

GATE-2015

Question Paper

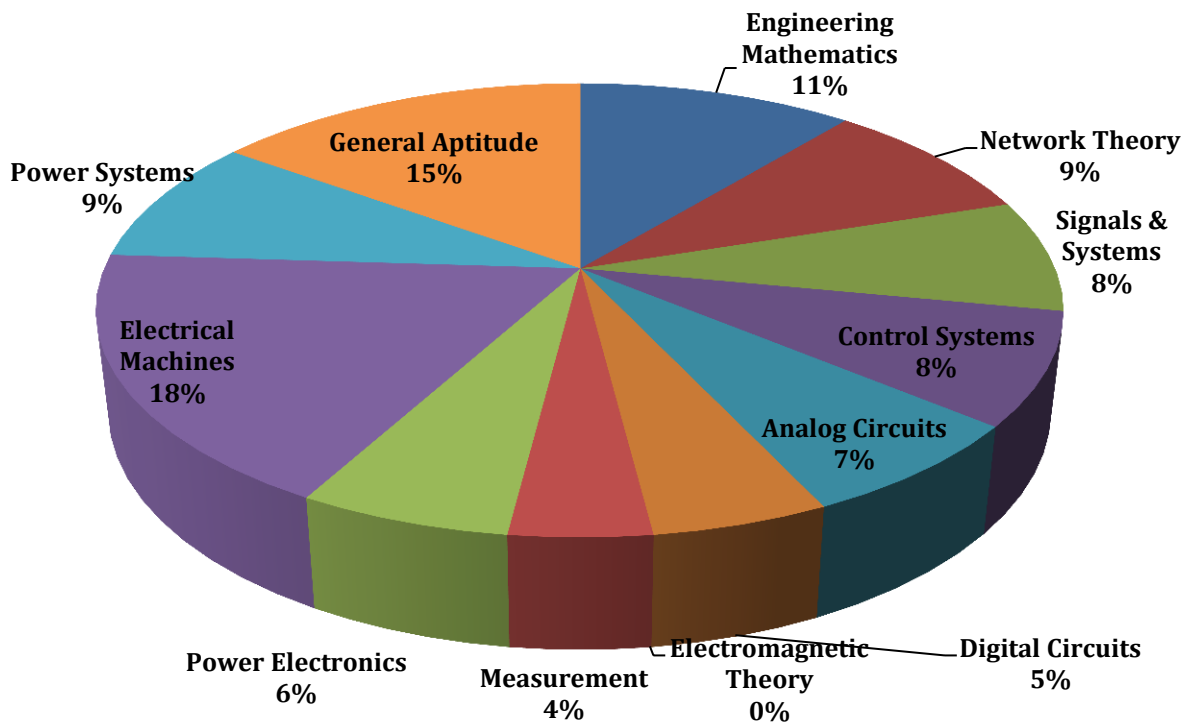
&

Answer Keys

Index

1. Question Paper Analysis
2. Question Paper & Answer keys

ANALYSIS OF GATE 2015 Electrical Engineering



GATE-2015- EE

SUBJECT	NO OF QUESTION	Topics Asked in Paper	Total Marks
Engineering Mathematics	1M:5 2M:3	Linear Algebra; Probability & distribution Calculus; Differential Equations Laplace Transform	11
Network Theory	1M:3 2M:3	Network Solution Methodology Transient /Steady State Analysis of RLC Circuit - to DC input Sinusoidal Steady State Analysis Laplace transforms	9
Signals & Systems	1M:0 2M:4	Linear Time invariant (LTI) System Fourier Representation of signal Z-Transform Frequency Response of LTI System	8
Control Systems	1M:2 2M:3	Time domain Analysis Root Locus Technique Frequency Response Analysis Nyquist Plot State Variable Analysis	8
Analog Circuits	1M:5 2M:1	Diode -Circuit -Analysis &Application DC Biasing-BJT's Feedback Oscillator Circuit Operational Amplifiers And Its Application	7
Digital Circuits	1M:1 2M:2	Boolean Algebra &KMap Combinational Digital Circuit Sequential Circuits	5
Electromagnetic Theory	1M:0 2M:0		0
Measurement	1M:2 2M:1	Measurement of Basic Electrical Quantities-1 Measurement of Basic Electrical Quantities-2	4
Power Electronics	1M:0 2M:3	Phase control rectifier Choppers	6
Electrical Machines	1M:4 2M:7	Transformers DC Machine Induction Machines Synchronous Machine	18
Power Systems	1M:3 2M:6	Transmission and Distribution, Economics and power Generation Symmetrical - Components & Fault Calculation Transient and over voltage	9
General Aptitude	1M:5 2M:5	Numerical Ability Verbal Ability	15
Total	65		100

GATE 2015 Examination
Electrical Engineering

Test Date: 07/02/2015
Test Time: 2:00 AM 5:00 PM
Subject Name: EE ELECTRICAL ENGINEERING

Section: General Aptitude

1. A generic term that includes various items of clothing such as a skirt, a pair of trousers and a shirt is
(A) fabric (C) fibre
(B) textile (D) apparel
[Ans. D]
2. Consider a function $f(x) = 1 - |x|$ on $-1 \leq x \leq 1$. The value of x at which the function attains a maximum and the maximum value of the function are:
(A) 0, -1 (C) 0, 1
(B) -1, 0 (D) -1, 2
[Ans. C]
3. We _____ our friend's birthday and we _____ how to make it up to him.
(A) completely forgot --- don't just know (C) completely forgot --- just don't know
(B) forgot completely --- don't just know (D) forgot completely ---- just don't know
[Ans. C]
4. Choose the statement where underlined word is used correctly.
(A) The industrialist had a personnel jet.
(B) I write my experience in my personnel diary.
(C) All personnel are being given the day off
(D) Being religious is a personnel aspect.
[Ans. C]
5. Based on the given statements, select the most appropriate option to solve the given question. What will be the total weight of 10 poles each of same weight?
Statements:
(I) One fourth of the weight of a pole is 5 Kg.
(II) The total weight of these poles is 160 kg more than the total weight of two poles.
(A) Statement I alone is not sufficient.
(B) Statement II alone is not sufficient.
(C) Either I or II alone is sufficient.
(D) Both statements I and II together are not sufficient.
[Ans. C]

