

GATE-2014

Question Paper

&

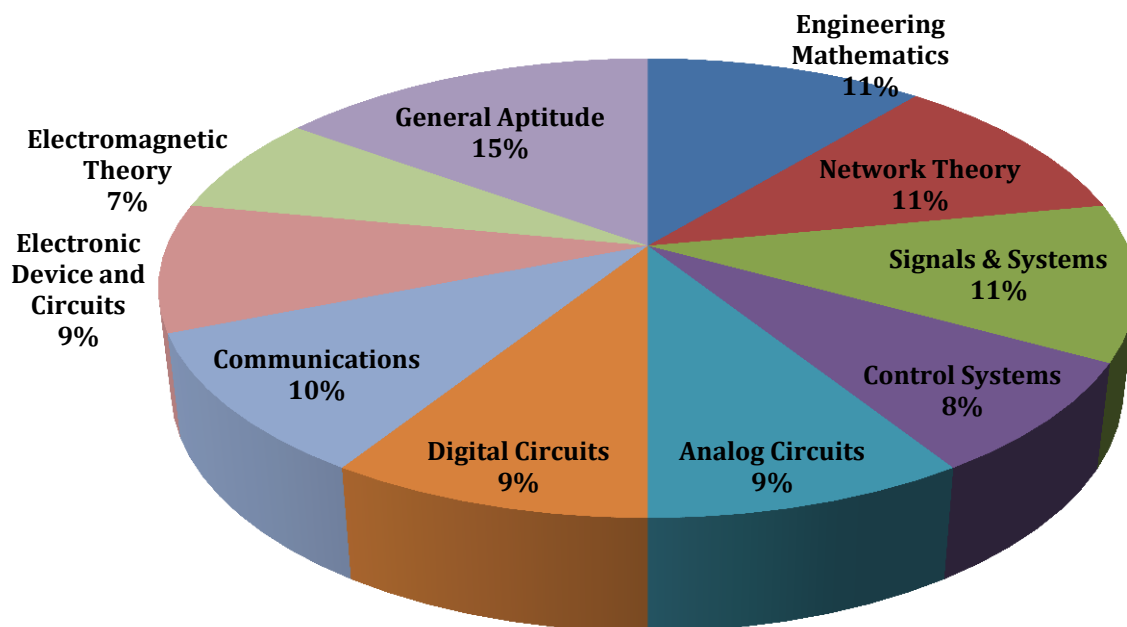
Answer Keys

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ANALYSIS OF GATE 2014 SET-1

Electronics and Communication Engineering



GATE-2014- ECE SET-1

SUBJECT	NO OF QUESTION	Topics Asked in Paper	Total Marks
Engineering Mathematics	1M:5 2M:3	Linear Algebra Probability and Distribution Numerical Method Calculus Complex Variable	11
Network Theory	1M:3 2M:4	Network Solution and methodology Sinusoidal study state Analysis Two -port Network	11
Signals & Systems	1M:3 2M:4	Introduction to S&S Linear Time invariant (LTI)System Fourier Representation of signal Z-Transform Frequency Response of LTI System	11
Control Systems	1M:2 2M:3	Time domain Analysis Stability & RouthHurwitz Criterion Root Locus Technique Frequency Response Analysis Nyquist Plot State Variable Analysis	8
Analog Circuits	1M:3 2M:3	Diode -Circuit -Analysis & Application Small Signal Modeling of BJT & FET Feedback Amplifiers Operational Amplifier and Its Application	9
Digital Circuits	1M:3 2M:3	Boolean Algebra & KMap Logic Gates Logic GATE Families Combinational Digital Circuit	9
Communications	1M:2 2M:4	Noise Angle modulation Digital Communication	10
Electronic Device and Circuits	1M:3 2M:3	Semiconductor theory Transistor Theory (BJT, FET) Opto Electronics, FET, MOSFET & CMOS	9
Electromagnetic Theory	1M:1 2M:3	Electronics & Magnetic Field Electromagnetic Waves Transmission Lines	7
General Aptitude	1M:5 2M:5	Numerical Ability Verbal Ability	15
Total	65		100

GATE 2014 Examination

Electronics and Communication Engineering SET-1

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

1. For matrices of same dimension M, N and scalar c, which one of these properties DOES NOT ALWAYS hold?

(A) $(M^T)^T = M$

(C) $(M + N)^T = M^T + N^T$

(B) $(cM)^T = c(M)^T$

(D) $MN = NM$

[Ans. D]

2. In a housing society, half of the families have a single child per family, while the remaining half have two children per family. The probability that a child picked at random, has a sibling is ____

[Ans. *] Range 0.65 to 0.68

3. C is a closed path in the z-plane given by $|z|=3$. The value of the integral $\oint_C \left(\frac{z^2 - z + 4j}{z + 2j} \right) dz$ is

(A) $-4\pi(1 + j2)$

(C) $-4\pi(3 + j2)$

(B) $4\pi(3 - j2)$

(D) $4\pi(1 - j2)$

[Ans. C]

4. A real (4×4) matrix A satisfies the equation $A^2 = I$, where I is the (4×4) identity matrix. The positive eigen value of A is ____.

