GATE-2012

Question Paper

&

Answer Keys

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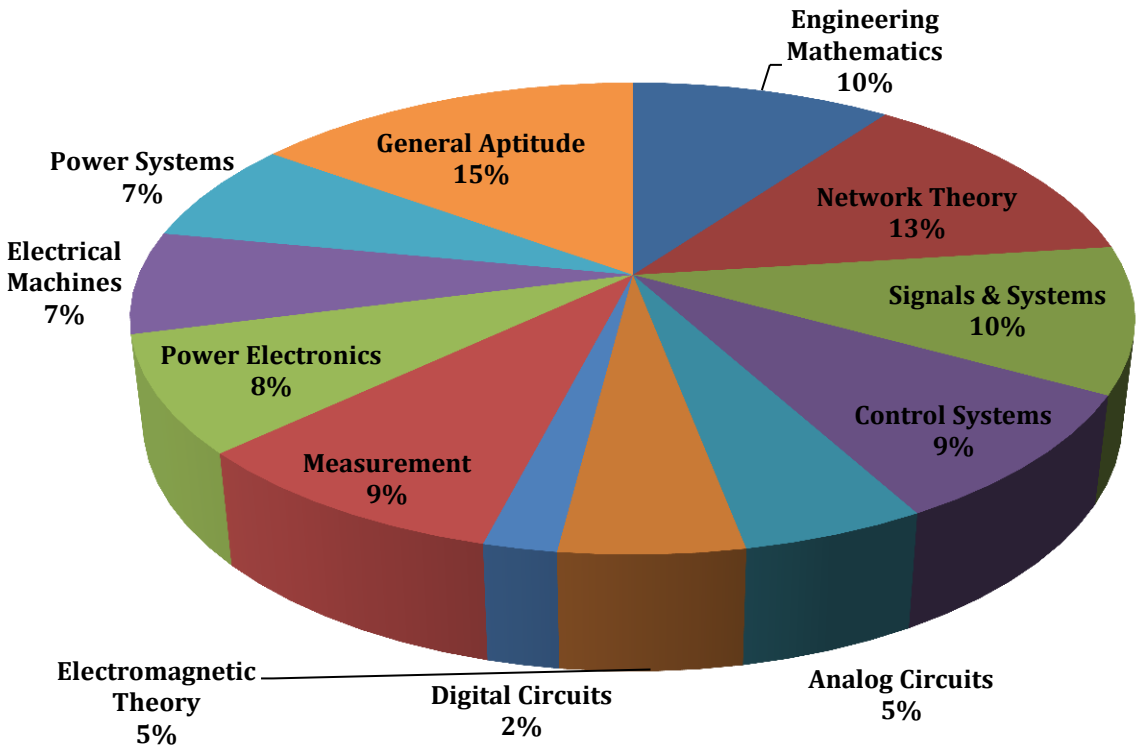
1. Question Paper Analysis
2. Question Paper & Answer keys

ANALYSIS OF GATE 2012
Electrical Engineering



GATE-2012- EE

SUBJECT	NO OF QUESTION	Topics Asked in Paper	Total Marks
Engineering Mathematics	1M:4 2M:3	Linear Algebra; Probability & distribution Numerical Method; Calculus Complex Variables	10
Network Theory	1M:5 2M:4	Network Solution Methodology RLC Circuit ; Sinusoidal Steady State Analysis Two Port Net works	13
Signals & Systems	1M:2 2M:4	Introduction to Signals & Systems Linear Time Invariant System Fourier Representation of Signals Z-Transform; Laplace-Transform	10
Control Systems	1M:1 2M:4	Stability & Routh Hurwitz Criterion Frequency Response Analysis Compensators & Controllers State Variable Analysis	9
Analog Circuits	1M:1 2M:2	Diode Circuits –Analysis And Application Small Signal Modeling Of BJT and FET BJT And JFET Frequency Response	5
Digital Circuits	1M:3 2M:1	Boolean algebra & Karnaugh maps Combinational and Sequential digital Circuits	5
Electromagnetic Theory	1M:0 2M:1	Electromagnetic fields	2
Measurement	1M:3 2M:3	Measurements of Basic Electrical Quantities(Current Voltage, Resistance, Inductance, Capacitance) Measurements of Basic Electrical Quantities (Power and Energy, CT, 2PT)	9
Power Electronics	1M:2 2M:3	Basics of power semiconductor devices Phase control rectifier Choppers; Inverters	8
Electrical Machines	1M:1 2M:3	Transformer Induction motors D.C. Machine	7
Power Systems	1M:3 2M:2	Economics Of Power Generation Symmetrical Components & Faults Calculations, Power System Stability	7
General Aptitude	1M:5 2M:5	Numerical Ability Verbal Ability	15
Total	**65**		**100**