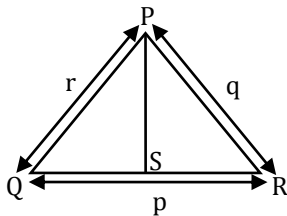
6. Out of the following four sentences, select the most suitable sentence with respect to grammar and usage:
- (A) Since the report lacked needed information, it was of no use to them.
 (B) The report was useless to them because there were no needed information in it.
 (C) Since the report did not contain the needed information, it was not real useful to them.
 (D) Since the report lacked needed information, it would not had been useful to them

[Ans. A]

7. If p, q, r, s are distinct integers such that:
 $f(p, q, r, s) = \max(p, q, r, s)$
 $g(p, q, r, s) = \min(p, q, r, s)$
 $h(p, q, r, s) = \text{remainder of } (p \times q) / (r \times s) \text{ if } (p \times q) > (r \times s) \text{ or remainder of } (r \times s) / (p \times q) \text{ if } (r \times s) > (p \times q)$
 Also a function $fg h(p, q, r, s) = f(p, q, r, s) \times g(p, q, r, s) \times h(p, q, r, s)$
 Also the same operations are valid with two variable functions of the form $f(p, q)$.
 What is the value of $fg(h(2, 5, 7, 3), 4, 6, 8)$?

[Ans. *]Range: 8 to 8

8. In a triangle PQR, PS is the angle bisector of $\angle QPR$ and $\angle QPS = 60^\circ$. What is the length of PS?



- (A) $\frac{(q+r)}{qr}$
 (B) $\frac{qr}{(q+r)}$

- (C) $\sqrt{(q^2 + r^2)}$
 (D) $\frac{(q+r)^2}{qr}$

[Ans. B]

9. Four branches of a company are located at M, N, O, and P. M is north of N at a distance of 4 km; P is south of O at a distance of 2 km; N is southeast of O by 1 km. What is the distance between M and P in km?

- (A) 5.34
 (B) 6.74

- (C) 28.5
 (D) 45.49

[Ans. A]

10. If the list of letters, P, R, S, T, U is an arithmetic sequence, which of the following are also in arithmetic sequence?

- (I) $2P, 2R, 2S, 2T, 2U$
 (II) $P-3, R-3, S-3, T-3, U-3$
 (III) P^2, R^2, S^2, T^2, U^2

- (A) I only
 (B) I and II

- (C) II and III
 (D) I and III

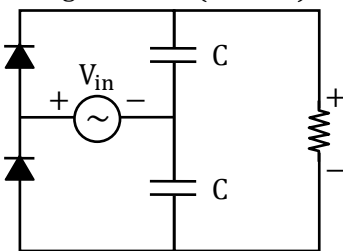
[Ans. B]

Section Name: Electrical Engineering

- When a bipolar junction transistor is operating in the saturation mode, which one of the following statements is TRUE about the state of its collector-base (CB) and the base-emitter (BE) junctions?
 - The CB junction is forward biased and the BE junction is reverse biased.
 - The CB junction is reverse biased and the BE junction is forward biased.
 - Both the CB and BE junctions are forward biased
 - Both the CB and BE junctions are reverse biased

[Ans. C]

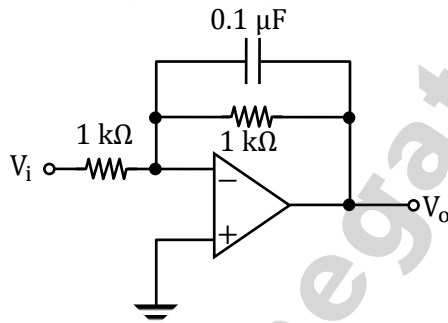
- In the following circuit, the input voltage V_{in} is $100 \sin(100\pi t)$. For $100\pi RC = 50$, the average voltage across R (in Volts) under steady-state is nearest to



- (A) 100 (B) 31.8 (C) 200 (D) 63.6

[Ans. D]

- The operational amplifier shown in the figure is ideal. The input voltage (in Volt) is $V_i = 2 \sin(2\pi \times 2000t)$. The amplitude of the output voltage V_o (in Volt) is _____.



[Ans. *] Range: 1.245 to 1.245

- A 3-bus power system network consists of 3 transmission lines. The bus admittance matrix of the uncompensated system is

$$\begin{bmatrix} -j6 & j3 & j4 \\ j3 & -j7 & j5 \\ j4 & j5 & -j8 \end{bmatrix} \text{ Pu.}$$

If the shunt capacitance of all transmission lines is 50% compensated, the imaginary part of the 3rd row 3rd column element (in pu) of the bus admittance matrix after compensation is

- (A) $-j7.0$ (B) $-j8.5$ (C) $-j7.5$ (D) $-j9.0$

[Ans. B]

- We have a set of 3 linear equations in 3 unknowns. 'X \equiv Y' means X and Y are not equivalent statements and 'X $\not\equiv$ Y' means X and Y are not equivalent statements.

P: There is a unique solution.