[Ans. *] Range 0.99 to 1.01

5. Let X_1, X_2 and X_3 , be independent and identically distributed random variables with the uniform distribution on $[0, 1]$. The probability $P\{X_1 \text{ is the largest}\}$ is ____

[Ans. *] Range 0.32 to 0.34

6. For maximum power transfer between two cascaded sections of an electrical network, the relationship between the output impedance Z_1 of the first section to the input impedance Z_2 of the second section is

(A) $Z_2 = Z_1$

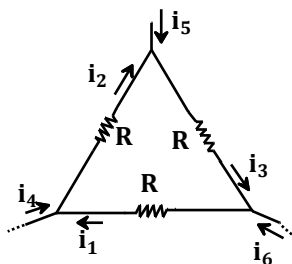
(C) $Z_2 = Z_1^*$

(B) $Z_2 = -Z_1$

(D) $Z_2 = -Z_1^*$

[Ans. C]

7. Consider the configuration shown in the figure which is a portion of a larger electrical network



For $R=1\ \Omega$ and currents $i_1 = 2A, i_4 = -1A, i_5 = -4A$, which one of the following is TRUE?

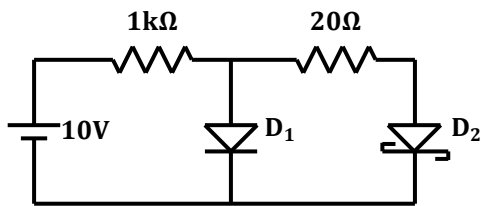
- (A) $i_6 = 5A$
- (B) $i_3 = -4A$
- (C) Data is sufficient to conclude that the supposed currents are impossible
- (D) Data is insufficient to identify the currents i_2, i_3 and i_6

[Ans. A]

8. When the optical power incident on a photodiode is $10\ \mu W$ and the responsivity is $0.8\ A/W$, the photocurrent generated (in μA) is _____.

[Ans. *] Range 7.99 to 8.01

9. In the figure, assume that the forward voltage drops of the PN diode D_1 and Schottky diode D_2 are $0.7\ V$ and $0.3\ V$, respectively. If ON denotes conducting state of the diode and OFF denotes non-conducting state of the diode, then in the circuit,



- (A) both D_1 and D_2 are ON
- (B) D_1 is ON and D_2 is OFF
- (C) both D_1 and D_2 are OFF
- (D) D_1 is OFF and D_2 is ON

[Ans. D]

10. If fixed positive charges are present in the gate oxide of an n-channel enhancement type MOSFET, it will lead to

- (A) a decrease in the threshold voltage
- (B) channel length modulation
- (C) an increase in substrate leakage current
- (D) an increase in accumulation capacitance

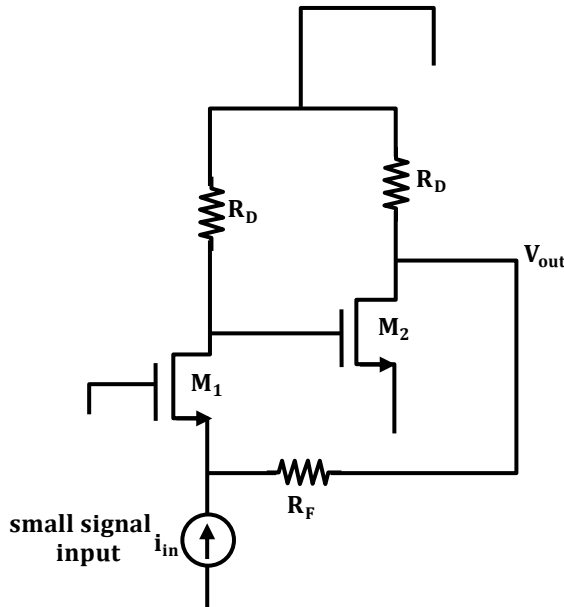
[Ans. A]

11. A good current buffer has

- (A) low input impedance and low output impedance
- (B) low input impedance and high output impedance
- (C) high input impedance and low output impedance
- (D) high input impedance and high output impedance

