GATE – 2015 – Electronics & Communication Engineering (EC)

DATE: 01/02/2015 Time: 9:00 AM - 12:00 PM

01. Choose the most suitable one word substitute for the following expression:
Connotation of a road or way
(a) Pertinacious (b) Viaticum (c) Clandestine (d) Ravenous

Ans: (b)

02. 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) practised (d) should be practising

Ans: (b)

03. Find the missing sequence in the letter series below:
A, CD, GHI, ?, UVWXY
(a) LMN (b) MNO (c) MNOP (d) NOPQ

Ans: (c)

04. Choose the correct verb to fill in the below:
Let us _____.
(a) introvert (b) alternate (c) atheist (d) altruist

Ans: (b)

05. If $x > y > 1$, which of the following <u>must</u> 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)

Ans: (a)

06. Ms. X will be in 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.

Ans: (b)

07. log tan 1° + log tan 2° + …… + log tan 89° is….
(a) 1 (b) $1/\sqrt{2}$ (c) 0 (d) –1

Ans: (c)

08. 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 _____.

Ans: 2.064

09. Ram and Shyam shared a secret and promised to each other it would remain between them. Ram expressed 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.

Ans: (a)

10. 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 look 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

Ans: (b)

Technical Questions

01. 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

Ans: (c)

02. The directivity of an antenna array can be increased by adding more antenna, as a larger number of elements
(a) improves the radiation efficiency
(d) increase the effective area of the antenna
(c) results in a better impedance matching
(d) allows more power to be transmitted by the antenna

Ans: (b)

03. 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
(c) a modulo-6 binary up counter

Ans: (a)

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

Ans: 0.155

05. 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, 00H
        JNZ LOOP
        CMP C
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
```

Ans: (c)

06. In the circuit shown, the voltage V_x (in Volts) is ____.

Ans: 8

07. 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 0.5μF capacitor is _____.

Ans: 100

08. Which one of the following process is preferred to form the gate dielectric (SiO_2) of MOSFETs ?
(a) Sputtering (b) Molecular beam epitaxy
(c) Wet oxidation (d) Dry oxidation

Ans: (d)

09. 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

Ans: (b)

10. Consider the Bode plot shown in the figure. Assume that all the poles and zeros are real-valued. The value of $f_H - f_L$ (in Hz) is _____.

Ans: 8970

11. 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)

Ans: (d)

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

Ans: 159.14

13. The value of $\sum_{n=0}^{\infty} n\left(\frac{1}{2}\right)^n$ is _____.

Ans: 2

14. If C is a circle of radius r with centre 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) $\frac{nj}{2\pi}$ (d) $2\pi n$

Ans: (b)

15. 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 real 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

Ans: (a)

16. 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

Ans: (a)

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

Ans: 10

18. At very high frequencies, the peak output voltage V_o (in Volts) is_____.

Ans: 0.5

19. 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) cos4x (c) 1 (d) 0

Ans: (c)

20. 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 _____.

Ans: 2

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

Ans: (b)

22. A message signal $m(t) = A_m \sin(2®f_m t)$ is used to modulate the phase of a carrier $A_c \cos(2®f_c t)$ to get the modulated signal $y(t) = A_c \cos(2®f_c t + m(t))$. 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 depend on A_m or f_m

Ans: (c)

23. 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.

Ans: (d)

24. Consider a four-point moving average filter defined by the equation $y[n] = \sum_{i=0}^{3} \alpha_i x[n-i]$.

The condition on the filter coefficients that results in a null at 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) $\alpha_1 = \alpha_2 = 0;\ \alpha_0 = \alpha_3$

Ans: (a)

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

Ans: 84.32

26. Consider the 3 m long lossless air-filled transmission line shown in the figure. It has a characteristic impedance of $120\pi\Omega$, is terminated by 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

Ans: (d)

27. Consider the differential equation $\dfrac{d^2x(t)}{dt^2} + 3\dfrac{dx(t)}{dt} + 2x(t) = 0$.

Given $x(0) = 20$ and $x(1) = 10/e$, where $e = 2.718$, the value of $x(2)$ is _____.

Ans: 0.855

28. 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) $\begin{bmatrix} 10 & 2+j0 \\ 2+j0 & 10 \end{bmatrix}$

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

Ans: (b)

29. A network is described by the state model as $\dot{x}_1 = 2x_1 - x_2 + 3u$, $\dot{x}_2 = -4x_2 - u$, $y = 3x_1 - 2x_2$

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

Ans: (a)

30. 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 _____.

Ans: 0.4

31. A realization of a stable discrete time system is shown in the 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) $5\left(-\frac{2}{3}\right)^n u[n] - 3\left(-\frac{1}{3}\right)^n u[n]$

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

Ans: (c)

32. In the circuit shown, 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 _____.

Ans: 3

33. 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 _____.

Ans: 4.3

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

Ans: 6

35. 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

$a_k = \frac{1}{16}\sum_{n=0}^{15}\tilde{x}[n]\exp\left(-j\frac{\pi}{8}kn\right)$ for all k. The value of the coefficients a_{31} is_____.

Ans: 0.5

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

Ans: – 0.5

37. 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 _____.

Ans: 2

38. 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 autocorrelation $R_{yy}\left(\frac{3T}{4}\right) \triangleq E\left[y(t)y\left(t - \frac{3T}{4}\right)\right]$ equals _____.

Ans: 0.25

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

Gate 1 Gate 2 Gate 3

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.

Ans: (c)

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

Then the value of α is _____.

Ans: 1.5

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

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

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

Ans: (c)

42. A 200m 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 _____.

Ans: 30

43. 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 _____.

Ans: 78.53

44. In the circuit shown, assume that the opamp is ideal. If the gain (V_o/V_{in}) is –12, the value of R (in kΩ) is ____.

Ans: 1

45. 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.

Ans: (b)

46. 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}

Ans: (b)

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

Ans: 120.22

48. 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 _____.

Ans: 0.02

49. For the system shown in the figure, s = –2.75 lies on the root locus if K is _____.

Ans: 0.3

50. A three bit pseudo random number generator is shown. Initially the value of output $Y = Y_2Y_1Y_0$ is set to 111. The value of output Y after three clock cycles is

(a) 000 (b) 001 (c) 010 (d) 100

Ans: (d)

51 In the circuit shown, the current I flowing through the 50 Ω resistor will be zero if the value of capacitor C (in μs) is _____.

Ans: 20

52. 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 dies is thrown. The expected value of X is _____.

Ans: 6

53. 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 _____.

Ans: 5

54. 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_T) 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 _____.

Ans: 1436.60

55. 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) inverts to buffers
(c) NOR gates to NAND gates and inverters to buffers
(d) 5 V to ground

Ans: (d)