Q: The equations are linearly independent.

R: All eigenvalues of the coefficient matrix are nonzero.

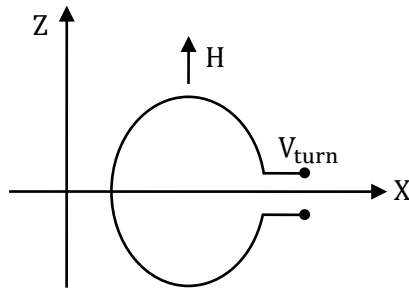
S: The determinant of the coefficient matrix is nonzero.

Which one of the following is TRUE?

- (A) $P \equiv Q \equiv R \equiv S$ (C) $P \equiv Q \neq R \equiv S$
 (B) $P \equiv R \neq Q \equiv S$ (D) $P \neq Q \neq R \neq S$

[Ans. A]

6. A circular turn of radius 1 m revolves at 60 rpm about its diameter aligned with the x-axis as shown in the figure. The value of μ_0 is $4\pi \times 10^{-7}$ in SI unit. If a uniform magnetic field intensity $\vec{H} = 10^7 \hat{z}$ A/m is applied, then the peak value of the induced voltage, V_{turn} (in Volts), is _____.

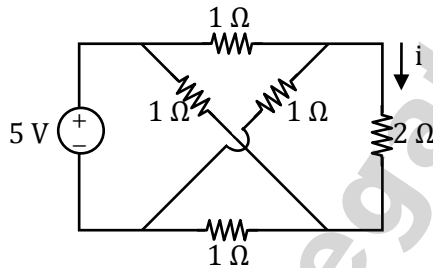


[Ans. *] Range: 39.47 to 39.47

7. The Laplace transform of $f(t) = 2\sqrt{t/\pi}$ is $s^{-3/2}$. The Laplace transform of $g(t) = \sqrt{1/\pi t}$ is
 (A) $3s^{-5/2}/2$ (B) $s^{-1/2}$ (C) $s^{1/2}$ (D) $s^{3/2}$

[Ans. B]

8. The current i (in Ampere) in the 2Ω resistor of the given network is _____.



[Ans. *] Range: 0 to 0

9. A 4-pole, separately excited, wave wound DC machine with negligible armature resistance is rated for 230 V and 5 kW at a speed of 1200 rpm. If the same armature coils are reconnected to form a lap winding, what is the rated voltage (in volts) and power (in kW) respectively at 1200 rpm of the reconnected machine if the field circuit is left unchanged?

- (A) 230 and 5 (C) 115 and 2.5
 (B) 115 and 5 (D) 230 and 2.5

[Ans. B]

10. Match the following.

Instrument Type	Used for
P. Permanent magnet moving coil	1. DC only
Q. Moving Iron connected through current transformer	2. AC only
R. Rectifier	3. AC and DC
S. Electrodynamicometer	

- (A) P-1, Q-2, R-1, S-3
(B) P-1, Q-3, R-1, S-2
(C) P-1, Q-2, R-3, S-3
(D) P-3, Q-1, R-2, S-1

[Ans. C]

11. Match the following.

- | | |
|------------------------------|--|
| P. Stoke's Theorem | 1. $\oiint D \cdot ds = Q$ |
| Q. Gauss's Theorem | 2. $\oint f(z) dz = 0$ |
| R. Divergence Theorem | 3. $\iiint (\nabla \cdot A) dv = \oiint A \cdot ds$ |
| S. Cauchy's Integral Theorem | 4. $\iint (\nabla \times A) \cdot ds = \oint A \cdot dl$ |

- (A) P-2, Q-1, R-4, S-3
(B) P-4, Q-1, R-3, S-2
(C) P-4, Q-3, R-1, S-2
(D) P-3, Q-4, R-2, S-1

[Ans. B]

12. Given $f(z) = g(z) + h(z)$, where f, g, h are complex valued functions of a complex variable z . Which one of the following statements is TRUE?

- (A) If $f(z)$ is differentiable at z_0 , then $g(z)$ and $h(z)$ are also differentiable at z_0 .
(B) If $g(z)$ and $h(z)$ are differentiable at z_0 , then $f(z)$ is also differentiable at z_0 .
(C) If $f(z)$ is continuous at z_0 , then it is differentiable at z_0 .
(D) If $f(z)$ is differentiable at z_0 , then so are its real and imaginary parts

[Ans. B]

13. Consider the following Sum of Products expression, F.

$$F = ABC + \bar{A}BC + A\bar{B}C + \bar{A}\bar{B}C + \bar{A}BC$$

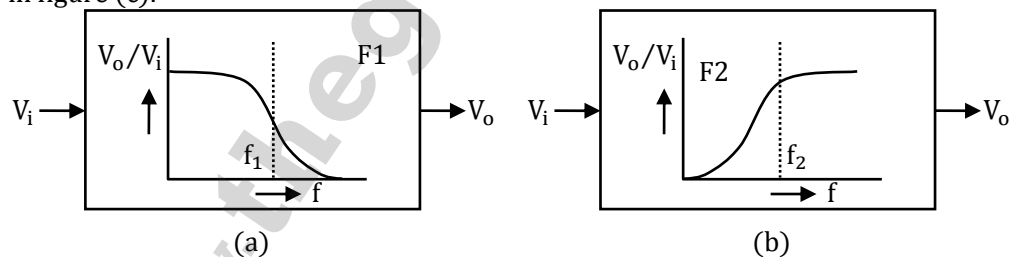
The equivalent Product of Sums expression is

- (A) $F = (A + \bar{B} + C)(\bar{A} + B + C)(\bar{A} + \bar{B} + C)$
(B) $F = (A + \bar{B} + \bar{C})(A + B + C)(\bar{A} + \bar{B} + \bar{C})$
(C) $F = (\bar{A} + B + C)(A + \bar{B} + \bar{C})(A + B + C)$
(D) $F = (\bar{A} + \bar{B} + C)(A + B + \bar{C})(A + B + C)$

[Ans. A]

Q.26 - Q.55 Carry Two Mark each.

