GATE-2015

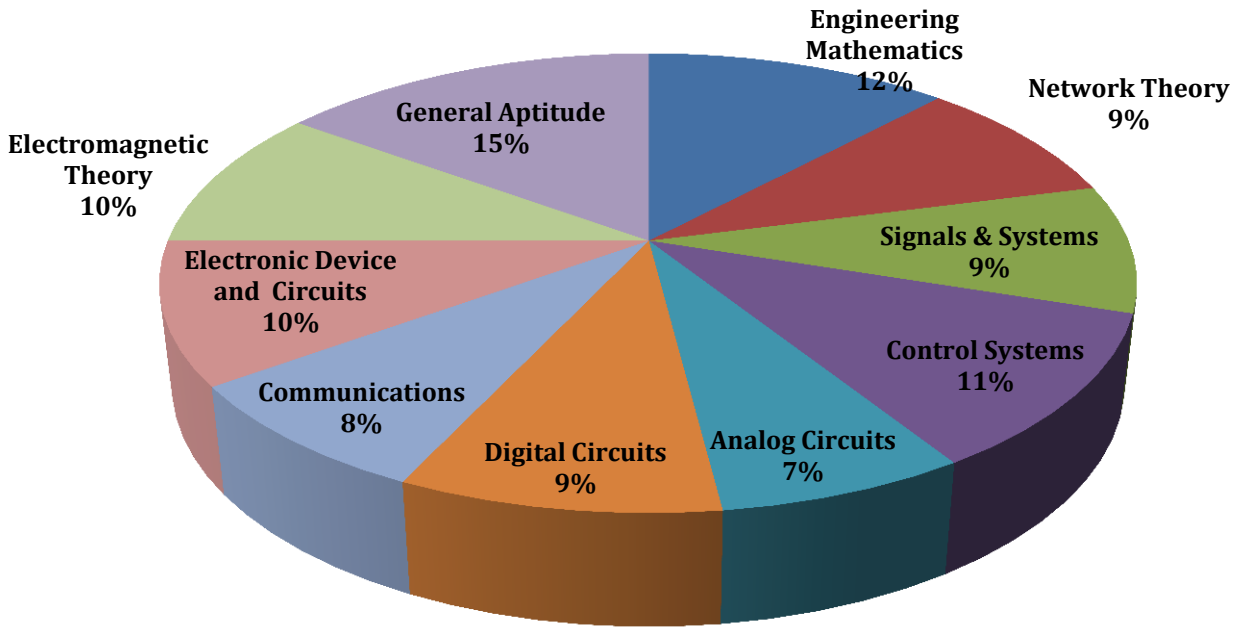
Question Paper

&

Answer Keys

Index

ANALYSIS OF GATE 2015 SET-3
Electronics and Communication Engineering



GATE-2015-ECE-SET-3

SUBJECT	NO OF QUESTION	Topics Asked in Paper	Total Marks
Engineering Mathematics	1M:4 2M:4	Linear Algebra, Probability and Distribution Numerical Method, Calculus Differential Equation, Complex Variable	12
Network Theory	1M:1 2M:4	Network Solution and methodology Sinusoidal steady state Analysis Laplace transforms Two –port Network	9
Signals & Systems	1M:3 2M:3	Introduction to S&S, Linear Time invariant (LTI)System, Fourier Representation of signal Z-Transform, Frequency Response of LTI System	9
Control Systems	1M:3 2M:4	Time domain Analysis, Stability & Routh Hurwitz Criterion, Frequency Response Analysis Nyquist Plot, Frequency response Analysis using bode plot, Compensators & Controllers, State Variable Analysis	11
Analog Circuits	1M:1 2M:3	Diode –Circuit –Analysis &Application DC Biasing-BJTs Operational Amplifier and Its Application	7
Digital Circuits	1M:3 2M:3	Logic Gates Sequential Digital Circuit & Counter Introduction to Microprocessor	9
Communications	1M:2 2M:3	DSBSC,SSB, and VSB, Modulation, Angle modulation, Digital Communication	8
Electronic Device and Circuits	1M:4 2M:3	P-n Junction Theory R Characteristics Transistor Theory (BIT, FE) FET(TEFT,MOSFET,)& CMOS	10
Electromagnetic Theory	1M:2 2M:4	Electronics & Magnetic Field Electromagnetic Waves Antennas Transmission Lines	10
General Aptitude	1M:5 2M:5	Numerical Ability Verbal Ability	15
Total	**65**		**100**