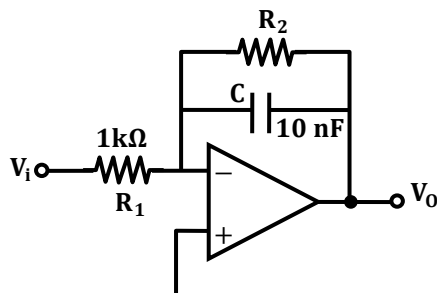
[Ans. B]

12. In the ac equivalent circuit shown in the figure, if i_{in} is the input current and R_F is very large, the type of feedback is



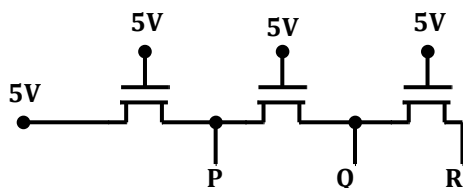
- (A) voltage-voltage feedback
(B) voltage-current feedback
(C) current-voltage feedback
(D) current-current feedback
- [Ans. B]

13. In the low-pass filter shown in the figure, for a cut-off frequency of 5 kHz, the value of R_2 (in $k\Omega$) is _____



[Ans. *] Range 3.1 to 3.26

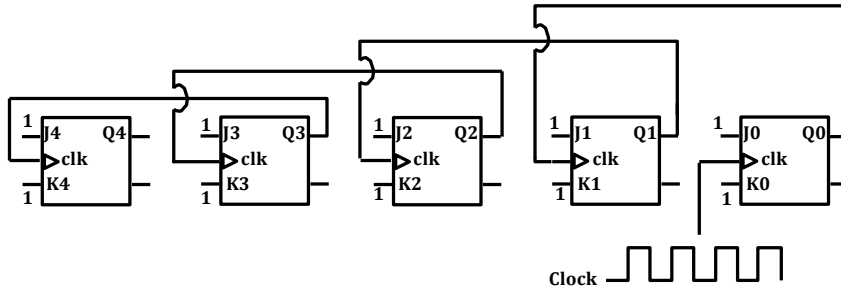
14. In the following circuit employing pass transistor logic, all NMOS transistors are identical with a threshold voltage of 1V. Ignoring the body-effect, the output voltages at P, Q and R are,



- (A) 4 V, 3 V, 2 V
(B) 5 V, 5 V, 5 V
(C) 4 V, 4 V, 4 V
(D) 5 V, 4 V, 3 V
- [Ans. C]

15. The Boolean expression $(X + Y)(X + \bar{Y}) + \overline{(XY)} + \bar{X}$ simplifies to
 (A) X (B) Y (C) XY (D) X+Y
[Ans. A]

16. Five JK flip-flops are cascaded to form the circuit shown in Figure. Clock pulses at a frequency of 1 MHz are applied as shown. The frequency (in kHz) of the waveform at Q3 is _____.



[Ans. *] Range 62.4 to 62.6

17. A discrete-time signal $x[n] = \sin(\pi^2 n)$, n being an integer, is
 (A) Periodic with period π (C) Periodic with period $\pi/2$
 (B) Periodic with period π^2 (D) not periodic
[Ans. D]

18. Consider two real valued signals, $x(t)$ band-limited to $[-500 \text{ Hz}, 500 \text{ Hz}]$ and $y(t)$ band-limited to $[-1 \text{ kHz}, 1 \text{ kHz}]$. For $z(t) = x(t).y(t)$, the Nyquist sampling frequency (in kHz) is _____.
[Ans. *] Range 2.99 to 3.01

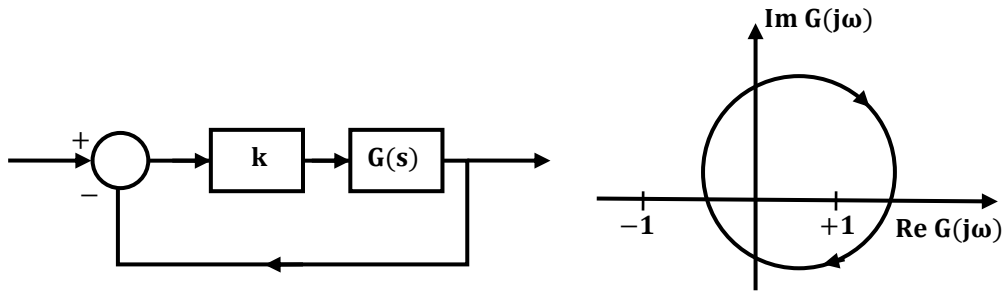
19. A continuous, linear time-invariant filter has an impulse response $h(t)$ described by

$$h(t) = \begin{cases} 3 & \text{for } 0 \leq t \leq 3 \\ 0 & \text{otherwise} \end{cases}$$
 When a constant input of value 5 is applied to this filter, the steady state output is____.
[Ans. *] Range 44 to 46