14. The filters F1 and F2 having characteristics as shown in figure (a) and (b) are connected as shown in figure (c).



The cut-off frequencies of F1 and F2 are f_1 and f_2 respectively. If $f_1 < f_2$, the resultant circuit exhibits the characteristic of a

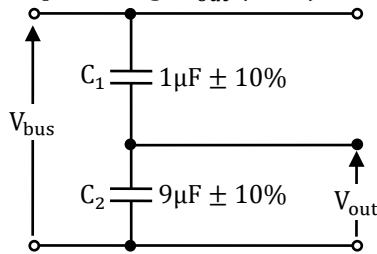
- (A) Band-pass filter
(B) Band-stop filter
(C) All pass filter
(D) High-Q filter

[Ans. B]

15. An open loop control system results in a response of $e^{-2t}(\sin 5t + \cos 5t)$ for a unit impulse input. The DC gain of the control system is _____.

[Ans. *] Range: 0.2414 to 0.2414

16. A capacitive voltage divider is used to measure the bus voltage V_{bus} in a high-voltage 50 Hz AC system as shown in the figure. The measurement capacitors C_1 and C_2 have tolerances of $\pm 10\%$ on their nominal capacitance values. If the bus voltage V_{bus} is 100 kV rms, the maximum rms output voltage V_{out} (in kV), considering the capacitor tolerances is _____.



[Ans. *] Range: 12.2 to 12.2

17. Two semi-infinite dielectric regions are separated by a plane boundary at $y = 0$. The dielectric constants of region 1 ($y < 0$) and region 2 ($y > 0$) are 2 and 5, respectively. Region 1 has uniform electric field $\vec{E} = 3\hat{a}_x + 4\hat{a}_y + 2\hat{a}_z$, where \hat{a}_x, \hat{a}_y and \hat{a}_z are unit vectors along the x, y and z axes, respectively. The electric field in region 2 is

- (A) $3\hat{a}_x + 1.6\hat{a}_y + 2\hat{a}_z$ (C) $1.2\hat{a}_x + 4\hat{a}_y + 0.8\hat{a}_z$
(B) $1.2\hat{a}_x + 4\hat{a}_y + 2\hat{a}_z$ (D) $3\hat{a}_x + 10\hat{a}_y + 0.8\hat{a}_z$

[Ans. A]

18. A 3-phase balanced load which has a power factor of 0.707 is connected to a balanced supply. The power consumed by the load is 5 kW. The power is measured by the two-wattmeter method. The readings of the two wattmeters are

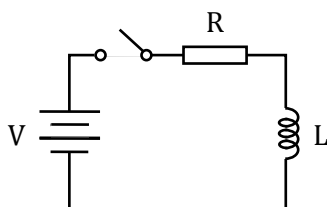
- (A) 3.94 kW and 1.06 kW (C) 5.00 kW and 0.00 kW
(B) 2.50 kW and 2.50 kW (D) 2.96 kW and 2.04 kW

[Ans. A]

19. A shunt-connected DC motor operates at its rated terminal voltage. Its no-load speed is 200 radian/second. At its rated torque of 500 Nm, its speed is 180 radian/second. The motor is used to directly drive a load whose load torque T_L depends on its rotational speed ω_r (in radian/second), such that $T_L = 2.78 \times \omega_r$. Neglecting rotational losses, the steady-state speed (in radian/second) of the motor, when it drives this load, is _____.

[Ans. *] Range: 180 to 180

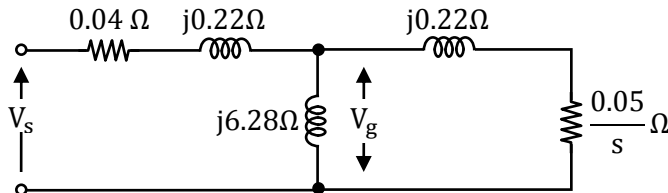
20. A series RL circuit is excited at $t = 0$ by closing a switch as shown in the figure. Assuming zero initial conditions, the value of $\frac{d^2i}{dt^2}$ at $t = 0^+$ is



- (A) $\frac{V}{L}$ (C) 0
 (B) $\frac{-V}{R}$ (D) $\frac{-RV}{L^2}$

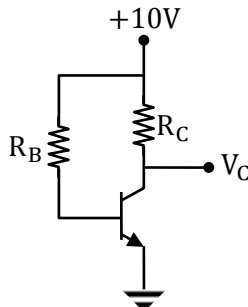
[Ans. D]

21. The figure shows the per-phase equivalent circuit of a two-pole three-phase induction motor operating at 50 Hz. The “air-gap” voltage, V_g across the magnetizing inductance, is 210 V rms, and the slip, s , is 0.05. The torque (in Nm) produced by the motor is _____.



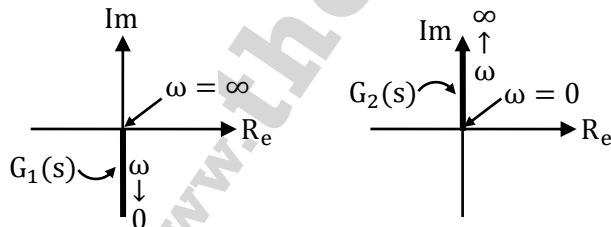
[Ans. *] Range: 401.66 to 401.66

22. In the following circuit, the transistor is in active mode and $V_C = 2$ V. To get $V_C = 4$ V, we replace R_C with R'_C . Then the ratio R'_C/R_C is _____.



