

GENERAL APTITUDE

Q. No. 1 – 5 Carry One Mark Each

1. Research in the workplace reveals that people work for many reasons_____.
- (A) money beside (B) beside money
(C) money besides (D) besides money

Answer: (D)

2. The probability that a k-digit number does NOT contain the digits 0,5, or 9 is
- (A) 0.3^k (B) 0.6^k (C) 0.7^k (D) 0.9^k

Answer: (C)

3. Find the smallest number y such that $y \times 162$ is a perfect cube.
- (A) 24 (B) 27 (C) 32 (D) 36

Answer: (D)

4. After Rajendra Chola returned from his voyage to Indonesia, he _____ to visit the temple in Thanjavur.
- (A) was wishing (B) is wishing (C) wished (D) had wished

Answer: (C)

5. Rahul, Murali, Srinivas and Arul are seated around a square table. Rahul is sitting to the left of Murali. Srinivas is sitting to the right of Arul. Which of the following pairs are seated opposite each other?
- (A) Rahul and Murali (B) Srinivas and Anil
(C) Srinivas and Murali (D) Srinivas and Rahul

Answer: (C)

Q. No. 6 – 10 carry Two Marks Each

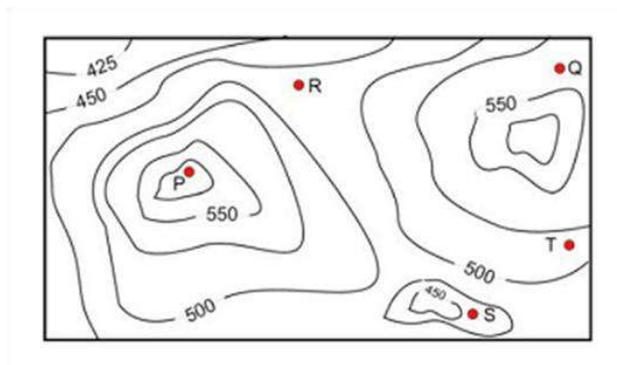
6. Six people are seated around a circular table. There are at least two men and two women. There are at least three right-handed persons. Every woman has a left-handed person to her immediate right. None of the women are right-handed. The number of women at the table is
- (A) 2 (B) 3
(C) 4 (D) Cannot be determined

Answer: (A)

7. The expression $\frac{(x+y)-|x-y|}{2}$ is equal to
- (A) the maximum of x and y (B) the minimum of x and y
(C) 1 (D) none of the above

Answer: (B)

8. A contour line joins locations having the same height above the mean sea level. The following is a contour plot of a geographical region. Contour lines are shown at 25m intervals in this plot. If in a flood, the water level rises to 525m. Which of the villages P,Q,R,S,T get submerged?



- (A) P, Q (B) P,Q,T (C) R,S,T (D) Q,R,S

Answer: (C)

9. Arun, Gulab, Neel and Shweta must choose one shirt each from a pile of four shirts coloured red, pink, blue and white respectively. Arun dislikes the colour red and Shweta dislikes the colour white, Gulab and Neel like all the colours. In how many different ways can they choose the shirts so that no one has a shirt with a colour he or she dislikes?
- (A) 21 (B) 18 (C) 16 (D) 14

Answer: (D)

10. “The hold of the nationalist imagination on our colonial past is such that anything inadequately or improperly nationalist is just not history.”
- Which of the following statements best reflects the author’s opinion?
- (A) Nationalists are highly imaginative.
(B) History is viewed through the filter of nationalism.
(C) Our colonial past never happened
(D) Nationalism has to be both adequately and properly imagined.

Answer: (B)

ELECTRICAL ENGINEERING

Q. No. 1 –25 carry One Mark Each

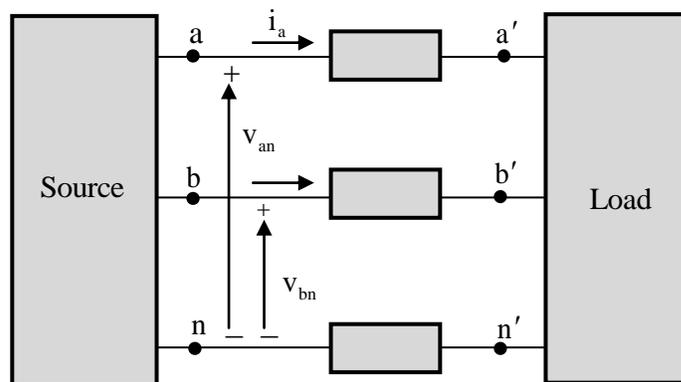
1. Consider $g(t) = \begin{cases} t - \lfloor t \rfloor, & t \geq 0 \\ t - \lceil t \rceil, & \text{otherwise} \end{cases}$

Where $t \in \mathbb{R}$

Here, $\lfloor t \rfloor$ represents the largest integer less than or equal to t and $\lceil t \rceil$ denotes the smallest integer greater than or equal to t . The coefficient of the second harmonic component of the Fourier series representing $g(t)$ is _____.