20. The forward path transfer function of a unity negative feedback system is given by

$$G(s) = \frac{K}{(s + 2)(s - 1)}$$
 The value of K which will place both the poles of the closed-loop system at the same location, is _____.
[Ans. *] Range 2.24 to 2.26

21. Consider the feedback system shown in the figure. The Nyquist plot of $G(s)$ is also shown. Which one of the following conclusions is correct?



- (A) $G(s)$ is an all-pass filter
 (B) $G(s)$ is a strictly proper transfer function
 (C) $G(s)$ is a stable and minimum-phase transfer function
 (D) The closed-loop system is unstable for sufficiently large and positive k

[Ans. D]

22. In a code-division multiple access (CDMA) system with $N = 8$ chips, the maximum number of users who can be assigned mutually orthogonal signature sequences is ____.

[Ans. *] Range 7.99 to 8.01

23. The capacity of a Binary Symmetric Channel (BSC) with cross-over probability 0.5 is ____.

[Ans. *] Range -0.01 to 0.01

24. A two-port network has scattering parameters given by $[S] = \begin{bmatrix} S_{11} & S_{12} \\ S_{21} & S_{22} \end{bmatrix}$. If the port-2 of the two-port is short circuited, the s_{11} parameter for the resultant one-port network is

- (A) $\frac{S_{11} - S_{11}S_{22} + S_{12}S_{21}}{1 + S_{22}}$ (C) $\frac{S_{11} + S_{11}S_{22} + S_{12}S_{21}}{1 - S_{22}}$
 (B) $\frac{S_{11} + S_{11}S_{22} - S_{12}S_{21}}{1 + S_{22}}$ (D) $\frac{S_{11} - S_{11}S_{22} + S_{12}S_{21}}{1 - S_{22}}$

[Ans. B]

25. The force on a point charge $+q$ kept at a distance d from the surface of an infinite grounded metal plate in a medium of permittivity ϵ is

- (A) 0 (C) $\frac{q^2}{16\pi\epsilon d^2}$ towards the plate
 (B) $\frac{q^2}{16\pi\epsilon d^2}$ away from the plate (D) $\frac{q^2}{4\pi\epsilon d^2}$ towards the plate

[Ans. A]

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

26. The Taylor expansion of $3 \sin x + 2 \cos x$ is

- (A) $2 + 3x - x^2 - \frac{x^3}{2} + \dots$ (C) $2 + 3x + x^2 + \frac{x^3}{2} + \dots$
 (B) $2 - 3x + x^2 - \frac{x^3}{2} + \dots$ (D) $2 - 3x - x^2 + \frac{x^3}{2} + \dots$

[Ans. A]

27. For a function $g(t)$, it is given that $\int_{-\infty}^{+\infty} g(t)e^{-j\omega t} dt = \omega e^{-2\omega^2}$ for any real value ω if $y(t) = \int_{-\infty}^t g(\tau) d\tau$, then $\int_{-\infty}^{+\infty} y(t)dt$ is
 (A) 0 (B) $-j$ (C) $-\frac{j}{2}$ (D) $\frac{j}{2}$

[Ans. B]

28. The volume under the surface $z(x, y) = x + y$ and above the triangle in the x - y plane defined by $\{0 \leq y \leq x \text{ and } 0 \leq x \leq 12\}$ is_____

[Ans. *] Range 862 to 866

29. Consider the matrix

$$J_6 = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

which is obtained by reversing the order of the columns of the identity matrix I_6 .

Let $P = I_6 + \alpha J_6$, where α is a non-negative real number. The value of α for which $\det(P) = 0$ is _____.