GATE 2015 Examination

Electronics and Communication Engineering

Test Date: 01/02/2015

Test Time: 9:00 AM 12:00 PM

Subject Name: EC ELECTRONICS AND COMMUNICATION ENGINEERING

Section: General Aptitude

1. Find the missing sequence in the letter series below:
A, CD, GHI?, UVWXY
(A) LMN
(B) MNO
(C) MNOP
(D) NOPQ

2. If $x > y > 1$, which of the following must be true?
(i) $\ln x > \ln y$
(ii) $e^x > e^y$
(iii) $y^x > x^y$
(iv) $\cos x > \cos y$
(A) (i) and (ii)
(B) (i) and (iii)
(C) (iii) and (iv)
(D) (ii) and (iv)

3. Choose the correct verb to fill in the blank below:
Let us _____.
(A) introvert
(B) alternate
(C) atheist
(D) altruist

4. Choose the most suitable one word substitute for the following expression:
Connotation of a road or way
(A) Perrinacious
(B) Viaticum
(C) Clandestine
(D) Ravenous

5. Choose the most appropriate word from the options given below to complete the following sentence.
If the athlete had wanted to come first in the race, he _____ several hours every day.
(A) should practise
(B) should have practised
(C) practiced
(D) should be practising

6. Ram and Shyam shared a secret and promised to each other that it would remain between them. Ram express himself in one of the following ways as given in the choices below. Identify the correct way as per standard English.
(A) It would remain between you and me.
(B) It would remain between I and you.
(C) It would remain between you and I.
(D) It would remain with me.

7. Ms. X will be Bagdogra from 01/05/2014 to 20/05/2014 and from 22/05/2014 to 31/05/2014. On the morning of 21/05/2014, she will reach Kochi via Mumbai.
Which one of the statements below is logically valid and can be inferred from the above sentences?
(A) Ms. X will be in Kochi for one day, only in May.
(B) Ms. X will be in Kochi for only one day in May.
(C) Ms. X will be only in Kochi for one day in May.
(D) Only Ms. X will be in Kochi for one day in May.

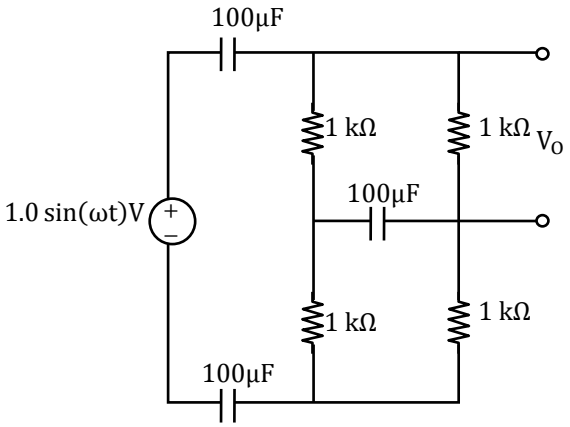
8. From a circular sheet of paper of radius 30 cm, a sector of 10% area is removed. If the remaining part is used to make a conical surface, then the ratio of the radius and height of the cone is _____.

9. In the following question, the first and the last sentence of the passage are in order and numbered 1 and 6. The rest of the passage is split into 4 parts and numbered as 2, 3, 4 and 5. These 4 parts are not arranged in proper order. Read the sentences and arrange them in a logical sequence to make a passage and choose the correct sequence from the given options.
1. On Diwali, the family rises early in the morning.
2. The whole family, including the young and the old enjoy doing this.
3. Children let off fireworks later in the night with their friends.
4. At sunset, the lamps are lit and the family performs various rituals.
5. Father, mother and children visit relatives and exchange gifts and sweets.
6. Houses looks so pretty with lighted lamps all around.
(A) 2, 5, 3, 4
(B) 5, 2, 4, 3
(C) 3, 5, 4, 2
(D) 4, 5, 2, 3

10. $\log \tan 1° + \log \tan 2° + \cdots + \log \tan 89°$ is _____
(A) 1
(B) $1/\sqrt{2}$
(C) 0
(D) -1

Section: Electronics and Communication Engineering

1. At very high frequencies, the peak output voltage V_0 (in Volts) is _____.



2. Which one of the following 8085 microprocessor programs correctly calculates the product of two 8-bit numbers stored in registers B and C?

