$$\underset{z \to -21}{\text{Lt}} (z+2i) = \frac{(z^2-4)}{(z-2i)(z+2i)} = \frac{-8}{-4i} = \frac{2}{i}$$

Sum of Residue = $-\frac{2}{1} + \frac{2}{1}$

$$\oint \frac{z^2-4}{z^2+4} dz = 2\pi i (\text{Sum or Residue}) = 2\pi i(0)$$

37.



From above fig.

$$X = \left[\left(Q \oplus \bar{Q} \right) \cdot \left(\overline{Q \oplus \bar{Q}} \right) \right]$$

X = 1 because

$Q \oplus \bar{Q} = 1$ always

$\Rightarrow$ $\overline{Q \oplus \bar{Q}} = 0$ always

$\therefore$ $\overline{\left(Q \oplus \bar{Q} \right) \cdot \left(\overline{Q \oplus \bar{Q}} \right)}$

$$= \left(\bar{1} \cdot 0 \right) = 0 = 1$$

$\therefore$ 'T' input = 1 always

for 'τ' flip flop of input = 1 then O/P will be implemented at the time of triggering.

$\therefore$ $f_1 = 0.5(f) = 0.5(1) = 0.5$KHt

38. $\begin{bmatrix} -1 & 0 \\ 0 & -2 \end{bmatrix}$ | A - 11| = 0 Satisfy all the criteria

40. By using Masongain formula:

$$TF = \frac{\frac{1}{s_2}(1-0) + \frac{1}{s}(1-0)}{1 - \left[\frac{-2}{s^2} - \frac{2}{s} - \frac{4}{s} \right]}$$

$$= \frac{s+1}{s^2 + 6s + 2}$$

41. Apply Laplace transform

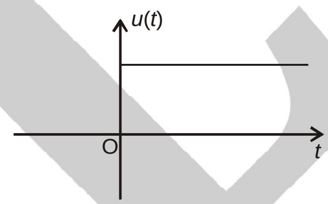
$h(s) = e^{-s} + e^{-3s}$

for input step voltage $\rightarrow$

$y(s) = h(5) \cdot 1/3$

$$= \left[e^{-s} + e^{-3s} \right] 1/s$$

$y(t) = 4(t - 1) + 4(t - 3)$



$\mu(t) = 1$ for t 30 = 0 prt < 0

$\therefore$ O/P in y(2) 4(z - 1) + 4(2 - 3) =(4 - 1)

= 4(z - 1) + 4 (2 - 3)

= 4(1) + (4 - 1) = 0 + 1 = 1

42. $q_1 = \frac{WL_1}{R_1} \quad \Rightarrow L_1 = \frac{q_1 R_1}{W}$

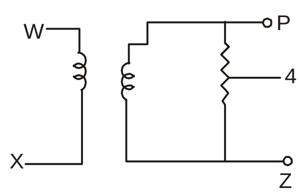
$q_2 = \frac{WL_2}{R_2}$

when connected in series

$L_{eq} = L_1 + L_2$, $R_{eq} = R_1 + R_2$

$$q_{eq} = \frac{WL_{eq}}{R_{eq}} = \frac{WL_1 + WL_2}{R_1 + R_2} = \frac{q_1 R_1 + q_2 R_2}{R_1 + R_2}$$

43.



where

$V_{w \times 1} = 100V$

$V_{pz} = 1.25 \times 100 = 125V$

$V_{yz_1} = 0.8 \times 125 = 100V$

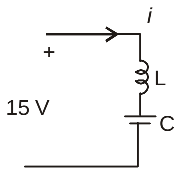
Hence $\frac{V_{yz_1}}{V_{w \times 1}} = \frac{100}{100}$

when $V_{yz_2} = 100V$

$V_{pz_2} = 125V$

$V_{w \times 2} = 100V$

44. When thyristor ON



$$Is = L\frac{di}{dt} + \frac{1}{C}\int_0^t i\,dt$$

$$\frac{Is}{s} = L[bI/s] + \frac{1}{c}\frac{I(s)}{s}$$

$$I(s) = \frac{15C}{Lcs^2+1}$$

$$I(s) = \frac{15/L}{s^2 \times \frac{1}{L1}} = \frac{\frac{15}{L}\times\frac{\sqrt{LL}}{\sqrt{LL}}}{r^2 \times |1|^2}$$

45. $$S = \frac{1500-1440}{1500} = 0.04$$

frequency of +ve seq. current in rotor

$$= \left(\frac{1500-1440}{1500}\right)\times 50 = 0.04 \times 50$$

rreq. of - ve current in rotor

$$= \left(\frac{1500+1440}{1500}\right)\times 50$$

= 98 Hz.