[Ans. *] Range 0.99 to 1.01

30. A Y-network has resistances of 10Ω each in two of its arms, while the third arm has a resistance of 11Ω . In the equivalent Δ -network, the lowest value (in Ω) among the three resistances is _____

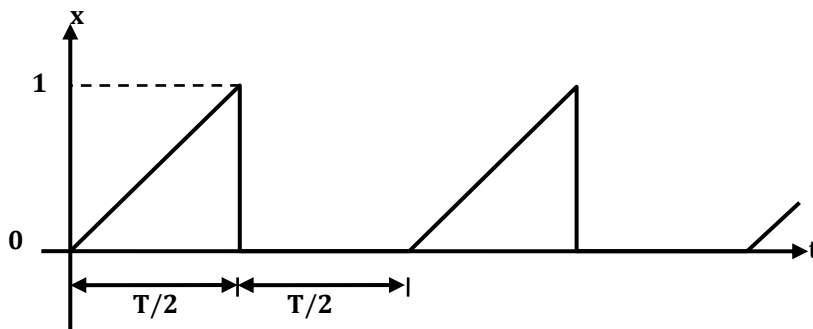
[Ans. *] Range 29.08 to 29.10

31. A 230 V rms source supplies power to two loads connected in parallel. The first load draws 10 kW at 0.8 leading power factor and the second one draws 10 kVA at 0.8 lagging power factor. The complex power delivered by the source is

- (A) $(18 + j 1.5)$ kVA (C) $(20 + j 1.5)$ kVA
 (B) $(18 - j 1.5)$ kVA (D) $(20 - j 1.5)$ kVA

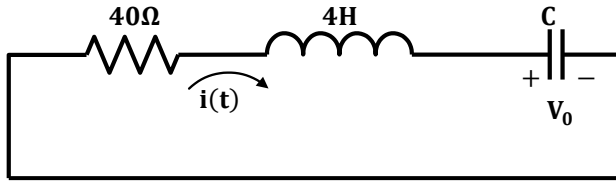
[Ans. B]

32. A periodic variable x is shown in the figure as a function of time. The root-mean-square (rms) value of x is _____.



[Ans. *] Range 0.39 to 0.42

33. In the circuit shown in the figure, the value of capacitor C (in mF) needed to have critically damped response $i(t)$ is _____.



[Ans. *] Range 9.99 to 10.01

34. A BJT is biased in forward active mode. Assume $V_{BE} = 0.7$ V, $kT/q = 25$ mV and reverse saturation current $I_S = 10^{-13}$ A. The transconductance of the BJT (in mA/V) is _____.

[Ans. *] Range 5.7 to 5.9

35. The doping concentrations on the p-side and n-side of a silicon diode are $1 \times 10^{16} \text{cm}^{-3}$ and $1 \times 10^{17} \text{cm}^{-3}$, respectively. A forward bias of 0.3 V is applied to the diode. At $T = 300$ K, the intrinsic carrier concentration of silicon $n_i = 1.5 \times 10^{10} \text{cm}^{-3}$ and $kT/q = 26$ mV. The electron concentration at the edge of the depletion region on the p-side is _____.

(A) $2.3 \times 10^9 \text{cm}^{-3}$

(C) $1 \times 10^{17} \text{cm}^{-3}$

(B) $1 \times 10^{16} \text{cm}^{-3}$

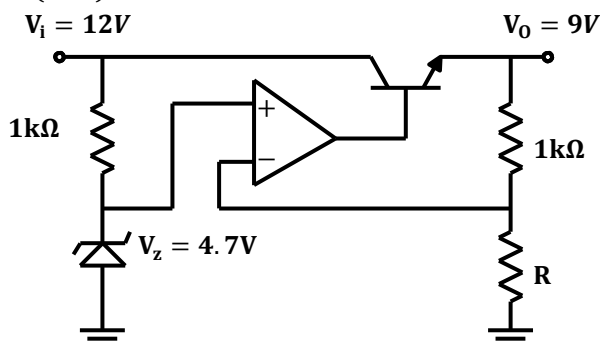
(D) $2.25 \times 10^6 \text{cm}^{-3}$

[Ans. A]

36. A depletion type N-channel MOSFET is biased in its linear region for use as a voltage controlled resistor. Assume threshold voltage $V_{TH} = -0.5$ V, $V_{GS} = 2.0$ V, $V_{DS} = 5$ V, $W/L = 100$, $C_{ox} = 10^{-8}$ F/cm² and $\mu_n = 800$ cm²/V-s. The value of the resistance of the voltage controlled resistor (in Ω) is _____.

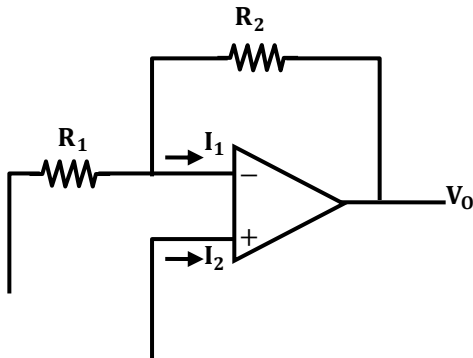
[Ans. *] Range 499 to 501

37. In the voltage regulator circuit shown in the figure, the op-amp is ideal. The BJT has $V_{BE} = 0.7$ V and $\beta = 100$, and the zener voltage is 4.7 V. For a regulated output of 9V, the value of R (in Ω) is _____.