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GATE 2011 Examination

Electrical Engineering

Q.1 - Q.25 Carry One Mark each.

1. Two independent random variables X and Y are uniformly distributed in the interval $[-1, 1]$. The probability that max $[X, Y]$ is less than $1/2$ is

(A) $3/4$
(B) $9/16$
(C) $1/4$
(D) $2/3$

[Ans. B]

2. If $x = \sqrt{-1}$, then the value of x^x is

(A) $e^{-\pi/2}$
(B) $e^{\pi/2}$
(C) x
(D) 1

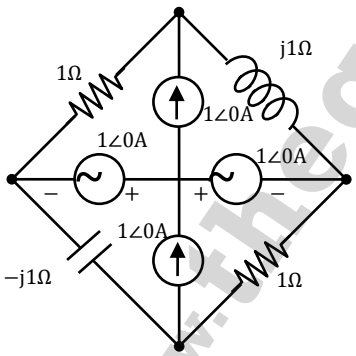
[Ans. A]

3. Given $f(z) = \frac{1}{z+1} - \frac{2}{z+3}$. If C is a counterclockwise path in the z – plane such that $|z+1| = 1$, the value of $\frac{1}{2\pi j}\oint_c f(z)dz$ is

(A) -2
(B) -1
(C) 1
(D) 2

[Ans. C]

4. In the circuit shown below, the current through the inductor is



(A) $\frac{2}{1+j}$ A
(B) $\frac{1}{1+j}$ A
(C) $\frac{-1}{1+j}$ A
(D) 0 A

[Ans. C]

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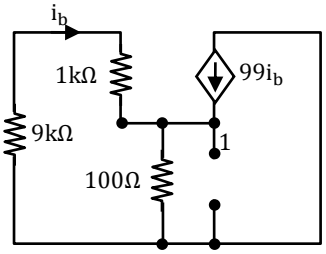
5. The impedance looking into nodes 1 and 2 in the given circuit is



(A) 50 Ω
(B) 100 Ω
(C) 5 kΩ
(D) 10.1 kΩ

[Ans. A]

6. A system with transfer function

$$G(s) = \frac{(s^2+9)(s+2)}{(s+1)(s+3)(s+4)}$$

is excited by $\sin(\omega t)$. The steady-state output of the system is zero at

(A) $\omega = 1$ rad/s
(B) $\omega = 2$ rad/s
(C) $\omega = 3$ rad/s
(D) $\omega = 4$ rad/s

[Ans. C]

7. In the sum of products function $f(X, Y, Z,) = \sum(2,3,4,5)$, the prime implicants are

(A) $\bar{X}Y, X\bar{Y}$
(B) $\bar{X}Y, \bar{X}\,\bar{Y}\bar{Z}, X\bar{Y}Z$
(C) $\bar{X}Y\bar{Z}, \bar{X}YZ, X\bar{Y}$
(D) $\bar{X}Y\bar{Z}, \bar{X}YZ, X\bar{Y}\,\bar{Z}, X\bar{Y}Z$

[Ans. A]

8. If $x[n] = (1/3)^{|n|} - (1/2)^n u[n]$, then the region of convergence (ROC) of its Z-transform in the Z-plane will be

(A) $\frac{1}{3} < |Z| < 3$
(B) $\frac{1}{3} < |Z| < \frac{1}{2}$
(C) $\frac{1}{2} < |Z| < 3$
(D) $\frac{1}{3} < |Z|$

[Ans. C]

9. The bus admittance matrix of a three-bus three-line system is

$$Y = j\begin{bmatrix} -13 & 10 & 5 \\ 10 & -18 & 10 \\ 5 & 10 & -13 \end{bmatrix}$$

