GATE – 2015 – Electronics & Communication Engineering (EC)

DATE: 31/01/2015 Time: 9:00 AM - 12:00 PM

General Aptitude:

01. Operators □, ◇, → are defined by : a □ b = $\frac{a-b}{a+b}$; a◇b = $\frac{a+b}{a-b}$; a→b = ab.

Find the value of (66 □ 6)→ (66 ◇ 6) .

(a) –2 (b) –1 (c) 1 (d) 2

Ans: (c)

02. Choose the most appropriate word from the options given below to complete the following sentence.
The principal presented the chief guest with a _____, as token of appreciation.
(a) momento (b) memento (c) momentum (d) moment

Ans: (b)

03. Choose the appropriate word/phrase, out of the four options given below, to complete the following sentence:
Frogs_____.

(a) Croak (b) Roar (c) Hiss (d) Patter

Ans: (a)

04. Choose the word most similar in meaning to the given word: (educe)
(a) Exert (b) Educate (c) Extract (d) Extend

Ans: (c)

05. If $\log_x (5/7) = -1/3$, then the value of x is

(a) 343/125 (b) 125/343 (c) –25/49 (d) –49/25

Ans: (a)

06. A cube of side 3 units is formed using a set of smaller cubes of side 1 unit; Find the proportion of the number of faces of the smaller cubes visible to those which are NOT visible.
(a) 1:4 (b) 1:3 (c) 1:2 (d) 2:3

Ans: (c)

07. The following question presents a sentence, part of which is underlined. Beneath the sentence you find four ways of phrasing the underlined part. Following the requirements of the standard written English, select the answer that produces the most effective sentence.
Tuberculosis, together with its effects, <u>ranks one of the leading causes of death</u> in India.

(a) ranks as one of the leading causes of death.
(b) rank as one of the leading causes of death.
(c) has the rank of the leading causes of death.
(d) are one of the leading causes of death.

Ans: (a)

08. Humpty Dumpty sits on a every day while having lunch. The wall sometimes breaks. A person sitting on the wall falls if the wall breaks.
Which one of the statements below is logically valid and can be inferred from the above sentences?
(a) Humpty Dumpty always falls while having lunch.
(b) Humpty Dumpty does not fall sometimes while having lunch.
(c) Humpty Dumpty never falls during dinner.
(d) When Humpty Dumpty does not sit on the wall, the wall does not break.

Ans: (b)

09. Find the missing Value:

6 5 4
7 4 7 2 1
1 9 2 8 1 2 1
4 1 5 2 3
3 ? 3

Ans: 3

10. Read the following paragraph and choose the correct statement.
Climate change has reduced human security and threatened human well being. An ignored reality of human progress is that human security largely depends upon environmental security. But on the contrary, human progress seems contradictory to environment security. To keep up both at the required level is a challenge to be addressed by one and all. One of the ways to curb the climate change may be suitable scientific innovations, while the other may be the Gandhian perspective on small scale progress with focus on sustainability.

(a) Human progress and security are positively associated with environmental security.
(b) Human progress is contradictory to environmental security.
(c) Human security is contradictory to environmental security.
(d) Human progress depends upon environmental security.

Ans: (d)

Technical Questions

01. Suppose A & B are two independent events with probabilities $P(A) \neq 0$ and $P(B) \neq 0$. Let $\overline{A}$ & $\overline{B}$ be their complements Which of the following statement is FALSE?

(a) $P(A \cap B) = P(A)P(B)$
(b) $P(A/B) = P(A)$
(c) $P(A \cup B) = P(A) + P(B)$
(d) $P(\overline{A} \cap \overline{B}) = P(\overline{A}).P(\overline{B})$

Ans: (c)

02. A region of negative differential resistance is observed in the current voltage characteristics of a silicon PN junction if

(a) both the P-region and the N-region are heavily doped
(b) the N-region is heavily doped compared to the P-region
(c) the P-region is heavily doped compared to the N-region
(d) an intrinsic silicon region is inserted between the P-region and the N-region

Ans: (a)

03. Consider a four bit D to A converter. The analog value corresponding to digital signals of values 0000 and 0001 are 0 V and 0.0625 V respectively. The analog value (in Volts) corresponding to the digital signal 1111 is _____.