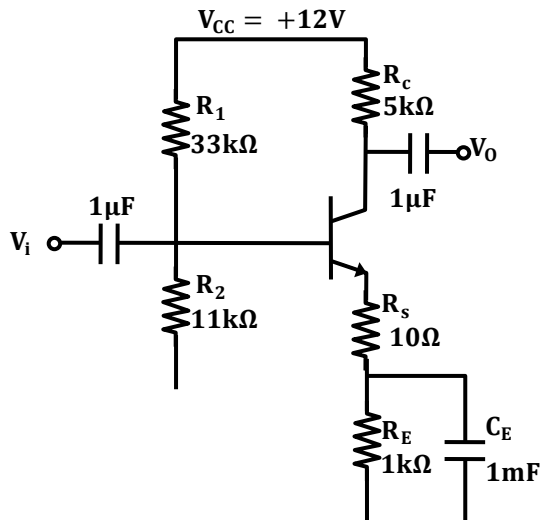
[Ans. *] Range 1092 to 1094

38. In the circuit shown, the op-amp has finite input impedance, infinite voltage gain and zero input offset voltage. The output voltage V_{out} is



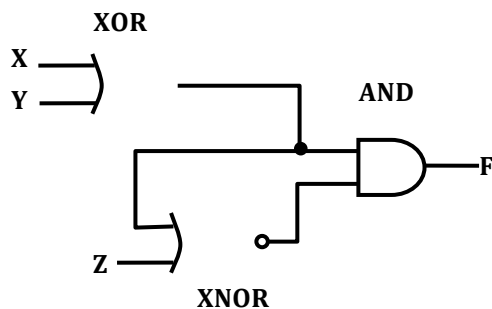
- (A) $-I_2(R_1 + R_2)$ (C) I_1R_2
(B) I_2R_2 (D) $-I_1(R_1 + R_2)$
[Ans. C]

39. For the amplifier shown in the figure, the BJT parameters are $V_{BE} = 0.7\text{ V}$, $\beta = 200$, and thermal voltage $V_T = 25\text{ mV}$. The voltage gain (V_o/V_i) of the amplifier is ____.



[Ans. *] Range - 240 to - 230

40. The output F in the digital logic circuit shown in the figure is

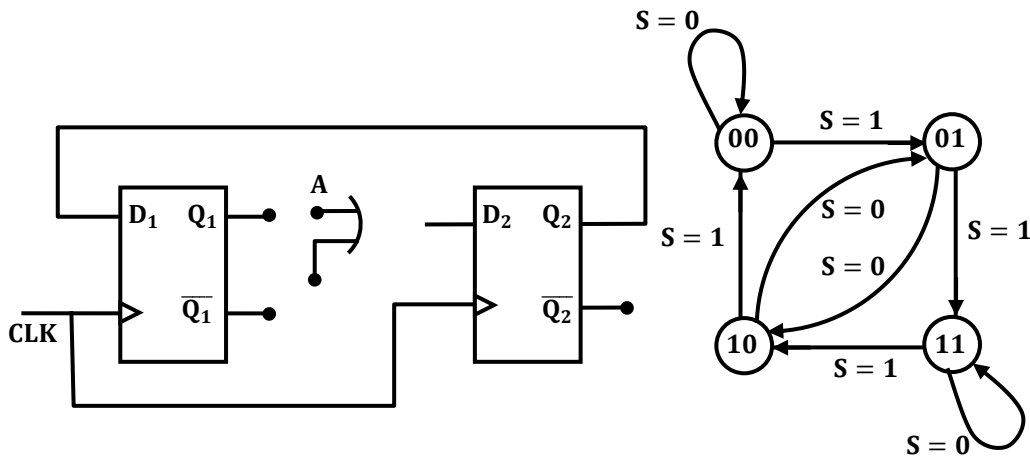


- (A) $F = \bar{x}yz + x\bar{y}z$ (C) $F = \bar{x}\bar{y}z + xyz$
(B) $F = \bar{x}y\bar{z} + x\bar{y}\bar{z}$ (D) $F = \bar{x}\bar{y}\bar{z} + xyz$
[Ans. A]

41. Consider the Boolean function, $F(w, x, y, z) = wy + xy + \bar{w}xyz + \bar{w}\bar{x}y + xz + \bar{x}\bar{y}\bar{z}$. Which one of the following is the complete set of essential prime implicants?
 (A) $w, y, xz, \bar{x}\bar{z}$ (C) $y, \bar{x}\bar{y}\bar{z}$
 (B) w, y, xz (D) $y, xz, \bar{x}\bar{z}$

[Ans. D]

42. The digital logic shown in the figure satisfies the given state diagram when Q1 is connected to input A of the XOR gate.