Answer: (*)

2. A source is supplying a load through a 2-phase, 3-wire transmission system as shown in figure below.



The instantaneous voltage and current in a phase are $v_{an} = 220\sin(100\pi t)$ V and $i_a = 10\sin(100\pi t)$ A respectively. Similarly for phase-b, the instantaneous voltage and current are $v_{bn} = 220\cos(100\pi t)$ V and $i_b = 10\cos(100\pi t)$ A, respectively. The total instantaneous power flowing from the source to the load is

- (A) 2200 W (B) $2200 \sin^2(100\pi t)$ W
 (C) 4400 W (D) $2200\sin(100\pi t)\cos(100\pi t)$ W

Answer: (A)

3. A three-phase, 50Hz, star-connected cylindrical-rotor synchronous machine is running as a motor. The machine is operated from a 6.6 kV grid and draws current at unity power factor (UPF). The synchronous reactance of the motor is 30Ω per phase. The load angle is 30° . The power delivered to the motor in kW is _____.

Answer: (838.31)

4. For a complex number z ,

$$\lim_{z \rightarrow i} \frac{z^2 + 1}{z^3 + 2z - i(z^2 + 2)} \text{ is}$$

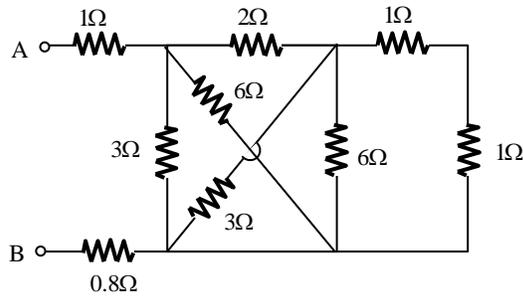
- (A) $-2i$ (B) $-i$ (C) i (D) $2i$

Answer: (D)

- (A) $p = -0.2, q = -0.1, r = -0.5$
- (B) $p = 0.2, q = 0.1, r = 0.5$
- (C) $p = -5, q = -10, r = -2$
- (D) $p = 5, q = 10, r = 2$

Answer: (B)

8. The equivalent resistance between the terminals A and B is _____ Ω .



Answer: (3)

9. The Boolean expression $AB + A\bar{C} + BC$ simplifies to

- (A) $BC + A\bar{C}$
- (B) $AB + A\bar{C} + B$
- (C) $AB + A\bar{C}$
- (D) $AB + BC$

Answer: (A)

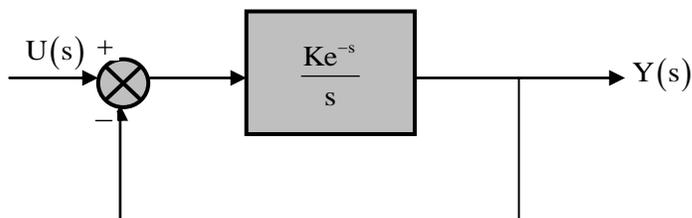
10. The following measurements are obtained on a single phase load:

$$V = 220V \pm 1\%, I = 5.0A \pm 1\% \text{ and } W = 555W \pm 2\%.$$

If the power factor is calculated using these measurements, the worst case error in the calculated power factor in percent is _____.

Answer: (4)

14. Consider the unity feedback control system shown. The value of K that results in a phase margin of the system to be 30° is _____.

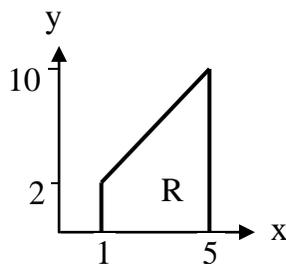


Answer: (1.047)

15. A solid iron cylinder is placed in a region containing a uniform magnetic field such that the cylinder axis is parallel to the magnetic field direction. The magnetic field lines inside the cylinder will
- (A) bend closer to the cylinder axis
 - (B) bend farther away from the axis
 - (C) remain uniform as before
 - (D) cease to exist inside the cylinder

Answer: (A)

16. Let $I = c \iint_R xy^2 dx dy$, where R is the region shown in the figure and $c = 6 \times 10^{-4}$.



The value of I equals _____.