If each transmission line between the two buses is represented by an equivalent π-network, the magnitude of the shunt susceptance of the line connecting bus 1 and 2 is

(A) 4
(B) 2
(C) 1
(D) 0

[Ans. B]

10. The slip of an induction motor normally does not depend on

(A) Rotor Speed
(B) Synchronous speed
(C) Shaft torque
(D) Core-loss component

[Ans. D]

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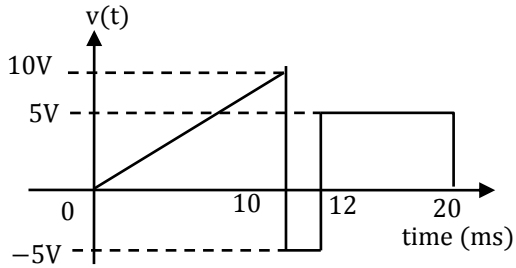
11. A two–phase load draws the following phase currents:
$i_1(t) = I_m \sin(\omega t - \phi_1)$,
$i_2(t) = I_m \cos(\omega t - \phi_2)$.
These currents are balanced if ϕ_1 is equal to
(A) $-\phi_2$
(B) ϕ_2
(C) $(\pi/2 - \phi_2)$
(D) $(\pi/2 + \phi_2)$
[Ans. D]

12. A periodic voltage waveform observed on an oscilloscope across a load is shown. A permanent magnet moving coil (PMMC) meter connected across the same load reads.



(A) 4 V
(B) 5 V
(C) 8 V
(D) 10 V
[Ans. A]

13. The bridge method commonly used for finding mutual inductance is
(A) Heaviside Campbell bridge
(B) Schering bridge
(C) De Sauty bridge
(D) Wien bridge
[Ans. A]

14. With initial condition $x(1) = 0.5$, the solution of the differential equation, $t\frac{dx}{dt} + x = t$ is
(A) $x = t - \frac{1}{2}$
(B) $x = t^2 - \frac{1}{2}$
(C) $xt = \frac{t^2}{2}$
(D) $x = \frac{t}{2}$
[Ans. C]

15. The unilateral Laplace transform of f(t) is $\frac{1}{s^2+s+1}$. The unilateral Laplace transform of t f(t) is
(A) $-\frac{s}{(s^2+s+1)^2}$
(B) $-\frac{2s+1}{(s^2+s+1)^2}$
(C) $\frac{s}{(s^2+s+1)^2}$
(D) $\frac{2s+1}{(s^2+s+1)^2}$
[Ans. D]

16. The average power delivered to an impedance $(4 - j3)\ \Omega$ by a current $5\cos(100\pi t + 100)$ A is
(A) 44.2 W
(B) 50 W
(C) 62.5 W
(D) 125 W
[Ans. B]

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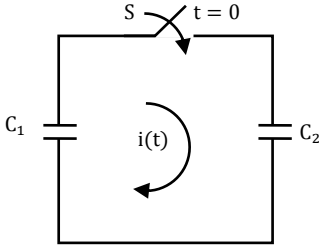
17. In the following figure, C1 and C2 are ideal capacitors. C_1 has been charged to 12 V before the ideal switch S is closed at t = 0. The current i(t) for all t is.

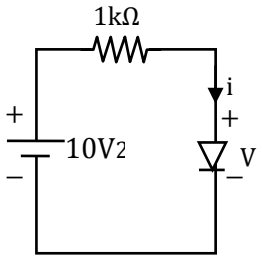


(A) Zero
(B) a step function
(C) an exponentially decaying function
(D) an impulse function

[Ans. D]

18. The I-V characteristics of the diode in the circuit given below are

$$i = \begin{cases} \dfrac{v - 0.7}{500} A, & v \geq 0.7 \text{ V} \\ 0 \text{ A}, & v < 0.7 \text{ V} \end{cases}$$



The current in the circuit is

(A) 10 mA
(B) 9.3 mA
(C) 6.67 mA
(D) 6.2 mA

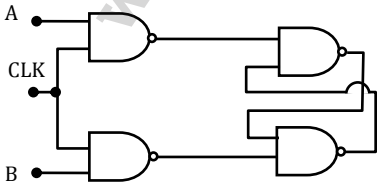
[Ans. D]