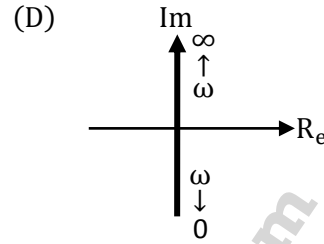
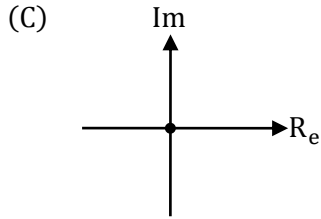
[Ans. *] Range: 0.75 to 0.75

23. Nyquist plots of two functions $G_1(s)$ and $G_2(s)$ are shown in figure



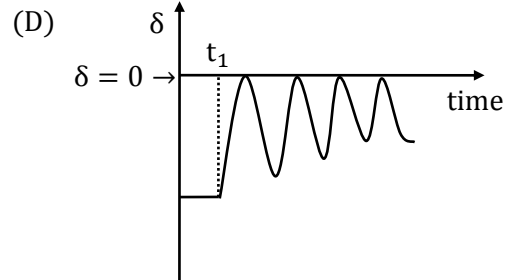
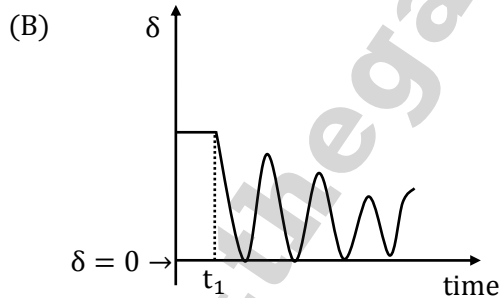
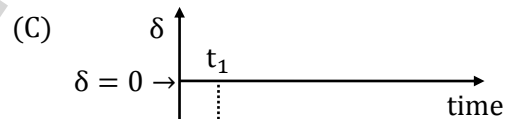
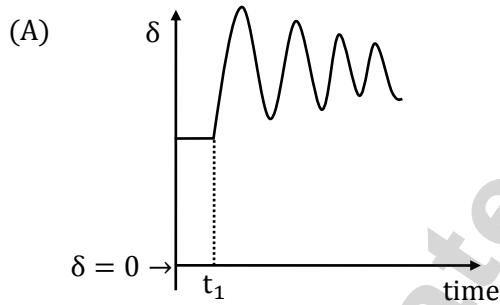
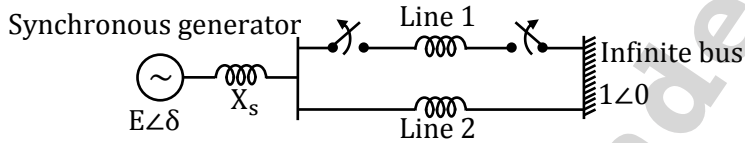
Nyquist plot of the product of $G_1(s)$ and $G_2(s)$ is





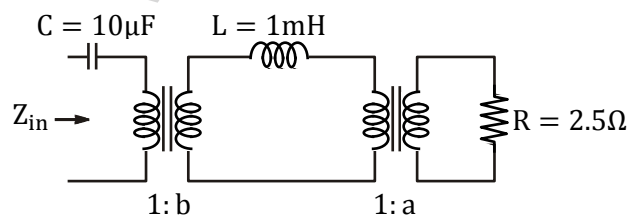
[Ans. B]

24. The synchronous generator shown in the figure is supplying active power to an infinite bus via two short, lossless transmission lines, and is initially in steady state. The mechanical power input to the generator and the voltage magnitude E are constant. If one line is tripped at time t_1 by opening the circuit breakers at the two ends (although there is no fault), then it is seen that the generator undergoes a stable transient. Which one of the following waveforms of the rotor angle δ shows the transient correctly?



[Ans. A]

25. Find the transformer ratios a and b such that the impedance (Z_{in}) is resistive and equals 2.5Ω when the network is excited with a sine wave voltage of angular frequency of 5000 rad/s .



(A) $a = 0.5, b = 2.0$

(C) $a = 1.0, b = 1.0$

(B) $a = 2.0, b = 0.5$

(D) $a = 4.0, b = 0.5$

[Ans. B]

26. For the system governed by the set of equations:

$$dx_1/dt = 2x_1 + x_2 + u$$

$$dx_2/dt = -2x_1 + u$$

$$y = 3x_1$$

The transfer function $Y(s)/U(s)$ is given by

(A) $3(s + 1)/(s^2 - 2s + 2)$

(C) $(s + 1)/(s^2 - 2s + 1)$

(B) $3(2s + 1)/(s^2 - 2s + 1)$

(D) $3(2s + 1)/(s^2 - 2s + 2)$

[Ans. A]

27. For linear time invariant systems, that are Bounded Input Bounded Output stable, which one of the following statements is TRUE?

(A) The impulse response will be integrable, but may not be absolutely integrable.

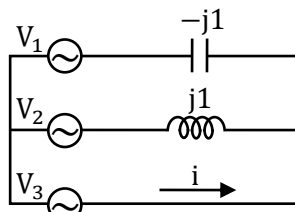
(B) The unit impulse response will have finite support.

(C) The unit step response will be absolutely integrable.

(D) The unit step response will be bounded.