(A)
```
    MVI A, 00 H
    JNZ LOOP
LOOP DCR B
    HLT
```

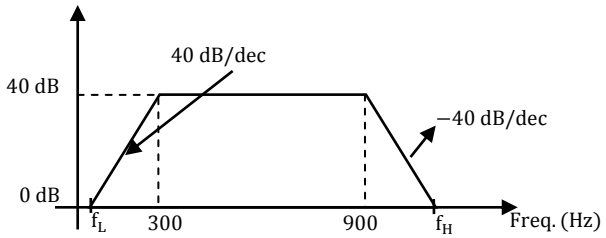
(B)
```
    MVI, A, 00H
    CMP C
LOOP DCR B
    JNZ LOOP
    HLT
```

(C)
```
    MVI A, 00H
LOOP ADD C
    DCR B
    JNZ LOOP
    HLT
```

(D)
```
    MVI A, 00H
    ADD C
    JNZ LOOP
LOOP INR B
    HLT
```

3. The impulse response of an LTI system can be obtained by
(A) Differentiating the unit ramp response
(B) Differentiating the unit step response
(C) Integrating the unit ramp response
(D) Integrating the unit step response

4. Consider the Bode plot shown in figure. Assume that all the poles and zeros are real valued.



The value of $f_H - f_L$ (in Hz) is _____.

5. A message signal $m(t) = A_m \sin(2\pi f_m t)$ is used to modulate the phase of a carrier $A_c \cos(2\pi f_c t)$ to get the modulated signal $y(t) = A_c \cos(2\pi f_c t + m(t))$. The bandwidth of $y(t)$
(A) Depends on A_M But not on F_M
(B) Depends on F_M But not on A_M
(C) Depends on both A_M And F_M
(D) Does not depends on A_M Or F_M

6. For $A = \begin{bmatrix} 1 & \tan x \\ -\tan x & 1 \end{bmatrix}$ the determinant of $A^T A^{-1}$ is
(A) $\sec^2 x$
(B) $\cos 4x$
(C) 1
(D) 0

7. The transfer function of a first order controller is given as

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

Where K, a and b are positive numbers. The condition for this controller to act as a phase lead compensator is

(A) $a < b$
(B) $a > b$
(C) $K < ab$
(D) $K > ab$

8. The directivity of an antenna array can be increased by adding more antenna elements, as a larger number of elements

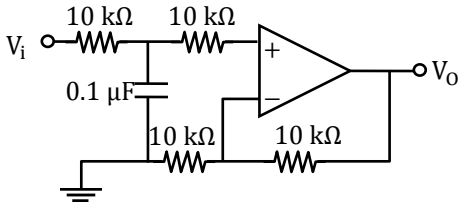
(A) improves the radiation efficiency
(B) increases the effective area of the antenna
(C) results in a better impedance matching
(D) allows more power to transmitted by the antenna

9. The contour on the x-y plane, where the partial derivative of $x^2 + y^2$ with respect to y is equal to the partial derivative of $6y + 4x$ with respect to x, is

(A) $y = 2$
(B) $x = 2$
(C) $x = y = 4$
(D) $x - y = 0$

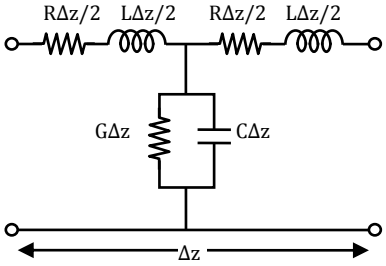
10. The phase margin (in degrees) of the system $G(s) = \frac{10}{s(s+10)}$ is _____

11. In the circuit shown using an ideal op-amp, the 3-dB cut-off frequency (in Hz) is _____.

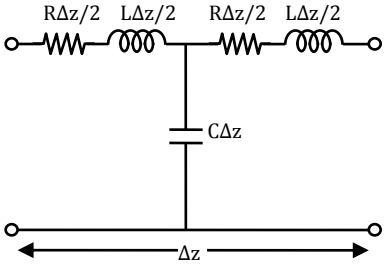


12. A coaxial cable is made of two brass conductors. The spacing between the conductors, is filled with Teflon ($\varepsilon_r' = 2.1$, $\tan\delta = 0$). Which one of the following circuits can represent the lumped element model of a small piece of this cable having length Δz?

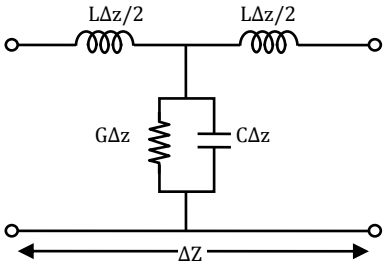
(A)



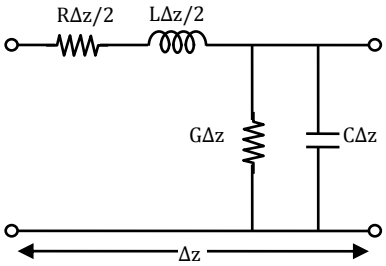
(B)



(C)