Answer: (0.999)

17. Consider the system with following input-output relation

$$y[n] = [1 + (-1)^n]x[n]$$

Where, $x[n]$ is the input and $y[n]$ is the output. The system is

- (A) invertible and time invariant
- (B) invertible and time varying
- (C) non-invertible and time invariant
- (D) non-invertible and time varying

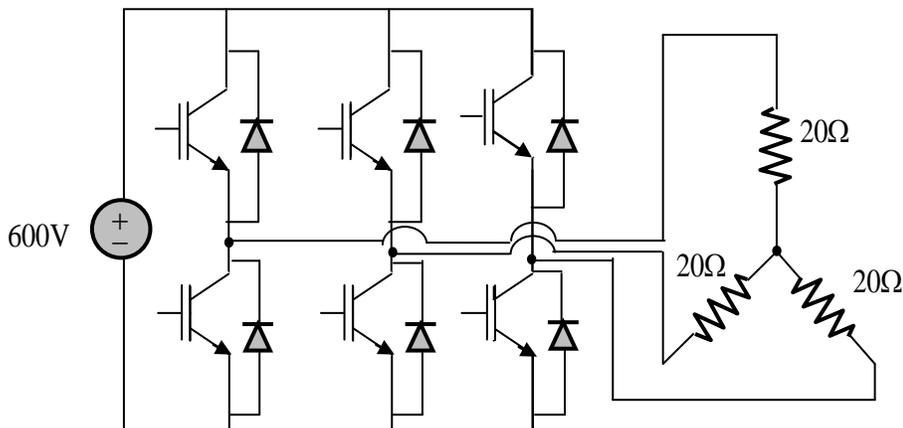
Answer: (D)

18. The slope and level detector circuit in a CRO has a delay of 100 ns. The start-stop sweep generator has a response time of 50 ns. In order to display correctly, a delay line of

- (A) 150 ns has to be inserted into the y-channel
- (B) 150 ns has to be inserted into the x-channel
- (C) 150 ns has to be inserted into both x and y channels
- (D) 100 ns has to be inserted into both x and y channels

Answer: (A)

19. A 3-phase voltage source inverter is supplied from a 600V DC source as shown in the figure below.



For a star connected resistive load of $20\ \Omega$ per phase, the load power for 120° device conduction, in kW is _____.

Answer: (8.99)

20. A closed loop system has the characteristic equation given by $s^3 + ks^2 + (k+2)s + 3 = 0$ For this system to be stable, which one of the following conditions should be satisfied?

- (A) $0 < k < 0.5$ (B) $0.5 < k < 1$
 (C) $0 < k < 1$ (D) $k > 1$

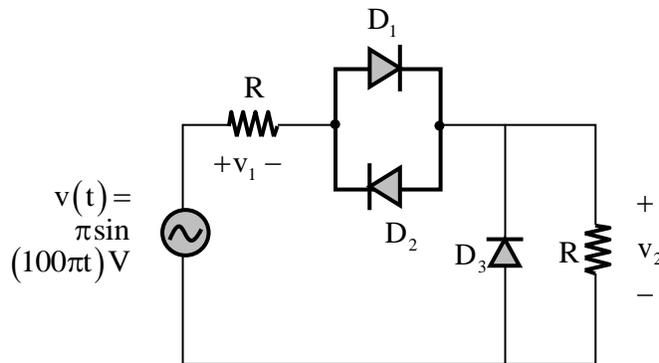
Answer: (D)

21. A 4 pole induction machine is working as an induction generator. The generator supply frequency is 60 Hz. The rotor current frequency is 5 Hz. The mechanical speed of the rotor in RPM is _____.

- (A) 1350 (B) 1650 (C) 1950 (D) 2250

Answer: (C)

22. For the circuit shown in the figure below, assume that diodes D_1 , D_2 and D_3 are ideal.



The DC components of voltages v_1 and v_2 , respectively are

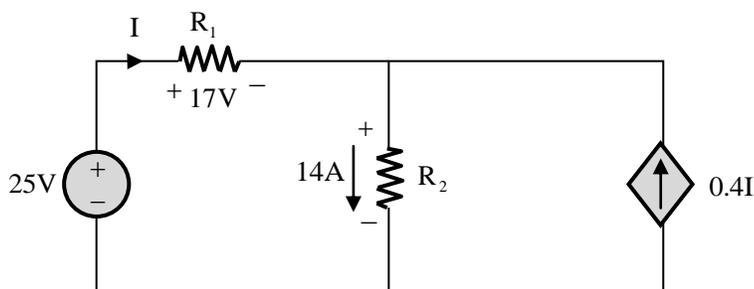
- (A) 0 V and 1 V (B) -0.5 V and 0.5 V
 (C) 1 V and 0.5 V (D) 1 V and 1 V