Suppose the XOR gate is replaced by an XNOR gate. Which one of the following options preserves the state diagram?

- (A) Input A is connected to $\bar{Q}\bar{2}$
 (B) Input A is connected to Q_2
 (C) Input A is connected to $\bar{Q}\bar{1}$ and S is complemented
 (D) Input A is connected to $\bar{Q}\bar{1}$
- [Ans. D]

43. Let $x[n] = \left(-\frac{1}{9}\right)^n u(n) - \left(-\frac{1}{3}\right)^n u(-n-1)$. The region of convergence (ROC) of the z-transform of $x[n]$
 (A) is $|z| > \frac{1}{9}$ (C) is $\frac{1}{3} > |z| > \frac{1}{9}$
 (B) is $|z| < \frac{1}{3}$ (D) Does not exist

[Ans. C]

44. Consider a discrete time periodic signal $x[n] = \sin\left(\frac{\pi n}{5}\right)$. Let a_k be the complex Fourier series coefficients of $x[n]$. The coefficients $\{a_k\}$ are non-zero when $k = Bm \pm 1$, where m is any integer. The value of B is ____.

[Ans. *] Range 9.99 to 10.01

45. A system is described by the following differential equation, where $u(t)$ is the input to the system and $y(t)$ is the output of the system.
 $\dot{y}(t) + 5y(t) = u(t)$
 When $y(0) = 1$ and $u(t)$ is a unit step function, $y(t)$ is

- (A) $0.2 + 0.8e^{-5t}$ (C) $0.8 + 0.2e^{-5t}$
 (B) $0.2 - 0.2e^{-5t}$ (D) $0.8 - 0.8e^{-5t}$
[Ans. A]

46. Consider the state space model of a system, as given below

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} -1 & 1 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & -2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 4 \\ 0 \end{bmatrix} u; y = [1 \quad 1 \quad 1] \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

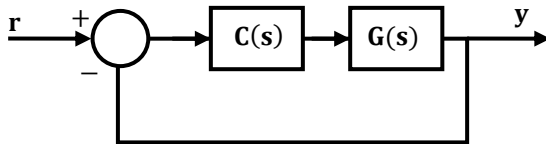
The system is

- (A) controllable and observable (C) uncontrollable and unobservable
 (B) uncontrollable and observable (D) controllable and unobservable
[Ans. B]

47. The phase margin in degrees of $G(s) = \frac{10}{(s+0.1)(s+1)(s+10)}$ calculated using the asymptotic Bode plot is _____.

[Ans. *] Range 42 to 48

48. For the following feedback system $G(s) = \frac{1}{(s+1)(s+2)}$. The 2%-settling time of the step response is required to be less than 2 seconds.



Which one of the following compensators $C(s)$ achieves this?

- (A) $3 \left(\frac{1}{s+5} \right)$ (C) $2(s+4)$
 (B) $5 \left(\frac{0.03}{s} + 1 \right)$ (D) $4 \left(\frac{s+8}{s+3} \right)$

[Ans. C]

49. Let X be a real-valued random variable with $E[X]$ and $E[X^2]$ denoting the mean values of X and X^2 , respectively. The relation which always holds true is

- (A) $(E[X])^2 > E[X^2]$ (C) $E[X^2] = (E[X])^2$
 (B) $E[X^2] \geq (E[X])^2$ (D) $E[X^2] > (E[X])^2$

[Ans. B]

50. Consider a random process $X(t) = \sqrt{2} \sin(2\pi t + \varphi)$, where the random phase φ is uniformly distributed in the interval $[0, 2\pi]$. The auto-correlation $E[X(t_1)X(t_2)]$ is

- (A) $\cos(2\pi(t_1 + t_2))$ (C) $\sin(2\pi(t_1 + t_2))$
 (B) $\sin(2\pi(t_1 - t_2))$ (D) $\cos(2\pi(t_1 - t_2))$

[Ans. D]

General Aptitude (Set – 3)

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

56. Choose the most appropriate phrase from the options given below to complete the following sentence.

The aircraft _____ take off as soon as its flight plan was filed.

- (A) is allowed to (C) was allowed to
(B) will be allowed to (D) has been allowed to

[Ans. C]

57. Read the statements:

All women are entrepreneurs.