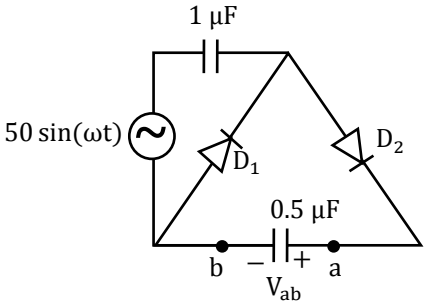
(D)



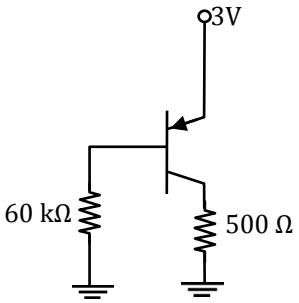
13. The modulation scheme commonly used for transmission from GSM mobile terminals is
(A) 4-QAM
(B) 16-PSK
(C) Walsh-Hadamard orthogonal codes
(D) Gaussian Minimum Shift Keying (GMSK)

14. Consider the function $g(t) = e^{-t}\sin(2\pi t)\, u(t)$ where $u(t)$ is the unit step function. The area under $g(t)$ is _____.

15. In the circuit shown, assume that diodes D_1 and D_2 are ideal. In the steady-state condition the average voltage V_{ab} (in Volts) across the 0.5 μF capacitor is _____.



16. In the circuit shown in the figure, the BJT has a current gain (β) of 50. For an emitter base voltage $V_{EB} = 600$ mV, the emitter collector voltage V_{EC} (in Volts) is _____.



17. Which one of the following processes is preferred to form the gate dielectric (SiO_2) of MOSFETs?
(A) Sputtering
(B) Molecular beam epitaxy
(C) Wet oxidation
(D) Dry oxidation

18. Consider a four point moving average filter defined by the equation $y[n] = \sum_{i=10}^{3} \alpha_i \; x[n-1]$ The condition on the filter coefficients that results in a null a zero frequency is

(A) $\alpha_1 = \alpha_2 = 0; \alpha_0 = -\alpha 3$
(B) $\alpha_1 = \alpha_2 = 1; \alpha_0 = -\alpha_3$
(C) $\alpha_0 = \alpha_3 = 0; \; \alpha_1 = \alpha_2$
(D) $\alpha_1 = \alpha_2 = 0; \; \alpha_0 = \alpha_3$

19. If the base width in a bipolar junction transistor is doubled, which one of the following statements will be TRUE?

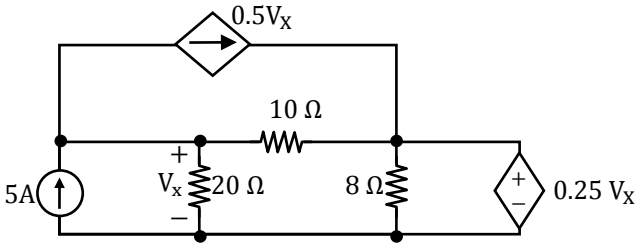
(A) Current gain will increase
(B) Unity gain frequency will increase
(C) Emitter base junction capacitance will increase
(D) Early voltage will increase

20. If C is a circle of radius r with center z_0, in the complex z-plane and if n is a non-zero integer, then $\oint_C \frac{dz}{(z-z_0)^{n+1}}$ equals

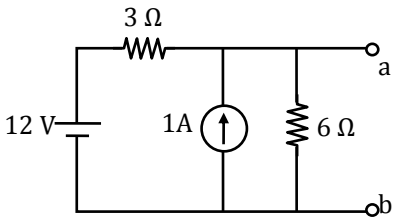
(A) $2\pi nj$
(B) 0
(C) $nj/2\pi$
(D) $2\pi n$

21. The value of $\sum_{n=\infty}^{\infty} n\left(\frac{1}{2}\right)^n$ is _____

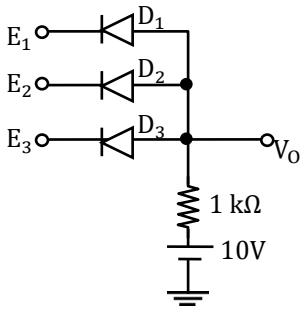
22. In the circuit shown, the voltage V_x(in Volts)is _____