Answer: (B)

23. A 10-bus power system consists of four generator buses indexed as G1, G2, G3, G4 and six load buses indexed as L1, L2, L3, L4, L5, L6. The generator bus G1 is considered as slack bus, and the load buses L3 and L4 are voltage controlled buses. The generator at bus G2 cannot supply the required reactive power demand, and hence it is operating at its maximum reactive power limit. The number of non-linear equations required for solving the load flow problem using Newton-Raphson method in polar form is _____.

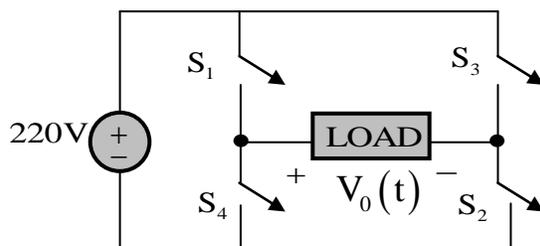
Answer: (14)

24. The power supplied by the 25 V source in the figure shown below is _____W.



Answer: (250)

25. In the converter circuit shown below, the switches are controlled such that the load voltage $V_o(t)$ is a 400 Hz square wave.



The RMS value of the fundamental component of $V_o(t)$ in volts is _____.

Answer: (198.06)

Q. No. 26 – 55 Carry Two Marks Each

26. The output expression for the the Karnaugh map shown below is

	CD			
AB \	00	01	11	10
00	0	0	0	0
01	1	0	0	1
11	1	0	1	1
10	0	0	0	0

(A) $B\bar{D} + BCD$

(B) $B\bar{D} + AB$

(C) $\bar{B}D + ABC$

(D) $B\bar{D} + ABC$

Answer: (D)

27. A 220 V DC series motor runs drawing a current of 30 A from the supply. Armature and field circuit resistances are 0.4Ω and 0.1Ω respectively. The load torque varies as the square of the speed. The flux in the motor may be taken as being proportional to the armature current. To reduce the speed of the motor by 50% the resistance in ohms that should be added in series with the armature is _____.

Answer: (10.75)

28. The transfer function of the system $Y(s)/U(s)$ whose state-space equations are given below is:

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

$$y(t) = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} x_1(t) \\ x_2(t) \end{bmatrix}$$

(A) $\frac{(s+2)}{(s^2 - 2s - 2)}$

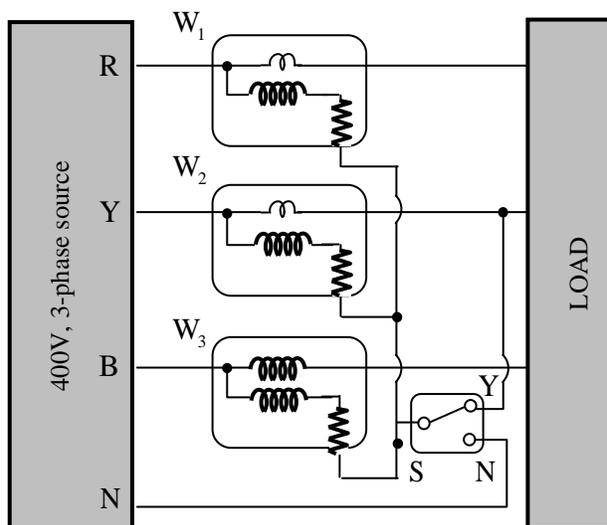
(B) $\frac{(s-2)}{(s^2 + s - 4)}$

(C) $\frac{(s-4)}{(s^2 + s - 4)}$

(D) $\frac{(s+4)}{(s^2 - s - 4)}$

Answer: (D)

29. The load shown in the figure is supplied by a 400 V (line to line) 3-phase source (RYB sequence).

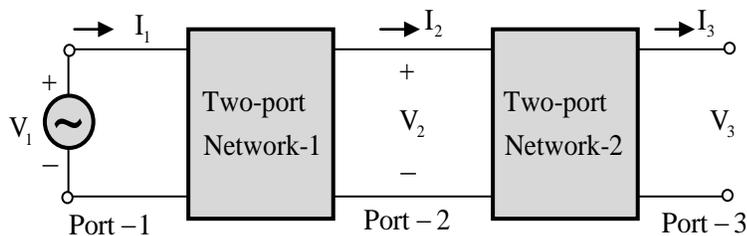


The load is balanced and inductive, drawing 3464 VA. When the switch S is in position N, the three wattmeters W_1 , W_2 and W_3 read 577.35 W each. If the switch is moved to position Y, the readings of the watt-meters in watts will be:

- (A) $W_1 = 1732$ and $W_2 = W_3 = 0$
- (B) $W_1 = 0$, $W_2 = 1732$ and $W_3 = 0$
- (C) $W_1 = 866$, $W_2 = 0$, $W_3 = 866$
- (D) $W_1 = W_2 = 0$ and $W_3 = 1732$

Answer: (D)

30. Two passive two-port networks are connected in cascade as shown in figure. A voltage source is connected at port 1.



Given: $V_1 = A_1 V_2 + B_1 I_2$

$$I_1 = C_1 V_2 + D_1 I_2$$

$$V_2 = A_2 V_3 + B_2 I_3$$

$$I_2 = C_2 V_3 + D_2 I_3$$

$A_1, B_1, C_1, D_1, A_2, B_2, C_2$ and D_2 are the generalized circuit constants. If the Thevenin equivalent circuit at port 3 consists of a voltage source V_T and an impedance Z_T , connected in series, then

(A) $V_T = \frac{V_1}{A_1 A_2}, Z_T = \frac{A_1 B_2 + B_1 D_2}{A_1 A_2 + B_1 C_2}$

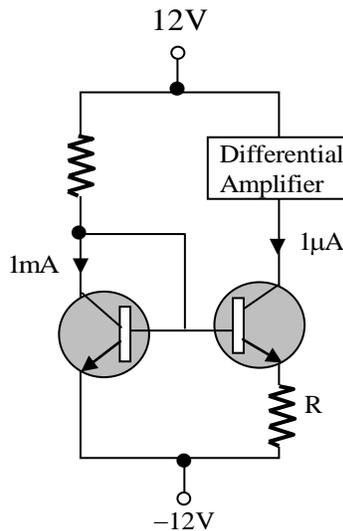
(B) $V_T = \frac{V_1}{A_1 A_2 + B_1 C_2}, Z_T = \frac{A_1 B_2 + B_1 D_2}{A_1 A_2}$

(C) $V_T = \frac{V_1}{A_1 + A_2}, Z_T = \frac{A_1 B_2 + B_1 D_2}{A_1 + A_2}$

(D) $V_T = \frac{V_1}{A_1 A_2 + B_1 C_2}, Z_T = \frac{A_1 B_2 + B_1 D_2}{A_1 A_2 + B_1 C_2}$

Answer: (D)

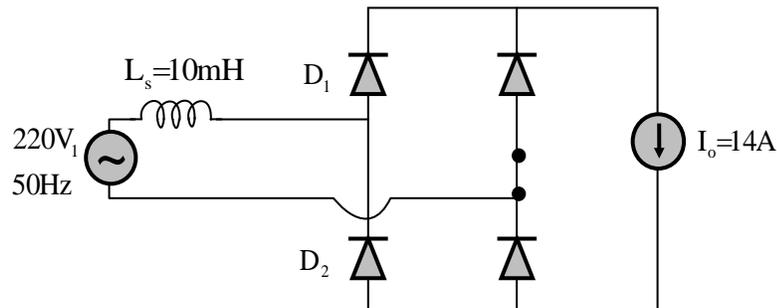
31. The circuit shown in the figure uses matched transistors with a thermal voltage $V_T = 25\text{mV}$. The base currents of the transistors are negligible.



The value of the resistance R in $k\Omega$ that is required to provide $1 \mu A$ bias current for the differential amplifier block shown is _____.

Answer: (172.7)

32. The figure below shows an uncontrolled diode bridge rectifier supplied from a 220 V, 50 Hz 1-phase ac source.



The load draws a constant current $I_o = 14A$. The conduction angle of the diode D_1 in degrees is _____.