Ans: 0.9375

04. In the circuit shown, the switch SW is thrown from position A to position B at time t= 0. The energy (in μJ) taken from the 3V source to charge the 0.1 μF capacitor from 0V to 3V is

(a) 0.3
(b) 0.45
(c) 0.9
(d) 3

Ans: (c)

05. The result of the convolution $x(-t) * \delta(-t - t_o)$ is

(a) $x(t+t_o)$
(b) $x(t-t_o)$
(c) $x(-t + t_o)$
(d) $x(-t-t_o)$

Ans: (d)

06. A function $f(x) = 1 - x^2 + x^3$ is defined in the closed interval [–1,1]. The value of x, in the open interval (–1,1) for which the mean value theorem is satisfied, is

(a) $-\frac{1}{2}$ (b) $-\frac{1}{3}$ (c) $\frac{1}{3}$ (d) $\frac{1}{2}$

Ans: (b)

07. The electric field component of a plane wave traveling in a lossless dielectric medium is given by $\vec{E}(z,t) = \hat{a}_y 2\cos\left(10^8 t - \frac{z}{\sqrt{2}}\right) V/m$. The wavelength (in m) for the wave is

Ans: 8.885

08. Negative feedback in a closed loop control system DOES NOT
(a) reduce the overall gain
(b) reduce bandwidth
(c) improve disturbance rejection
(d) reduce sensitivity to parameter variation

Ans: (b)

09. For the circuit with ideal diodes shown in the figure, the shape of the output (V_{out}) for the given sine wave input (V_{in}) will be

(a)

(b)

(c)

(d)

Ans: (c)

10. A silicon sample is uniformly doped with donor type impurities with a concentration of $10^{16}/cm^3$. The electron and hole mobilities in the sample are $1200 cm^2/V\text{-}s$ and $400 cm^2/V\text{-}s$ respectively. Assume complete ionization of impurities. The charge of an electron is 1.6×10^{-19} C. The resistivity of the sample (in Ω-cm) is _____.

Ans: 0.5208

11. The waveform of a periodic signal x(t) is shown in the figure.

A signal g(t) is defined by $g(t) = x\left(\frac{t-1}{2}\right)$. The average power of g(t) is _____.

Ans: 2

12. The polar plot of the transfer $G(s) = \frac{10(s+1)}{(s+10)}$ for $0 \le \omega < \infty$ will be in the

(a) first quadrant
(b) second quadrant
(c) third quadrant
(d) fourth quadrant

Ans: (a)

13. A unity negative feedback system has the open-loop transfer function $G(s) = \frac{K}{s(s+1)(S+3)}$. The value of the gain K(>0) at which the root locus crosses the imaginary axis is _____.

Ans: 12

14. In the given circuit, the values of V_1 and V_2 respectively are

(a) 5V,25V (b) 10V, 30V (c) 15 V, 35V (d) 0V, 20V

Ans: (a)

15. The value of p such that the vector $\begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$ is an eigenvector of the matrix $\begin{bmatrix} 4 & 1 & 2 \\ P & 2 & 1 \\ 14 & -4 & 10 \end{bmatrix}$ is ———.

Ans: 17

16. Consider a straight, infinitely long, current carrying conductor lying on the z – axis. Which one of the following plots (in linear scale) qualitatively represents the dependence of H_ϕ on r, where H_ϕ is the magnitude of the azimuthal component of magnetic field outside the conductor and r is the radial distance from the conductor?

a)

b)

c)

d)

Ans: (c)

17. In the network shown in the figure, all resistors are identical with R= 300 Ω. The resistance R_{ab} (in Ω) of the network is _____.