[Ans. *]

28. In the given network $V_1 = 100\angle 0^\circ\text{V}$, $V_2 = 100\angle -120^\circ\text{V}$, $V_3 = 100\angle +120^\circ\text{V}$. The phasor current i (in Ampere) is



(A) $173.2\angle -60^\circ$

(C) $100.0\angle -60^\circ$

(B) $173.2\angle 120^\circ$

(D) $100.0\angle 120^\circ$

[Ans. A]

29. Two coins R and S are tossed. The 4 joint events $H_R H_S$, $T_R T_S$, $H_R T_S$, $T_R H_S$, have probabilities 0.28, 0.18, 0.30, 0.24 respectively, where H represents head and T represents tail. Which one of the following is TRUE?

(A) The coin tosses are independent

(C) S is fair, R is not

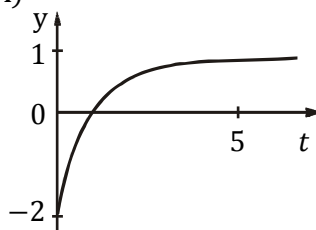
(B) R is fair, S is not

(D) The coin tosses are dependent

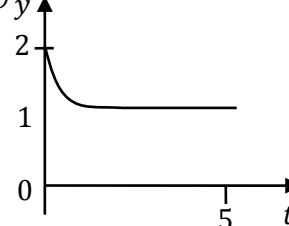
[Ans. D]

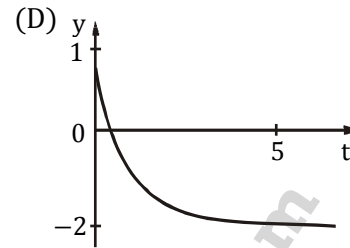
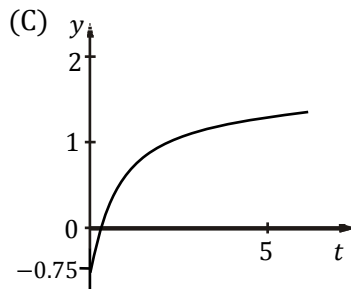
30. The unit step response of a system with the transfer function $G(s) = \frac{1-2s}{1+s}$ is given by which one of the following waveforms

(A)



(B)



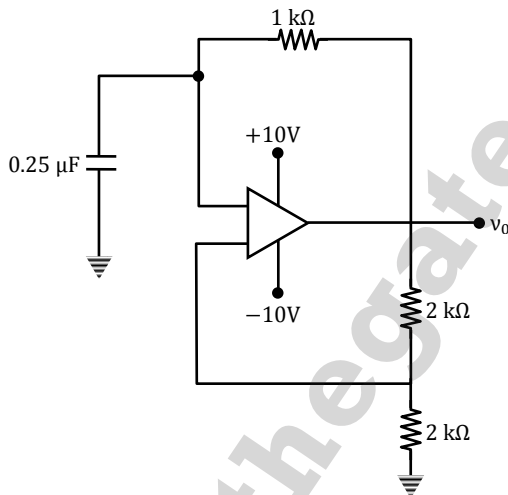


[Ans. A]

31. A three-phase, 11 kV, 50 Hz, 2 pole, star connected, cylindrical rotor synchronous motor is connected to an 11 kV, 50 Hz source. Its synchronous reactance is 50Ω per phase, and its stator resistance is negligible. The motor has a constant field excitation. At a particular load torque, its stator current is 100 A at unity power factor. If the load torque is increased so that the stator current is 120 A, then the load angle (in degrees) at this load is ____.

[Ans. *] Range: 47.26 to 47.26

32. The saturation voltage of the ideal op-amp shown below is $\pm 10V$. The output voltage v_o of the following circuit in the steady-state is



- (A) Square wave of period 0.55 ms.
 (B) Triangular wave of period 0.55 ms.
 (C) Square wave of period 0.25 ms.
 (D) Triangular wave of period 0.25 ms.

[Ans. A]

33. A 220 V, 3-phase, 4-pole, 50 Hz induction motor of wound rotor type is supplied at rated voltage and frequency. The stator resistance, magnetizing reactance, and core loss are negligible. The maximum torque produced by the rotor is 225% of full load torque and it occurs at 15% slip. The actual rotor resistance is 0.03Ω /phase. The value of external resistance (in Ohm) which must be inserted in a rotor phase if the maximum torque is to occur at start is ____.

[Ans. *] Range: 0.17 to 0.17

34. Consider a signal defined by

$$x(t) = \begin{cases} e^{j10t} & \text{for } |t| \leq 1 \\ 0 & \text{for } |t| > 1 \end{cases}$$

Its Fourier Transform is

(A) $\frac{2 \sin(\omega - 10)}{\omega - 10}$

(B) $2e^{j10} \frac{\sin(\omega - 10)}{\omega - 10}$

(C) $\frac{2 \sin \omega}{\omega - 10}$

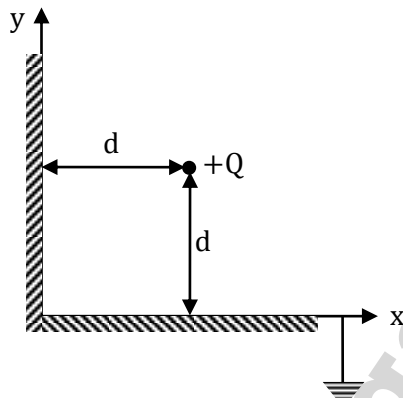
(D) $e^{j10\omega} \frac{2 \sin \omega}{\omega}$

[Ans. A]

35. Two identical coils each having inductance L are placed together on the same core. If an overall inductance of αL is obtained by interconnecting these two coils, the minimum value of α is _____