Answer: (224.17)

33. Consider the differential equation

$$(t^2 - 81) \frac{dy}{dt} + 5ty = \sin(t) \text{ with } y(1) = 2\pi .$$

There exists a unique solution for this differential equation when 't' belongs to the interval

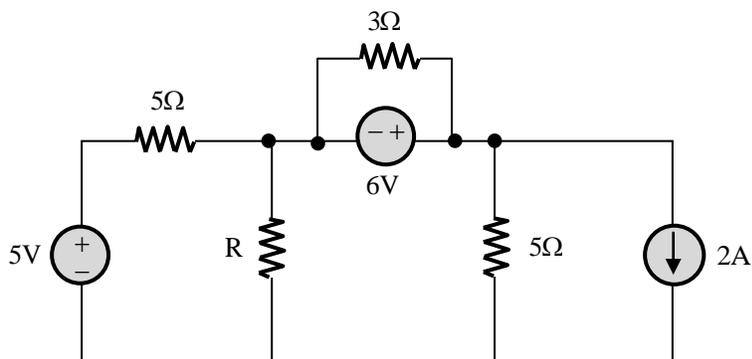
- (A) (-2, 2) (B) (-10, 10) (C) (-10, 2) (D) (0, 10)

Answer: (A)

34. A separately excited DC generator supplies 150 A to a 145 V DC grid. The generator is running at 800 RPM. The armature resistance of the generator is 0.1Ω . If the speed of the generator is increased to 1000 RPM, the current in amperes supplied by the generator to the DC grid is _____.

Answer: (550)

35. In the circuit shown below, the maximum power transferred to the resistor R is _____ W.



Answer: (3.025)

36. Let a causal LTI system be characterized by the following differential equation, with initial rest condition

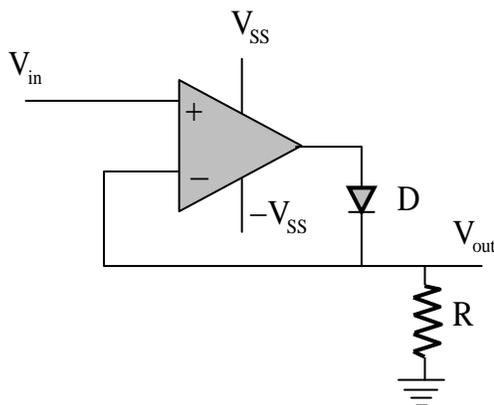
$$\frac{d^2y}{dt^2} + 7\frac{dy}{dt} + 10y(t) = 4x(t) + 5\frac{dx(t)}{dt}$$

Where $x(t)$ and $y(t)$ are the input and output respectively. The impulse response of the system is ($u(t)$ is the unit step function)

- (A) $2e^{-2t}u(t) - 7e^{-5t}u(t)$ (B) $-2e^{-2t}u(t) + 7e^{-5t}u(t)$
 (C) $7e^{-2t}u(t) - 2e^{-5t}u(t)$ (D) $-7e^{-2t}u(t) + 2e^{-5t}u(t)$

Answer: (B)

37. The approximate transfer characteristic for the circuit shown below with an ideal operational amplifier and diode will be



There is a transmission line, connected between buses 1 and 3, which is represented by the circuit shown in figure.

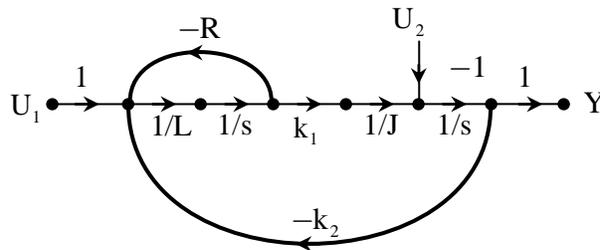
If this transmission line is removed from service, What is the modified bus admittance matrix?

- (A) $\begin{bmatrix} -j19.9 & j20 & 0 \\ j20 & -j39.9 & j20 \\ 0 & j20 & -j19.9 \end{bmatrix}$ pu
- (B) $\begin{bmatrix} -j39.95 & j20 & 0 \\ j20 & -j39.9 & j20 \\ 0 & j20 & -j39.95 \end{bmatrix}$ pu
- (C) $\begin{bmatrix} -j19.95 & j20 & 0 \\ j20 & -j39.9 & j20 \\ 0 & j20 & -j19.95 \end{bmatrix}$ pu
- (D) $\begin{bmatrix} -j19.95 & j20 & j20 \\ j20 & -j39.9 & j20 \\ j20 & j20 & -j19.95 \end{bmatrix}$ pu

Answer: (C)

40. In the system whose signal flow graph is shown in the figure, $U_1(s)$ and $U_2(s)$ are inputs. The transfer

function $\frac{Y(s)}{U_1(s)}$ is



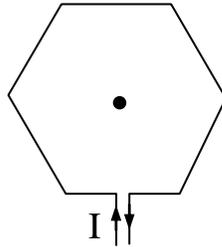
- (A) $\frac{k_1}{JLs^2 + JRs + k_1k_2}$
- (B) $\frac{k_1}{JLs^2 - JRs - k_1k_2}$
- (C) $\frac{k_1 - U_2(R + sL)}{JLs^2 + (JR - U_2L)s + k_1k_2 - U_2R}$
- (D) $\frac{k_1 - U_2(sL - R)}{JLs^2 - (JR + U_2L)s - k_1k_2 + U_2R}$

Answer: (A)

41. For a system having transfer function $G(s) = \frac{-s+1}{s+1}$, a unit step input is applied at time $t=0$. The value of the response of the system at $t=1.5$ sec is _____.