Ans: 100

18. In the circuit shown below, the Zener diode is ideal and the Zener voltage is 6V. The output voltage V_o (in volts) is _____.

Ans: 5

19. In an 8085 microprocessor, the shift registers which store the result of an addition and the overflow bit are, respectively.

(a) B & F (b) A & F (c) H & F (d) A & C

Ans: (b)

20. In the circuit, shown at resonance, the amplitude of the sinusoidal voltage (in Volts) across the capacitor is _____ . (1 M)

Ans: 25

21. A sinusoidal signal of 2 kHz frequency is applied to a delta modulator. The sampling rate and step-size Δ of the delta modulator are 20,000 samples per second and 0.1 V, respectively. To prevent slope overload, the maximum amplitude of the sinusoidal signal (in Volts) is

(a) $\frac{1}{2\pi}$ (b) $\frac{1}{\pi}$ (c) $\frac{2}{\pi}$ (d) π

Ans: (a)

22. Consider the signal $s(t) = m(t)\cos(2\pi f_c t) + \hat{m}(t)\sin(2\pi f_c t)$ where $\hat{m}(t)$ denotes the Hilbert transform of m(t) and band width of m(t) is very small compared to f_c. The signal s(t) is a.

(a) High pass signal
(b) Low pass signal
(c) Band pass signal
(d) Double side band suppressed carrier signal

Ans: (c)

23. Let Z = x + iy be a complex variable consider continuous integration is performed along the unit circle in anti clockwise direction. Which one of the following statements is NOT TRUE?

(a) The residue of $\frac{z}{z^2-1}$ at $z=1$ is $\frac{1}{2}$

(b) $\oint_C z^2 dz = 0$

(c) $\frac{1}{2\pi i}\oint_C \frac{1}{z} dz = 1$

(d) $\bar{z}$(complex conjugate of z) is an analytical function

Ans: (d)

24. A 16kb (=16,384 bit) memory array is designed as a square with an aspect ratio of one (number of rows = number of columns). The minimum number of address lines needed for the row decoder is _____.

Ans: 7

25. Consider the system of linear equations :

$x - 2y + 3z = -1$
$x - 3y + 4z = 1$ and
$-2x + 4y - 3z = k$,

The value of k for which the system has infinitely many solutions is _____.

Ans: 2

26. Two sequences [a,b,c] and [A,B,C] are related as,

$$\begin{bmatrix} A \\ B \\ C \end{bmatrix} = \begin{bmatrix} 1 & 1 & 1 \\ 1 & W_3^{-1} & W_3^{-2} \\ 1 & W_3^{-2} & W_3^{-4} \end{bmatrix} \begin{bmatrix} a \\ b \\ c \end{bmatrix} \quad \text{Where } W_3 = e^{j\frac{2\pi}{3}}.$$

If another sequence [p, q, r] is derived as,

$$\begin{bmatrix} p \\ q \\ r \end{bmatrix} = \begin{bmatrix} 1 & 1 & 1 \\ 1 & W_3^{1} & W_3^{2} \\ 1 & W_3^{2} & W_3^{4} \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & W_3^{2} & 0 \\ 0 & 0 & W_3^{4} \end{bmatrix} \begin{bmatrix} A/3 \\ B/3 \\ C/3 \end{bmatrix},$$

then the relationship between the sequences [p, q, r] and [a, b, c] is

(a) [p, q, r] = [b, a, c] (b) [p, q, r] = [b, c, a] (c)[p, q, r] = [c, a, b] (d) [p, q, r] = [c, b, a]

Ans: (c)

27. The maximum area (in sqare units) of a rectangle whose vertices lie on the ellipse $x^2 + 4y^2 = 1$ is _____.

Ans: 1

28. In the circuit shown, switch SW is closed at t = 0. Assuming zero initial conditions, the value of $v_c(t)$ (in Volts) at t = 1sec is _____.