[Ans. *] Range: 2 to 2

36. Two semi-infinite conducting sheets are placed at right angles to each other as shown in the figure. A point charge of +Q is placed at a distance of d from both sheets. The net force on the charge is $\frac{Q^2}{4\pi\epsilon_0} \frac{K}{d^2}$, where K is given by



(A) 0

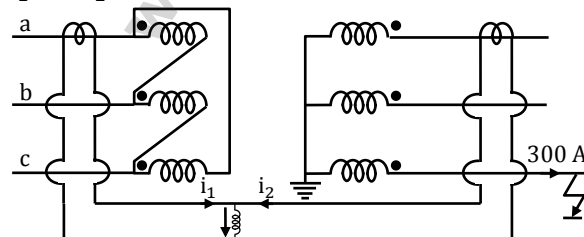
(B) $-\frac{1}{4}\hat{i} - \frac{1}{4}\hat{j}$

[Ans. D]

(C) $-\frac{1}{8}\hat{i} - \frac{1}{8}\hat{j}$

(D) $\frac{1 - 2\sqrt{2}}{8\sqrt{2}}\hat{i} + \frac{1 - 2\sqrt{2}}{8\sqrt{2}}\hat{j}$

37. A 3-phase transformer rated for 33 kV/11 kV is connected in delta/star as shown in figure. The current transformers (CTs) on low and high voltage sides have a ratio of 500/5. Find the currents i_1 and i_2 , if the fault current is 300 A as shown in figure



(A) $i_1 = 1/\sqrt{3} \text{ A}, i_2 = 0 \text{ A}$

(B) $i_1 = 0 \text{ A}, i_2 = 0 \text{ A}$

[Ans. A]

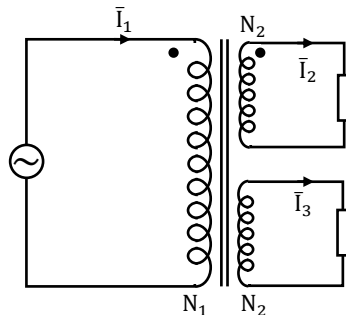
(C) $i_1 = 0 \text{ A}, i_2 = 1/\sqrt{3} \text{ A}$

(D) $i_1 = 1/\sqrt{3} \text{ A}, i_2 = 1/\sqrt{3} \text{ A}$

38. The volume enclosed by the surface $f(x, y) = e^x$ over the triangle bounded by the lines $x = y$; $x = 0$; $y = 1$ in the xy plane is _____.

[Ans. *] Range: 0.718 to 0.718

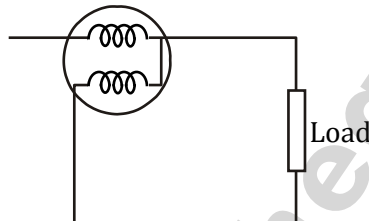
39. A three-winding transformer is connected to an AC voltage source as shown in the figure. The number of turns are as follows: $N_1 = 100, N_2 = 50, N_3 = 50$. If the magnetizing current is neglected, and the currents in two windings are $\bar{I}_2 = 2 \angle 30^\circ$ A and $\bar{I}_3 = 2 \angle 150^\circ$ A, then what is the value of the current \bar{I}_1 in Ampere?



- (A) $1 \angle 90^\circ$ (C) $4 \angle 90^\circ$
(B) $1 \angle 270^\circ$ (D) $4 \angle 270^\circ$

[Ans. A]

40. The coils of a wattmeter have resistances 0.01Ω and 1000Ω ; their inductances may be neglected. The wattmeter is connected as shown in the figure, to measure the power consumed by a load, which draws 25 A at power factor 0.8. The voltage across the load terminals is 30 V. The percentage error on the wattmeter reading is _____.



[Ans. *] Range: 0.15 to 0.15

41. An open loop transfer function $G(s)$ of a system is

$$G(S) = \frac{K}{s(s+1)(s+2)}$$

For a unity feedback system, the breakaway point of the root loci on the real axis occurs at,

- (A) -0.42 (C) -0.42 and -1.58
(B) -1.58 (D) none of the above

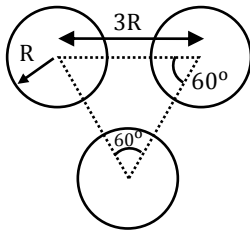
[Ans. A]

42. The z - Transform of a sequence $x[n]$ is given as $X(z) = 2z + 4 - 4/z + 3/z^2$. If $y[n]$ is the first difference of $x[n]$, then $Y(z)$ is given by

- (A) $2z + 2 - 8/z + 7/z^2 - 3/z^3$ (C) $-2z - 2 + 8/z - 7/z^2 + 3/z^3$
(B) $-2z + 2 - 6/z + 1/z^2 - 3/z^3$ (D) $4z - 2 - 8/z - 1/z^2 + 3/z^3$

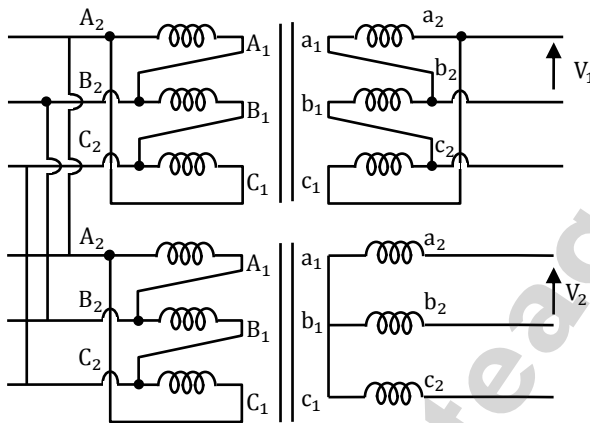
[Ans. A]

43. A composite conductor consists of three conductors of radius R each. The conductors are arranged as shown below. The geometric mean radius (GMR) (in cm) of the composite conductor is kR . The value of k is _____



[Ans. *] Range: 1.914 to 1.914

44. Two three - phase transformers are realized using single-phase transformers as shown in the figure.



The phase difference (in degree) between voltages V_1 and V_2 is _____

[Ans. *] Range: 30 to 30

45. With an armature voltage of 100 V and rated field winding voltage, the speed of a separately excited DC motor driving a fan is 1000 rpm, and its armature current is 10 A. The armature resistance is 1Ω . The load torque of the fan load is proportional to the square of the rotor speed. Neglecting rotational losses, the value of the armature voltage (in Volt) which will reduce the rotor speed to 500 rpm is _____.