46 . $y = 5x^2 + 10x$ (1, 2)

$$\frac{dy}{dx} = 10x + 10$$

when $x = 1.5$

$$\frac{dy}{dx} = 10 \times 1.5 + 10 = 25$$

47. $f(x) = x^3 + 2x - 1 = 0$

Newton = Raphson method

$$x_{n+1} = x_n - \frac{f(x_n)}{f^1(x_n)}$$

$$= x_n - \frac{x_n^3+2x_n-1}{3x_n^2+2}$$

$$= \frac{3x_n^3+2x_n-x_n^3-2x_n+1}{3x_n^2+2}$$

$$x_{n+1} = \frac{2x_n^3+1}{3x_n^2+2}$$

n = 0

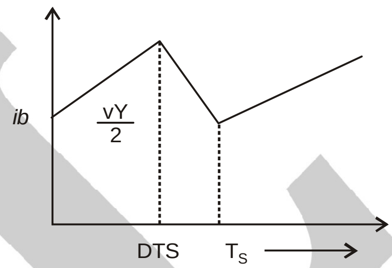
$$x_1 = \frac{2x_0^3+1}{3x_0^2+2} \quad x_0 = 12$$

$$= \frac{2(1.2)^3+1}{3(1.2)^2+2} = \frac{4.456}{6.32}$$

= 0.705

49. $$I_L(\text{Peak- peak}) = \frac{V_n}{L}DT_3$$

D → Duty Ration



$$\begin{cases}\text{Given } f = 250kHz \\ \therefore T = 1/(250 \times S)\end{cases}$$

i.e. peak peak inductor current

$$= \frac{V_{in}}{L}DTs = \frac{12}{(100\times10^{-6})}\times\frac{(0.4)\times1}{2x\times6^2}$$

= 0.192A

50. Matrix $[C^T/1^TC^T] = \begin{bmatrix}1 & -2\\0 & 0\end{bmatrix}$

$$ATCT = \begin{bmatrix}-2 & 0\\0 & -1\end{bmatrix}\begin{bmatrix}1\\0\end{bmatrix} = \begin{bmatrix}-2\\0\end{bmatrix}$$

Rank of Matrix $[C^T/ATCT]$ = 1 because $\begin{vmatrix}1 & -2\\0 & 0\end{vmatrix} = 0$

$\because$ rank = 1 ≠ No. of states = 2

$\therefore$ the system is not observable

51. $\therefore$ $x_1(0); x_2(0) = 0$

$$e^{At} = \lambda^{-1}\left[(s_1 - A)^{-1}\right] = \begin{bmatrix}e^{-2t} & 0\\0 & e^{-t}\end{bmatrix}$$

$$e^{\lambda A} = \begin{bmatrix}e^{+2n} & 0\\0 & e^{tn}\end{bmatrix}, e^{-xA}\cdot B = \begin{bmatrix}e^{t2n} & 0\\0 & e^{TL}\end{bmatrix}\begin{bmatrix}1\\1\end{bmatrix} = \begin{bmatrix}e^{+2n}\\e^{+n}\end{bmatrix}$$

$$\int_0^t e^{-xA}\cdot B_4(x)dx = \begin{bmatrix}\frac{e^{+2t}-1}{2}\\ \frac{e^{+t}-1}{1}\end{bmatrix}$$

$$y(t) = [1\ 0]\begin{bmatrix}\frac{1}{x}(1-e^{-2t})\\ 1-e^{-t}\end{bmatrix}$$

$$\therefore \quad y(t) = \tfrac{1}{2}\left[1-e^{-2t}\right] = \frac{1}{2} - \frac{1}{2}e^{-2t}$$

53. $\begin{bmatrix}Q_2\\Q_3\end{bmatrix}\begin{bmatrix}0\\-0.1\end{bmatrix}$ and $\begin{bmatrix}P_2\\P_3\end{bmatrix} = \begin{bmatrix}0.1\\-0.2\end{bmatrix}$

Now, so $P_1 + P_2 + P_3 = 0$

$P1 + 0.1 - 0.2 = 0 \Rightarrow P_1 = 0.1\ P_2$.

Now, Base $VA = \dfrac{(100\times10^3)^2}{100}$

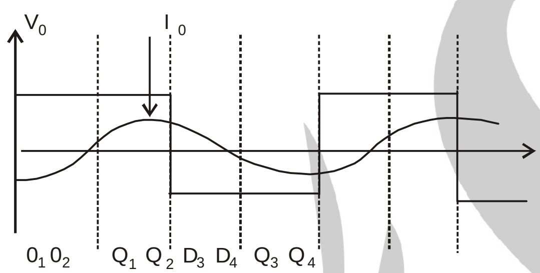
$= 100 \times 10^6$

Base MVA = 100

Real power = 100 × 0.1 = 10 mw

54. In voltage source Inverter

With RL load. Current is lagging



When $V_0 = +V_C$ Either D_1D_2 or $Q_1\ Q_2$ Conduct

but when $\left.\begin{matrix}V_0 = +V_C\\ Z_0 = -V_C\end{matrix}\right\} \rightarrow D_1\ D_2$ Conduct.