23. For the current shown in the figure, the Thevenin equivalent voltage (in Volts) across terminals a-b is _____.

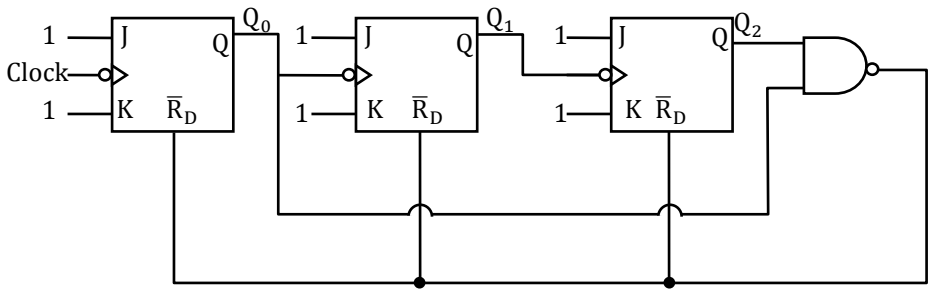


24. In the circuit shown diodes D_1, $D_2$and D_3 are ideal, and the inputs E_1, $E_2$and E_3 are '0 V' for logic '0' and ''10 V'' for logic '1'. What logic gate does the circuit represent?



(A) 3 input OR gate
(B) 3 input NOR gate
(C) 3 input AND gate
(D) 3 input XOR gate

25. The circuit shown consists of J-K flip-flops, each with an active low asynchronous reset ($\overline{R}_d$ input). The counter corresponding to this circuit is

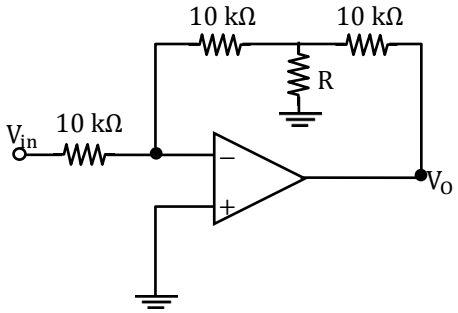


(A) a modulo-5 binary up counter
(B) a modulo-6 binary down counter
(C) a modulo-5 binary down counter
(D) a modulo-6 binary up counter

26. Suppose x[n] is an absolutely summable discrete-time signal. Its z-transform is a rational function with two poles and two zeroes. The poles are at $z = \pm 2j$. Which one of the following statements is TRUE for the signal x[n]?

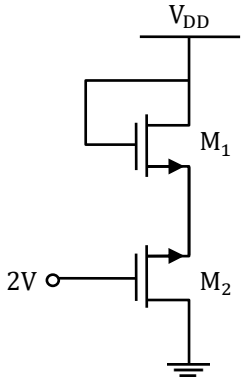
(A) It is a finite duration signal.
(B) It is a causal signal.
(C) It is a non-causal signal.
(D) It is a periodic signal.

27. In the circuit shown, assume that the op-amp is ideal. If the gain (V_0/V_m) is– 12, the value of R (in kΩ) is _____.



28. A fair die with faces {1, 2, 3, 4, 5, 6} is thrown repeatedly till '3' is observed for the first time. Let X denote the number of times the die is thrown. The expected value of X is____.

29. In the circuit shown, the both the enhancement mode NMOS transistors have the following characteristics: $k_n = \mu_n C_{ox}(W/L) = 1mA/V^2$; $V_{TN} = 1V$. Assume that the channel length modulation parameter λ is zero and body is shorted to source. The minimum supply voltage V_{DD} (in volts) needed to ensure that transistor. M_1 operates in saturation mode of operation is _____.



30. The characteristic equation of an LTI system is given by
$F(s) = s^5 + 2s^4 + 3s^3 + 6s^2 - 4s - 8 = 0$. The number of roots that lie strictly in the left half s-plane is _____.

31. A network is described by the state model is
$\dot{x}_1 = 2x_1 - x_2 + 3u$
$\dot{x}_2 = -4x_2 - u$
$y = 3x_1 - 2x_2$
The transfer function $H(s)\left(= \frac{Y(s)}{U(s)}\right)$ is