[Ans. *] Range: 47.5 to 47.5

46. The incremental costs (in Rupees/MWh) of operating two generating units are functions of their respective powers P_1 and P_2 in MW, and are given by

$$\frac{dC_1}{dP_1} = 0.2P_1 + 50$$

$$\frac{dC_2}{dP_2} = 0.24P_2 + 40$$

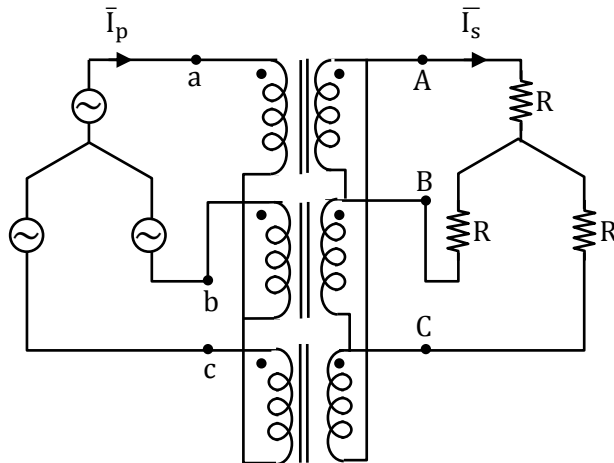
Where, $20\text{MW} \leq P_1 \leq 150 \text{ MW}$

$20\text{MW} \leq P_2 \leq 150 \text{ MW}$

For a certain load demand, P_1 and P_2 have been chosen such that $dC_1/dP_1 = 76 \text{ Rs/MWh}$ and $dC_2/dP_2 = 68.8 \text{ Rs/MWh}$. If the generations are rescheduled to minimize the total cost, then P_2 is

[Ans. *] Range: 136.36 to 136.36

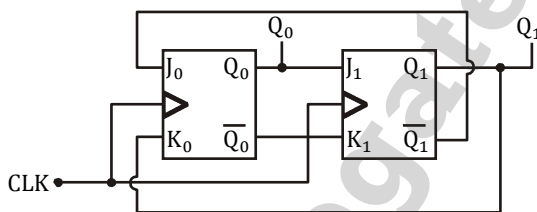
51. A balanced (positive sequence) three-phase AC voltage source is connected to a balanced, star connected load through a star-delta transformer as shown in figure. The line-to-line voltage rating is 230 V on the star side, and 115 V on the delta side. If the magnetizing current is neglected and $\bar{I}_s = 100\angle 0^\circ$ A, then what is the value on \bar{I}_p in Ampere?



- (A) $50\angle 30^\circ$ (C) $50\sqrt{3}\angle 30^\circ$
(B) $50\angle -30^\circ$ (D) $200\angle 30^\circ$

[Ans. A]

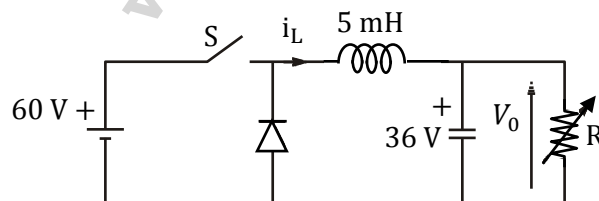
52. In the following sequential circuit, the initial state (before the first clock pulse) of the circuit is $Q_1Q_0 = 00$. The state (Q_1Q_0), immediately after the 333rd clock pulse is



- (A) 00 (C) 10
(B) 01 (D) 11

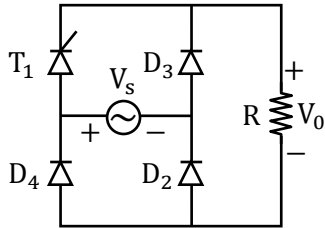
[Ans. B]

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



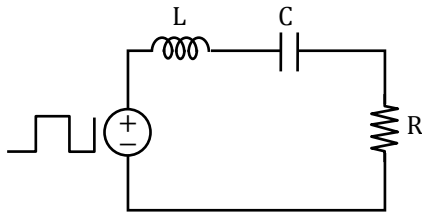
[Ans. *] Range: 2500 to 2500

54. In the given rectifier, the delay angle of the thyristor T_1 measured from the positive going zero crossing of V_s is 30° . If the input voltage V_s is $100 \sin(100\pi t)$ V, the average voltage across R (in Volt) under steady-state is _____.



[Ans. *] Range: 61.53 to 61.53

55. A symmetrical square wave of 50% duty cycle has amplitude of ± 15 V and time period of 0.4π ms. This square wave is applied across a series RLC circuit with $R = 5 \Omega$, $L = 10$ mH, and $C = 4 \mu\text{F}$. The amplitude of the 5000 rad/s component of the capacitor voltage (in Volt) is _____.



[Ans. *] Range: 15 to 15