Answer: (0.554)

42. The magnitude of magnetic flux density (B) in micro Teslas (μT) at the center of a loop of wire wound as a regular hexagon of side length 1m carrying a current ($I=1\text{A}$), and placed in vacuum as shown in the figure is _____.



Answer: (0.692)

43. The figure shows the single line diagram of a power system with a double circuit transmission line.



The expression for electrical power is $(1.5 \sin \delta)$, where δ is the rotor angle. The system is operating at the stable equilibrium point with mechanical power equal to 1 pu. If one of the transmission line circuits is removed, the maximum value of δ as the rotor swings, is 1.221 radian. If the expression for electrical power with one transmission line circuit removed is $P_{\max} \sin \delta$, the value of P_{\max} in pu is _____.

Answer: (1.22)

44. A 375W, 230 V, 50 Hz capacitor start single-phase induction motor has the following constants for the main and auxiliary windings (at starting): $Z_m = (12.50 + j15.75)\Omega$ (main winding), $Z_a = (24.50 + j12.75)\Omega$ (auxiliary winding). Neglecting the magnetizing branch the value of the capacitance (in μF) to be added in series with the auxiliary winding to obtain maximum torque at starting is _____.

Answer: (149.5)

45. A function $f(x)$ is defined as

$$f(x) = \begin{cases} e^x, & x < 1 \\ \ln x + ax^2 + bx, & x \geq 1 \end{cases} \quad \text{where } x \in \mathbb{R}$$

Which one of the following statements is TRUE?

- (A) $f(x)$ is NOT differentiable at $x=1$ for any values of a and b .
- (B) $f(x)$ is differentiable at $x = 1$ for the unique values of a and b
- (C) $f(x)$ is differentiable at $x = 1$ for all values of a and b such that $a + b = e$
- (D) $f(x)$ is differentiable at $x = 1$ for all values of a and b .

Answer: (B)

46. Consider a causal and stable LTI system with rational transfer function $H(z)$. Whose corresponding impulse response begins at $n = 0$. Furthermore, $H(1) = \frac{5}{4}$. The poles of $H(z)$ are $P_k = \frac{1}{\sqrt{2}} \exp\left(j \frac{(2k-1)\pi}{4}\right)$ for $k = 1, 2, 3, 4$. The zeros of $H(z)$ are all at $z = 0$. Let $g[n] = j^n h[n]$. The value of $g[8]$ equals _____.

Answer: (0.897)

47. Only one of the real roots of $f(x) = x^6 - x - 1$ lies in the interval $1 \leq x \leq 2$ and bisection method is used to find its value. For achieving an accuracy of 0.001, the required minimum number of iterations is _____.

Answer: (10)

48. Two parallel connected, three-phase, 50Hz, 11kV, star-connected synchronous machines A and B, are operating as synchronous condensers. They together supply 50 MVAR to a 11 kV grid. Current supplied by both the machines are equal. Synchronous reactances of machine A and machine B are 1Ω and 3Ω respectively. Assuming the magnetic circuit to be linear, the ratio of excitation current of machine A to that of machine B is _____.

Answer: (0.744)

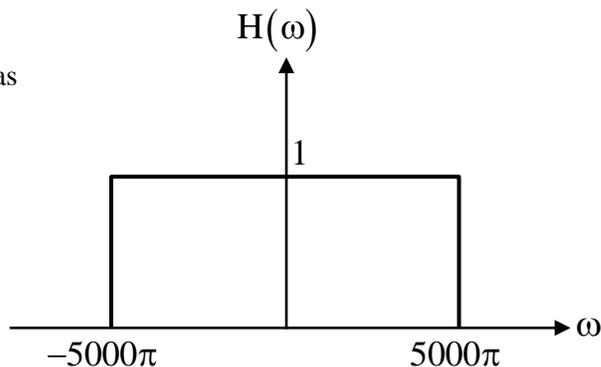
49. The positive, negative and zero sequence reactances of a star-connected synchronous generator are 0.2 pu, 0.2 pu, and 0.1 pu, respectively. The generator is on open circuit with a terminal voltage of 1 pu. The minimum value of the inductive reactance, in pu, required to be connected between neutral and ground so that the fault current does not exceed 3.75 pu if a single line to ground fault occurs at the terminals is _____ (assume fault impedance to be zero).