19. The output Y of a 2-bit comparator is logic 1 whenever the 2-bit input A is greater than the 2-bit input B.
The number of combinations for which the output is logic 1, is

(A) 4
(B) 6
(C) 8
(D) 10

[Ans. B]

20. Consider the given circuit



In this circuit, the race around

(A) Does not occur
(B) Occurs when CLK = 0
(C) Occurs when CLK = 1 and A =B =1
(D) Occurs when clk = 1 and A = B = 0

[Ans. A]

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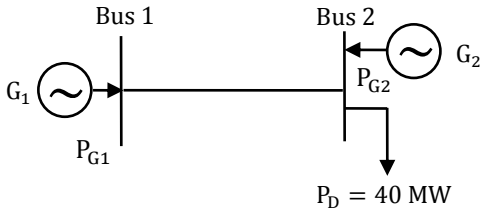
21. The figure shows a two-generator system supplying a load of PD = 40 MW, Connected at bus 2.



The fuel cost of generators G_1 and G_2 are:
C_1 (P_{G1}) = 10,000 Rs/MWh and C_2 (P_{G2}) =12,500 Rs/MWh. And the loss in the line is $P_{loss(pu)} = 0.5\ P_{G1}^2(pu)$, where the loss coefficient is specified in pu on a 100 MVA base. The most economic power generation schedule in MW is

(A) $P_{G1} = 20, P_{G2} = 22$
(B) $P_{G1} = 22, P_{G2} = 20$
(C) $P_{G1} = 20, P_{G2} = 20$
(D) $P_{G1} = 0, P_{G2} = 40$

[Ans. A]

22. The sequence components of the fault current are as follows: $I_{positive} = j\ 1.5$ pu, $I_{negative} = -j\ 0.5$ pu, $I_{zero} = -j1$ pu. The type of fault in the system is

(A) LG
(B) LL
(C) LLG
(D) LLLG

[Ans. C]

23. A half-controlled single-phase bridge rectifier is supplying an R-L load. It is operated at a firing angle α and the load current is continuous. The fraction of cycle that the freewheeling diode conducts is

(A) 1/2
(B) $(1 - \alpha/\pi)$
(C) $\alpha/2\pi$
(D) α/π

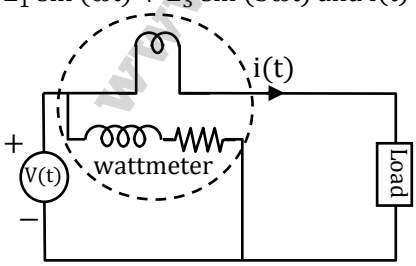
[Ans. D]

24. The typical ratio of Latching current to holding current in a 20 A thyristor is

(A) 5.0
(B) 2.0
(C) 1.0
(D) 0.5

[Ans. B]

25. For the circuit shown in the figure, the voltage and current expressions are $v(t) = E_1 \sin(\omega t) + E_3 \sin(3\omega t)$ and $i(t) = I_1 \sin(\omega t - \phi_1) + I_3 \sin(3\omega t - \phi_3 +) + I_5 \sin(5\omega t)$.



(A) $\frac{1}{2} E_1 I_1 \cos\phi_1$
(B) $\frac{1}{2}[E_1 I_1 \cos\phi_1 + E_1 I_3 \cos\phi_3 + E_1 I_5]$
(C) $\frac{1}{2}[E_1 I_1 \cos\phi_1 + E_3 I_3 \cos\phi_3]$
(D) $\frac{1}{2}[E_1 I_1 \cos\phi_1 + E_3 I_1 \cos\phi_1]$

[Ans. C]

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

26. Given that $A = \begin{bmatrix} -5 & -3 \\ 2 & 0 \end{bmatrix}$ and $I = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$, the value of A^3 is

(A) 15 A + 12 I
(B) 19A + 30
(C) 17 A + 15 I
(D) 17A +21

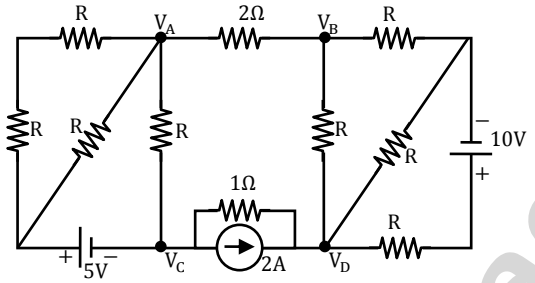
[Ans. B]