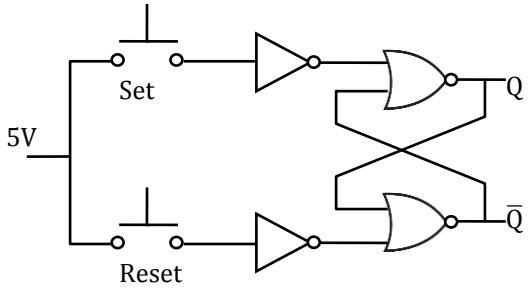
(A) $\frac{11s + 35}{(s-2)(s+4)}$

(B) $\frac{11s - 35}{(s-2)(s+4)}$

(C) $\frac{11s + 38}{(s-2)(s+4)}$

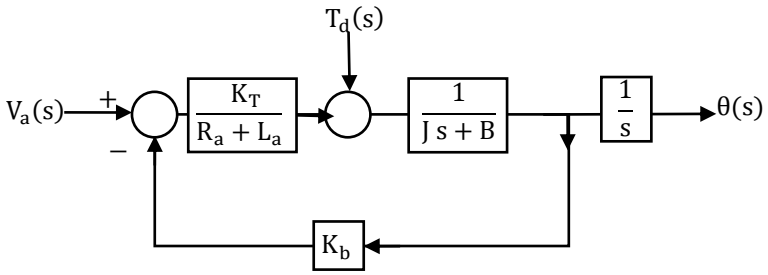
(D) $\frac{11s - 38}{(s-2)(s+4)}$

32. An SR latch is implemented using TTL gates as shown in the figure. The set and reset pulse inputs are provided using the push-button switches. It is observed that the circuit fails to work as desired. The SR latch can be made functional by changing

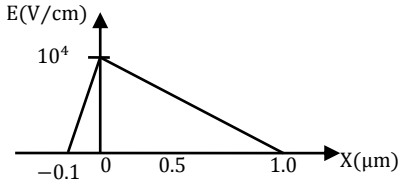


(A) NOR gates to NAND gates
(B) inverters to buffers
(C) NOR gates to NAND gates and inverters to buffers
(D) 5 V to ground

33. The position control of a DC servo-motor is given in the figure. The values of the parameters are $K_r = 1$ N-m/A, $R_a = 1\ \Omega$, $L_a = 0.1$H. $J = 5$ kg-m^2, $B = 1$ N-m (rad/sec) and $K_b = 1$ V/(rad/sec). The steady-state position response (in radians) due to unit impulse disturbance torque T_d is _____.



34. The electric field profile in the depletion region of a p-n junction in equilibrium is shown in the figure. Which one of the following statements is NOT TRUE?



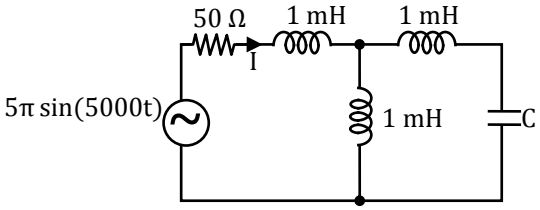
(A) The left side of the junction is n-type and the right side is p-type
(B) Both the n-type and p-type depletion regions are uniformly doped
(C) The potential difference across the depletion region is 700 mV
(D) If the p-type region has a doping concentration of 10^{15} cm^{-3}, then the doping concentration in the n-type region will be 10^{16} cm^{-3}

35. An npn BJT having reverse saturation current $I_s = 10^{-15}$ A is biased in the forward active region with $V_{BE} = 700$ mV. The thermal voltage (V_r) is 25 mV and the current gain (β) may vary from 50 to 150 due to manufacturing variations. The maximum emitter current (in μA) is_____.

36. A vector field $D = 2\rho^2 + a_\rho + z\,a_z$ exists inside a cylindrical region enclosed by the surfaces $\rho = 1$, $z = 0$ and $z = 5$. Let S be the surface bounding this cylindrical region. The surface integral of this field on S$\left(\oiint_S D.\,ds\right)$ is _____

37. Consider the differential equation
$\frac{d^2x(t)}{dt^2} + 3\frac{dx(t)}{dt} + 2x(t) = 0$
Given $x(0) = 20$ and $x(1) = \frac{10}{e}$, where $e = 2.718$ the value of $x(2)$is _____

38. In the circuit shown, the current I flowing through the 50 Ω resistor will be zero if the value of capacitor C (in μF) is_____.



39. The current in an enhancement mode NMOS transistor biased in saturation mode was measured to be 1 mA at a drain-source voltage of 5 V. When the drain source voltage was increased to 6 V while keeping gate-source voltage same, the drain current increased to 1.02 mA. Assume that drain to source saturation voltage is much smaller than the applied drain-source voltage. The channel length modulation parameter λ (in V^{-1}) is ____.

40. The Newton-Raphson method is used to solve the equation $f(x) = x^3 - 5x^2 + 6x - 8 = 0$. Taking the initial guess as $x = 5$, the solution obtained at the end of the first iteration is_____.