Answer: (0.1)

50. Let the signal $x(t) = \sum_{k=-\infty}^{+\infty} (-1)^k \delta\left(t - \frac{k}{2000}\right)$ be passed through an LTI system with frequency response $H(\omega)$, as given in the figure below.

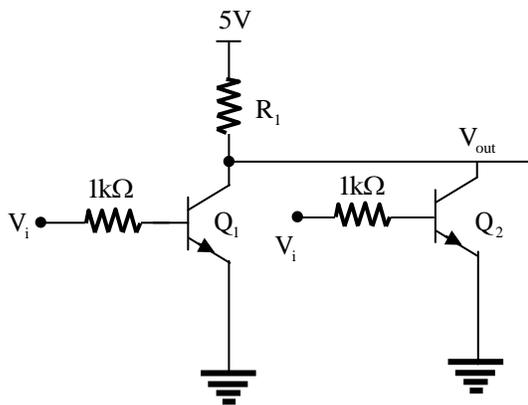
The Fourier series representation of the output is given as

- (A) $4000 + 4000\cos(2000\pi t) + 4000\cos(4000\pi t)$
- (B) $2000 + 2000\cos(2000\pi t) + 2000\cos(4000\pi t)$
- (C) $4000\cos(2000\pi t)$
- (D) $2000\cos(2000\pi t)$



Answer: (C)

51. The logical gate implement using the circuit shown below where V_1 and V_2 are inputs (with 0V as digital 0 and 5V as digital 1) and V_{out} is the output, is



- (A) NOT (B) NOR (C) NAND (D) XOR

Answer: (B)

52. A load is supplied by a 230 V, 50 Hz source. The active power P and the reactive power Q consumed by the load are such that

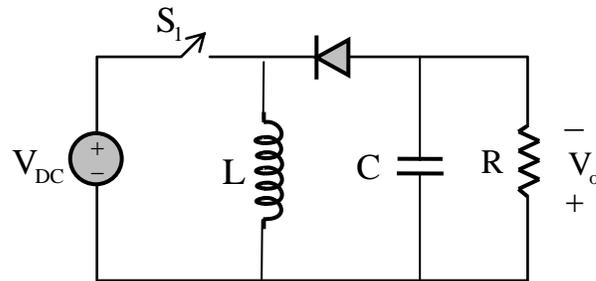
$$1\text{kW} \leq P \leq 2\text{kW} \text{ and } 1\text{kVAR} \leq Q \leq 2\text{kVAR}$$

A capacitor connected across the load for power factor correction generates 1 kVAR reactive power. The worst case power factor after power factor correction is

- (A) 0.447 lag (B) 0.707 lag (C) 0.894 lag (D) 1

Answer: (B)

53. The input voltage V_{DC} of the buck-boost converter shown below varies from 32V to 72V.



Assume that all components are ideal, inductor current is continuous, and output voltage is ripple free. The range of duty ratio D of the converter for which the magnitude of the steady state output voltage remains constant at 48 V is

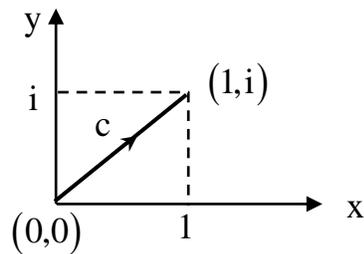
- (A) $\frac{2}{5} \leq D \leq \frac{3}{5}$ (B) $\frac{2}{3} \leq D \leq \frac{3}{4}$ (C) $0 \leq D \leq 1$ (D) $\frac{1}{3} \leq D \leq \frac{2}{3}$

Answer: (A)

54. A three-phase, three winding $\Delta/\Delta/Y$ (1.1kV/6.6kV/400 V) transformer is energized from AC mains at the 1.1 kV side. It supplies 900 kVA load at 0.8 power factor lag from the 6.6 kV winding and 300 kVA load at 0.6 power factor lag from the 400 V winding. The RMS line current in ampere drawn by the 1.1 kV winding from the mains is _____.

Answer: (625.09)

55. Consider the line integral $I = \int_C (x^2 + iy^2) dz$ where $z = x + iy$. The line C is shown in the figure below.



The value of I is

- (A) $\frac{1}{2}i$ (B) $\frac{2}{3}i$ (C) $\frac{3}{4}i$ (D) $\frac{4}{5}i$

Answer: (B)

***** END OF THE PAPER *****