27. The maximum value of
$f(x) = x^3 - 9x^2 + 24x + 5$ in the interval [1,6] is

(A) 21
(B) 25
(C) 41
(D) 46

[Ans. C]

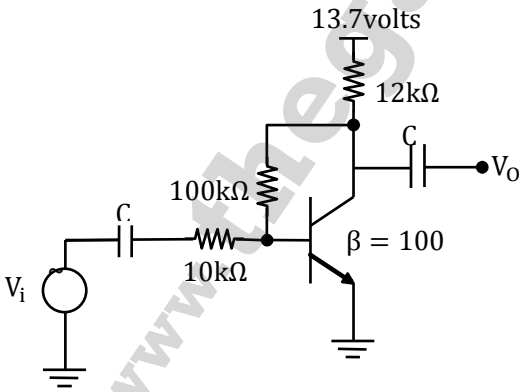
28. If VA − VB =6 V, then VC − VD is



(A) −5 V
(B) 2 V
(C) 3 V
(D) 6 V

[Ans. A]

29. The voltage gain A_V of the circuit shown below is



(A) $|A_v| \approx 200$
(B) $|A_v| \approx 100$
(C) $|A_v| \approx 20$
(D) $|A_v| \approx 10$

[Ans. D]

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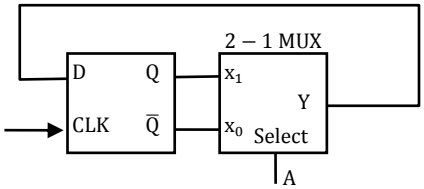
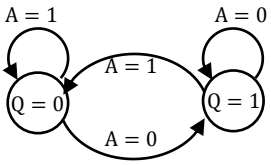
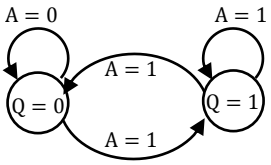
30. The state transition diagram for the logic circuit shown is



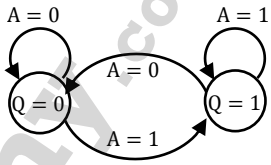
(A)



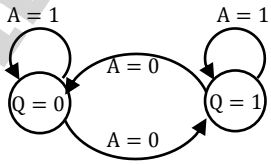
(B)



(C)



(D)



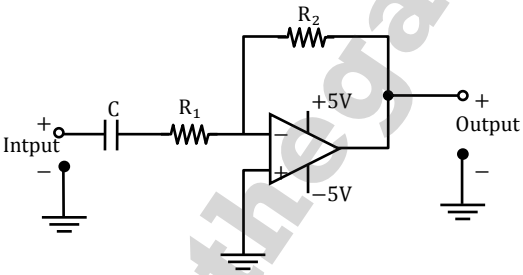
[Ans. D]

31. Let y[n] denote the convolution of h[n] and g[n], where h[n]= (1/2)n u[n] and g[n] is causal sequence. If y[0]=1 and y[1]=1/2, then g[1] equals

(A) 0
(B) 1/2
(C) 1
(D) 3/2

[Ans. A]

32. The circuit shown is a



(A) Low pass filter with
$f_{3dB} = \frac{1}{(R_1 + R_2)C}$ rad/s

(B) High pass filter with
$f_{3dB} = \frac{1}{R_1 C}$ rad/s

(C) Low pass filter with
$f_{3dB} = \frac{1}{R_1 C}$ rad/s

(D) High pass filter with
$f_{3dB} = \frac{1}{(R_1 + R_2)C}$ rad/s

[Ans. B]

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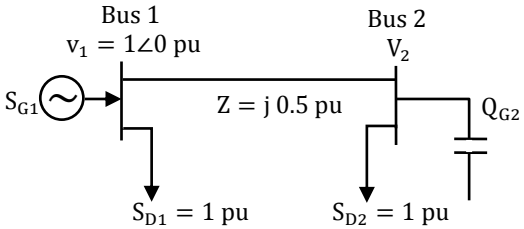
33. For the system shown below, S_{D1} and S_{D2} are complex power demands at bus 1 and bus 2 respectively. If $|V2| = 1$ pu, the VAR rating of the capacitor (Q_{G2}) connected at bus 2 is