Some women are doctors.

Which of the following conclusions can be logically inferred from the above statements?

- (A) All women are doctors (C) All entrepreneurs are women
(B) All doctors are entrepreneurs (D) Some entrepreneurs are doctors

[Ans. D]

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

Many ancient cultures attributed disease to supernatural causes. However, modern science has largely helped ____ such notions.

- (A) impel (C) propel
(B) dispel (D) repel

[Ans. B]

59. The statistics of runs scored in a series by four batsmen are provided in the following table. Who is the most consistent batsman of these four?

Batsman	Average	Standard deviation
K	31.2	5.21
L	46.0	6.35
M	54.4	6.22
N	17.9	5.90

- (A) K (B) L (C) M (D) N

[Ans. A]

60. What is the next number in the series?

12 35 81 173 357 ____

[Ans. *] Range 725 to 725

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

61. Find the odd one from the following group:

W,E,K,O I,Q,W,A F,N,T,X N,V,B,D

- (A) W,E,K,O (C) F,N,T,X
(B) I,Q,W,A (D) N,V,B,D

[Ans. D]

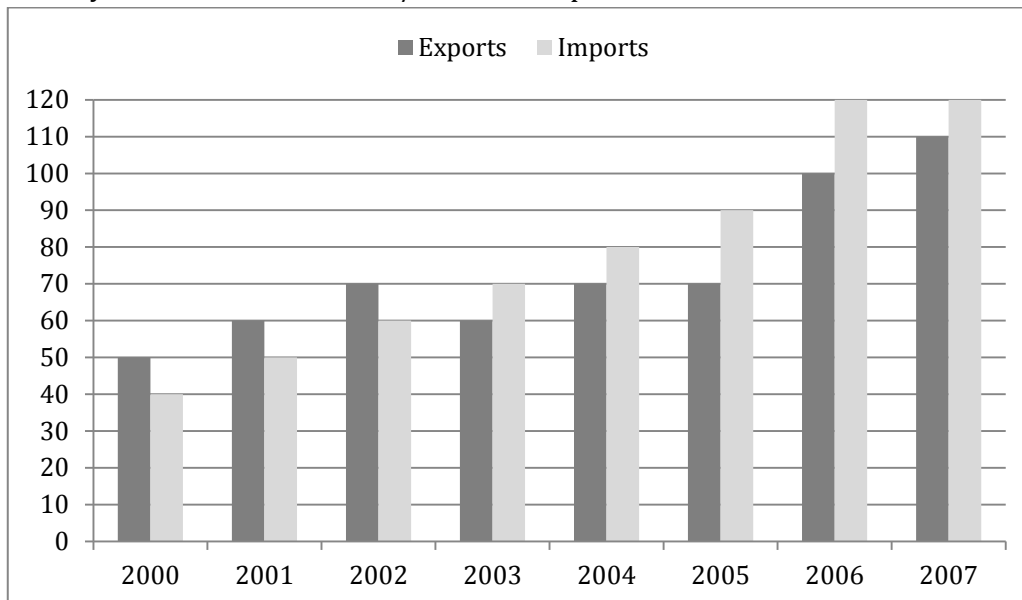
62. For submitting tax returns, all resident males with annual income below Rs 10 lakh should fill up Form P and all resident females with income below Rs 8 lakh should fill up Form Q. All people with incomes above Rs 10 lakh should fill up Form R, except non residents with income above Rs 15 lakhs, who should fill up Form S. All others should fill Form T. An example of a person who should fill Form T is
- (A) a resident male with annual income Rs 9 lakh
 (B) a resident female with annual income Rs 9 lakh
 (C) a non-resident male with annual income Rs 16 lakh
 (D) a non-resident female with annual income Rs 16 lakh

[Ans. B]

63. A train that is 280 metres long, travelling at a uniform speed, crosses a platform in 60 seconds and passes a man standing on the platform in 20 seconds. What is the length of the platform in metres?

[Ans. *] Range 560 to 560

64. The exports and imports (in crores of Rs.) of a country from 2000 to 2007 are given in the following bar chart. If the trade deficit is defined as excess of imports over exports, in which year is the trade deficit $1/5$ th of the exports?



(A) 2005

(B) 2004

(C) 2007

(D) 2006

[Ans. D]

65. You are given three coins: one has heads on both faces, the second has tails on both faces, and the third has a head on one face and a tail on the other. You choose a coin at random and toss it, and it comes up heads. The probability that the other face is tails is

(A) $1/4$

(C) $1/2$

(B) $1/3$

(D) $2/3$

[Ans. B]