41. The complex envelope of the bandpass signal $x(t) = -\sqrt{2}\left(\frac{\sin(\pi t/5)}{\frac{\pi t}{5}}\right)\sin\left(\pi t - \frac{\pi}{4}\right)$, centered about $f = \frac{1}{2}$ Hz, is

(A) $\left(\frac{\sin(\pi t/5)}{\frac{\pi t}{5}}\right)e^{j\frac{\pi}{4}}$

(B) $\left(\frac{\sin(\pi t/5)}{\frac{\pi t}{5}}\right)e^{-j\frac{\pi}{4}}$

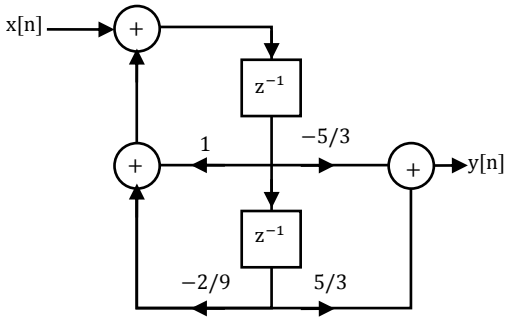
(C) $\sqrt{2}\left(\frac{\sin(\pi t/5)}{\frac{\pi t}{5}}\right)e^{j\frac{\pi}{4}}$

(D) $\sqrt{2}\left(\frac{\sin(\pi t/5)}{\frac{\pi t}{5}}\right)e^{-j\frac{\pi}{4}}$

42. A coaxial capacitor of inner radius 1 mm and outer radius 5 mm has a capacitance a per unit length of 172 pF/m. If the ratio of outer radius to inner is doubled, the capacitance per unit length (in pf/m) is_____.

43. The variance of the random variable X with probability density function $f(x) = \frac{1}{2}|x|e^{-|x|}$ is _____.

44. A realization of a stable discrete time system is shown in figure. If the system is excited by a unit step sequence input x[n], the response y[n] is_____.



(A) $4\left(-\frac{1}{3}\right)^{n} u[n] - 5\left(-\frac{2}{3}\right)^{n} u[n]$

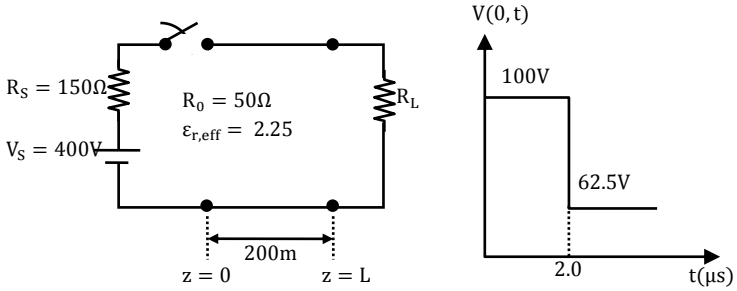
(B) $5\left(-\frac{2}{3}\right)^{n} u[n] - 3\left(-\frac{1}{3}\right)^{n} u[n]$

(C) $5\left(\frac{1}{3}\right)^{n} u[n] - 5\left(\frac{2}{3}\right)^{n} u[n]$

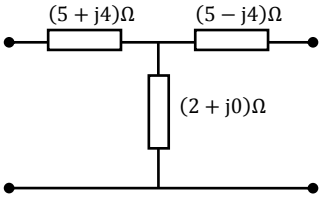
(D) $5\left(\frac{2}{3}\right)^{n} u[n] - 5\left(\frac{2}{3}\right)^{n} u[n]$

45. Let $\tilde{x}[n] = 1 + \cos\left(\frac{\pi n}{8}\right)$ be a periodic signal with period 16. Its DFS coefficients are defined by $a_k = \frac{1}{16}\sum_{n=0}^{15} \tilde{x}[n] \exp\left(-j\frac{\pi}{8} kn\right)$ or all k. The value of the coefficient a_{31} is ____.

46. A 200 m long transmission line having parameters shown in the figure is terminated into a load R_L. The line is connected to a 400 V source having source resistance R_s through a switch, which is closed at $t = 0$. The transient response of the circuit at the input of the line $(z = 0)$ is also drawn in the figure. The value of R_L (in Ω) is _____.



47. The ABCD parameters of the following 2-port network are



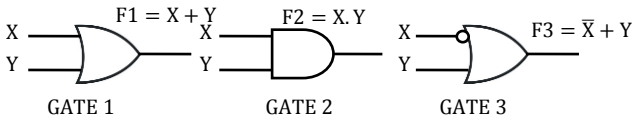
(A) $\begin{bmatrix} 3.5 + j2 & 20.5 \\ 20.5 & 3.5 - j2 \end{bmatrix}$

(B) $\begin{bmatrix} 3.5 + j2 & 30.5 \\ 0.5 & 3.5 - j2 \end{bmatrix}$

(C) $\begin{bmatrix} 10 & 2 + j0 \\ 2 + j0 & 10 \end{bmatrix}$

(D) $\begin{bmatrix} 7 + j4 & 0.5 \\ 30.5 & 7 - j4 \end{bmatrix}$

48. A universal logic gate can implement any Boolean function by connecting sufficient number of them appropriately. Three gates are shown.