(A) 0.2 pu
(B) 0.268 pu
(C) 0.312 pu
(D) 0.4 pu

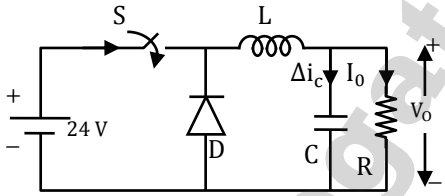
[Ans. B]

34. A cylindrical rotor generator delivers 0.5 pu power in the steady state to an infinite bus through a transmission line of reactance 0.5 pu. The generator no-load voltage is 1.5 pu and the infinite bus voltage is 1pu. The inertia constant of the generator is 5MW-S/MVA generator reactance is 1 pu, the critical clearing angle, in degrees, for a three –phase dead short circuit fault at the generator terminal is

(A) 53.5
(B) 60.2
(C) 70.8
(D) 79.6

[Ans. D]

35. In the circuit shown, an ideal switch S is operated at 100 kHz with a duty ratio of 50 %. Given that Δic is 1.6 A peak-to-peak and I0 is 5 A dc, the peak current in S is



(A) 6.6 A
(B) 5.0 A
(C) 5.8 A
(D) 4.2 A

[Ans. C]

36. A 220 V, 15 kW, 1000 rpm shunt motor with armature resistance of 0.25 Ω, has a rated line current of 68 A and a rated field current of 2.2 A. The change in field flux required to obtain a speed of 1600 rpm while drawing a line current of 52.8 A and a field current of 1.8 A is

(A) 18.18 % increase
(B) 18.18 % decrease
(C) 36.36 % increase
(D) 36.36 % decrease

[Ans. *] Range 12.45 to 12.65

37. A fair coin is tossed till a head appears for the first time probability that the number of required tosses is odd , is

(A) 1/3
(B) 1/2
(C) 2/3
(D) 3/4

[Ans. C]

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38. The direction of vector A is radially outward from the origin, with $|A| = kr^n$ where $r^2 = x^2 + y^2 + z^2$ and k is a constant. The value of n for which $\nabla A = 0$ is

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

[Ans. A]

39. Consider the differential equation

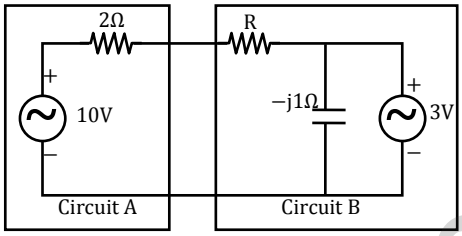
$$\frac{d^2y(t)}{dt^2} + 2\frac{dy(t)}{dt} + y(t) = \delta(t) \text{ with } y(t)|_{t=0^-} = -2 \text{ and } \frac{dy}{dt}|_{t=0^-} = 0.$$

The numerical value of $\frac{dy}{dt}\Big|_{t=0^+}$ is

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

[Ans. D]

40. Assuming both the voltage sources are in phase the value of R for which maximum power is transferred from circuit A to circuit B is



(A) 0.8 Ω
(B) 1.4 Ω
(C) 2 Ω
(D) 2.8 Ω

[Ans. A]

41. The state variable description of an LTI system is given by

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\\ \dot{x}_3\end{bmatrix} = \begin{bmatrix}0 & a_1 & 0\\ 0 & 0 & a_2\\ a_3 & 0 & 0\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix} + \begin{bmatrix}0\\ 0\\ 1\end{bmatrix}u$$

$$y = \begin{bmatrix}1 & 0 & 0\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix}$$

Where y is the output and u is the input. The system is controllable for

(A) $a_1 \neq 0, a_2 = 0, a_3 \neq 0$
(B) $a_1 = 0, a_2 \neq 0, a_3 \neq 0$
(C) $a_1 = 0, a_2 \neq 0, a_3 = 0$
(D) $a_1 \neq 0, a_2 \neq 0, a_3 = 0$

[Ans. D]