similarly $\left.\begin{matrix}V_0 = +V_C\\ I_0 = +V_C\end{matrix}\right\} \rightarrow Q_1\ Q_2$ Conduct.

so when $V_0 = -V_C$, Either $D_3\ D_4\ Q_2\ Q_3\ Q_4$

when $\left.\begin{matrix}V_0 = -V_C\\ I_0 = -V_C\end{matrix}\right\} \rightarrow D_3\ D_4$ Conduct.

when $\left.\begin{matrix}V_0 = -V_C\\ I_0 = -V_C\end{matrix}\right\} \rightarrow Q_3\ Q_4$ Conduct.

So when, $V_0 < 0$ & $i0 > 0$

$$I(s) = 15\sqrt{\frac{C}{L}}\,\frac{\frac{1}{\sqrt{LC}}}{s^{2+}\left(\frac{1}{\sqrt{LC}}\right)^2}$$

$$i(t) = 15\sqrt{\frac{C}{L}}\sin W_{0t}$$

where $W_0 = \dfrac{1}{\sqrt{LC}}$

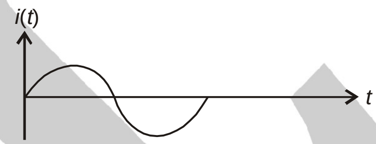
Hence Current is a sinusoidal

$$2\pi f_0 = \frac{1}{\sqrt{LC}}$$

$$f_0 = \frac{10^4}{2} = 5000$$

$$T_0 = \frac{1}{5000} = 2\times10^{-4}\ \text{sec}$$

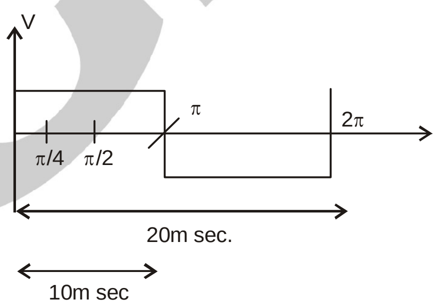
Total time period



as holding current & latching current is zero so. Thyristor is ON for only ** positive half cycle. So time period for which Thyristor is ON is 2×10^{-4}.

55. b = 50 Hz

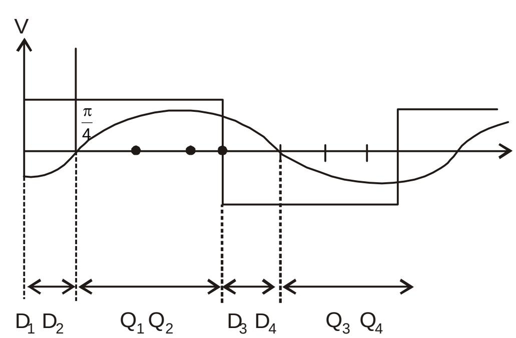
$$T = \frac{1}{50} = 20m\,\text{sec}$$



$$\theta = \tan^{-1}\frac{WL}{R}$$

$$= \tan^{-1}\left(\frac{2\pi\times50\times9.55\times10^{-3}}{3}\right)$$

$$\theta = 45°$$



57. $\frac{\text{Mon} + \text{Tues} + \text{Wed.}}{3} = 41$

Mon + Tues + Wed. = 123 ...(1)

$\frac{\text{Tues} + \text{Wed} + \text{Thurs.}}{3} = 43^o$

Tue + Wed + Thu. = 129° ...(2)

(2) - (1)

Tues + Wed + Thu - (Mon + Tues. + Wed.)

= 129 - 123 = 6°

Thu. - Mon. = 6° $\Rightarrow \frac{115x}{100} - x = 6^o$

Thus. = Mon $\times \frac{115}{100} = \frac{15x}{100} = 6°$

Mon = x x = 40°

Thurs = $\frac{115x}{100}$

$\therefore$ Thurs = $\frac{115 \times 40}{100} = 46^o$

61. at a leap year

52 weeks, and 2 extra day they are (Mon, Tues) (Tues, Wed) (Wed Thu.) (Thus. Fri) (Fri. Sat) (Sat. Sun) (Sun Mond.)

n(s) = 7

n(E) = 2 P(E) = $\frac{2}{7}$

64. Average Speed = $\frac{\text{Total distance}}{\text{total time taken}}$

Total Distance = $\frac{8 + 6 + 16}{15 + 15 + 15} = \frac{30 \times 60}{45}$

= 40km/h.

n n