Which one of the following statements is TRUE?

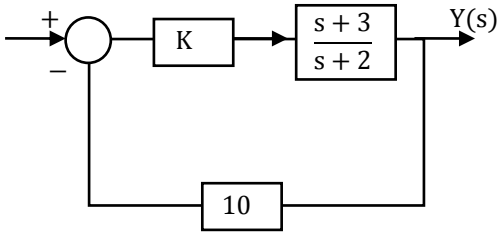
(A) Gate 1 is a universal gate.

(B) Gate 2 is a universal gate.

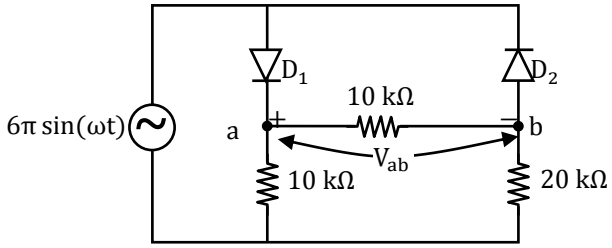
(C) Gate 3 is a universal gate.

(D) None of the gates shown is a universal gate.

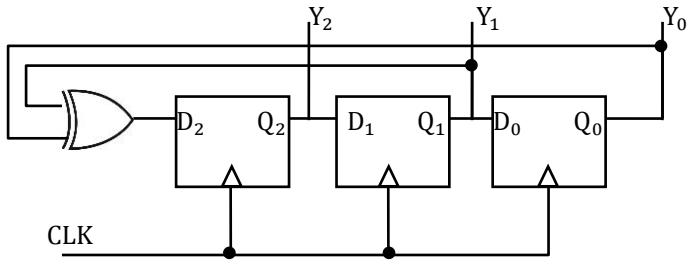
49. For the system shown in figure, $s = -2.75$ lies on the root locus if K is____.



50. In the circuit shown, assume that the diodes D_1 and D_2 are ideal. The average value of voltage V_{ab} (in Volts), across terminals 'a' and 'b' is _____.



51. A three bit pseudo random number generator is shown. Initially the value of output $Y = Y_2\ Y_1\ Y_0$ is set to 111. The value of output Y after three clock cycles is



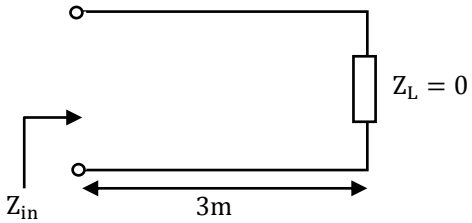
(A) 000

(B) 001

(C) 010

(D) 100

52. Consider the 3 m long lossless air-filled transmission line shown in the figure. It has a characteristic impedance of 120 πΩ, is terminated by a short circuit, and is excited with a frequency of 37.5 MHz. What is the nature of the input impedance (Z_{in})?



(A) Open
(B) Short
(C) Inductive
(D) Capacitive

53. Consider a continuous time signal defined as

$$x(t) = \left(\frac{\sin(\pi t/2)}{(\pi t/2)}\right) * \sum_{n=-\infty}^{\infty} \delta(t - 10n)$$

Where '*' denotes the convolution operation and t is in seconds. The Nyquist sampling rate (in samples/sec) for x(t) is_____.

54. A random binary wave y(t) is given by

$$y(t) = \sum_{n=-\infty}^{\infty} X_n p(t - nT - \phi)$$

where $p(t) = u(t) - u(t - T)$, $u(t)$ is the unit step function and ϕ is an independent random variable with uniform distribution in [0, T]. The sequence $\{X_n\}$ consists of independent and identically distributed binary valued random variables with $P\{X_n = +1\} = P\{X_n = -1\} = 0.5$ for each n.

The value of the autocorrection $R_{yy}\left(\frac{3T}{4}\right) \triangleq E\left[y(t)y\left(t - \frac{3T}{4}\right)\right]$ equals _____

55. Two sequences $x_1[n]]$ and $x_2[n]$have the same energy. Suppose $x_1[n] = \alpha\, 0.5^n\, u[n]$, where α is a positive real number and u[n] is the unit step sequence. Assume

$$x_2[n] = \begin{cases} \sqrt{1.5} & \text{for } n = 0, 1 \\ 0 & \text{otherwise} \end{cases}$$

Then the value of α is _____.