42. The Fourier transform of a signal h(t) is $H(j\omega) = (2\cos\omega)(\sin 2\omega)/\omega$. The value of h(0) is

(A) 1/4
(B) 1/2
(C) 1
(D) 2

[Ans. C]

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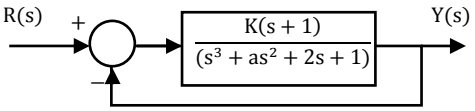
43. The Feedback system shown below oscillates at 2 rad/s when



(A) K=2 and a=0.75
(B) K=3 and a=0.75
(C) K=4 and a=0. 5
(D) K=2 and a=0.5

[Ans. A]

44. The input x(t) and output y(t) of a system are related as $y(t) = \int_{-\infty}^{t} x(\tau)\cos(3\tau)\,d\tau$. The system is

(A) time-invariant and stable
(B) stable and not time-invariant
(C) time-invariant and not stable
(D) not time-invariant and not stable

[Ans. D]

45. An analog voltmeter uses external multiplier settings. With a multiplier setting of 20 kΩ it reads 440 V and with a multiplier setting of 80 kΩ, it reads 352 V. For a multiplier setting of 40 kΩ the voltmeter reads

(A) 371V
(B) 383V
(C) 394V
(D) 406V

[Ans. D]

46. The locked rotor current in a 3-phase, star connected 15 kW, 4-pole, 230 V, 50 Hz induction motor at rated conditions is 50 A. Neglecting losses and magnetizing current, the approximate locked rotor line current drawn when the motor is connected to a 236 V, 57 Hz supply is

(A) 58.5 A
(B) 45.0 A
(C) 42.7 A
(D) 55.6 A

[Ans. B]

47. A single phase 10 kVA, 50 Hz transformer with 1 kV primary winding draws 0.5 A and 55 W, at rated voltage and frequency, on no load. A second transformer has a core with all its linear dimensions $\sqrt{2}$ times the corresponding dimensions of the first transformer. The core material and lamination thickness are the same in both transformers. The primary windings of both the transformers have the same number of turns. If a rated voltage of 2 kV at 50 Hz is applied to the primary of the second transformer, then the no load current and power, respectively, are

(A) 0.7 A, 77.8 W
(B) 0.7 A, 155.6 W
(C) 1A, 110 W
(D) 1A, 220 W

[Ans. B]

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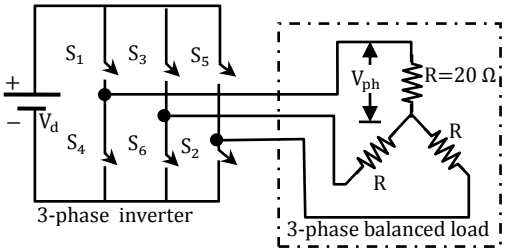
Common Data for Questions 48 and 49

In the 3-phase inverter circuit shown, the load is balanced and the gating scheme is 180° conduction mode. All the switching devices are ideal.



48. The rms value of load phase voltage is

(A) 106.1 V
(B) 141.4 V
(C) 212.2 V
(D) 282.8 V

[Ans. B]

49. If the dc bus voltage $V_d = 300V$, the power consumed by 3-phase load is

(A) 1.5 kW
(B) 2.0 kW
(C) 2.5 kW
(D) 3.0 kW

[Ans. D]

Common Data for Q.No. 50 and 51

With 10 V dc connected at port A in the linear nonreciprocal two-port network shown below, the following were observed:

(i) 1Ω connected at port B draws a current of 3 A
(ii) 2.5Ω connected at port B draws a current of 2 A

50. For the same network, with 6 V dc connected at port A, 1Ω connected at port B draws 7/3 A. If 8 V dc is connected to port A, the open circuit voltage at port B is

(A) 6 V
(B) 7 V
(C) 8 V
(D) 9 V

[Ans. B]

51. With 10 V dc connected at port A, the current drawn by 7Ω. connected at port B is

(A) 3/7 A
(B) 5/7 A
(C) 1 A
(D) 9/7 A

[Ans. C]

Statement for Linked Answer Q.No. 52 & 53

In the circuit shown, the three voltmeter reading $V_1 = 220V$, $V_2 = 122$ V, $V_3 = 136$ V

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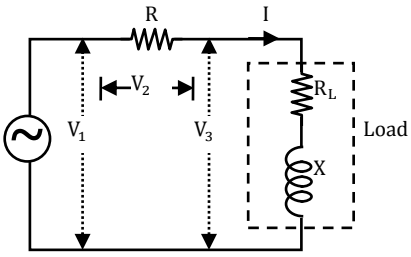

52. The power factor of the load is
(A) 0.45
(B) 0.50
(C) 0.55
(D) 0.60
[Ans. A]

53. If RL = 5Ω, the approximate power consumption in the load is
(A) 700W
(B) 750W
(C) 800W
(D) 850W
[Ans. B]

Statement Linked answer Questions 54 & 55
The transfer function of a compensator is given as

$$G_c(s) = \frac{s+a}{s+b}$$

54. $G_c(s)$ is a lead compensator if
(A) $A = 1, b = 2$
(B) $A = 3, b = 2$
(C) $A = -3, b = -1$
(D) $A = 3, b = 1$
[Ans. A]

55. The phase of the above lead compensator is maximum at
(A) $\sqrt{2}$ rad/s
(B) $\sqrt{3}$rad/s
(C) $\sqrt{6}$rad/s
(D) $1/\sqrt{3}$rad/s
[Ans. A]

General Aptitude One Marks Question Q. 56 to Q. 60

56. One of the parts (A, B, C, D) in the sentence given below contains an ERROR. Which one of the following is INCORRECT?
I requested that he should be given the driving test today instead of tomorrow
(A) Requested that
(B) Should be given
(C) The driving test
(D) Instead of-tomorrow
[Ans. B]

57. If $(1.001)^{1259} = 3.52$ and $(1.001)^{2062} = 7.85$, then $(1.001)^{3321} =$
(E) 2.23
(F) 4.33
(G) 11.37
(H) 27.64
[Ans. D]

58. Choose the most appropriate alternative from the options given below to complete the following sentence:

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If the tired soldier wanted to lie down, he _____ the mattress out on the balcony.

(A) Should take
(B) Shall take
(C) Should have taken
(D) Will have taken

[Ans. A]

59. Choose the most appropriate word from the options given below to complete the following sentence:
Given the seriousness of the situation that he had to face, his ____ was impressive.

(A) beggary
(B) nomenclature
(C) jealousy
(D) nonchalance

[Ans. D]

60. Which one of the following options is the closest in meaning to the word given below?
Latitude

(A) Eligibility
(B) Freedom
(C) Coercion
(D) Meticulousness

[Ans. B]

General Aptitude Two Marks Question Q. 61 to Q. 65

61. A and B are friends. They decide to meet between 1 PM and 2 PM on a given day. There is a condition that whoever arrives first will not wait for the other for more than 15 minutes. The probability that they will meet on that day is

(A) 1/4
(B) 1/16
(C) 7/16
(D) 9/16

[Ans. A]

62. One of the legacies of the Roman legions was discipline. In the legions, military law prevailed and discipline was brutal. Discipline on the battlefield kept units obedient, intact and fighting even when the odds and conditions were against them.
Which one of the following statements best sums up the meaning of the above passage?

(A) Thorough regimentation was the main reason for the efficiency of the Roman legions even in adverse circumstances
(B) The legions were treated inhumanly as if the men were animals
(C) Discipline was the armies' inheritance from their seniors
(D) The harsh discipline to which the legions were subjected to led to the odds and conditions being.....against them

[Ans. A]

63. Raju has 14 currency notes in his pocket consisting of only ₹ 20 notes and ₹ 10 notes. The total money value of the notes is ₹ 230. The number of ₹ 10 notes that Raju has is

(A) 5
(B) 6
(C) 9
(D) 10

[Ans. A]

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64. There are eight bags of rice looking alike, seven of which have equal weight and one is slightly heavier. The weighing balance is of unlimited capacity. Using this balance, the minimum number of weighing's required to identify the heavier bag is

(A) 2
(B) 3
(C) 4
(D) 8

[Ans. A]

65. The data given in the following table summarizes the monthly budget of an average household.

Category	Amount (₹)
Food	4000
Clothing	1200
Rent	2000
Savings	1500
Other expenses	1800

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

(A) 10%
(B) 14%
(C) 81%
(D) 86%

[Ans. D]

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