Ans: 2.528

29. A 3 input majority gate is defined by the logic function M(a,b,c) = ab+bc+ca. Which one of the following gates is represented by the function $M\left(\overline{M(a,b,c)}, M\left(a,b,\overline{c}\right), c\right)$?

(a) 3-Input NAND gate
(b) 3-Input XOR gate
(c) 3-Input NOR gate
(d) 3-Input XNOR gate

Ans: (b)

30. A vector $\vec{P}$ is given by $\vec{P} = x^3 y\,\vec{a}_x - x^2y^2\,\vec{a}_y - x^2yz\,\vec{a}_z$. Which one of the following statements is TRUE?

(a) $\vec{P}$ is solenoidal, but not irrotational
(b) $\vec{P}$ is irrotational, but not solenoidal
(c) $\vec{P}$ is neither solenoidal nor irrotational
(d) $\vec{P}$ is both solenoidal and irrotational

Ans: (a)

31. A lead compensator network includes a parallel combination of R and C in the feed-forward path. If the transfer function of the compensator $G_C(S) = \dfrac{s+2}{s+4}$. The value of RC is ———.

Ans: 0.5

32. A MOSFET in saturation has a drain current of 1 mA for V_{DS} =0.5V. If the channel length modulation coefficient is 0.05 V^{-1}, the output resistance (in kΩ) of the MOSFET is _____

Ans: 20

33. The solution of the differential equation $\dfrac{d^2y}{dt^2} + \dfrac{2\,dy}{dt} + y = 0$ with $y(0) = y'(0) = 1$ is

(a) $(2-t)e^{t}$
(b) $(1+2t)e^{-t}$
(c) $(2+t)e^{-t}$
(d) $(1-2t)e^{t}$

Ans: (b)

34. The input X to the Binary Symmetric Channel (BSC) shown in the figure is '1' with probability 0.8. The cross-over probability is 1/7. If the received bit Y = 0, the conditional probability that '1' was transmitted is _____.

P[X = 0] = 0.2

P[X = 1] = 0.8

Ans: 0.4

35. For the discrete time system shown in the figure, the poles of the system transfer function are

located at

(a) 2, 3 (b) 1/2 , 3 (c) 1/2, 1/3 (d) 2, 1/3

Ans: (c)

36. The damping ratio of a series RLC circuit can be expressed as

(a) $\frac{R^2C}{2L}$ (b) $\frac{2L}{R^2C}$ (c) $\frac{R}{2}\sqrt{\frac{C}{L}}$ (d) $\frac{2}{R}\sqrt{\frac{L}{C}}$

Ans: (c)

37. For the NMOSFET in the circuit shown, the threshold voltage is V_{th}, where $V_{th}>0$. The source voltage V_{SS} is varied from 0 to V_{DD}. Neglecting the channel length modulation, the drain current I_D as a function of V_{SS} is represented by

Ans: (a)

38. In the circuit shown, assume that the opamp is ideal. The bridge output voltage V_0 (in mV) for δ = 0.05 is ____.

Ans: 250

39. The electric field intensity of a plane wave traveling in free space is given by the following expression $E(x,t) = a_y\, 24\pi \cos(\omega t - k_0 x)$ (V/m). In this field, consider a square area 10 cm × 10 cm on a plane x+y = 1. The total time-averaged power (in mW) passing through the square area is _____.

Ans: 53.33

40. In the given circuit, the maximum power (in Watts) that can be transferred to the load R_L is ____.

Ans: 1.656

41. In the system shown in Figure (a), m(t) is a low-pass signal with bandwidth W Hz. The frequency response of the band-pass filter H(f) is shown in Figure (b).If it is desired that the output signal z(t) = 10x(t), the maximum value of W (in Hz) should be strictly less than _____

Ans: 350

42. The longitudinal component of the magnetic field inside an air-filled rectangular waveguide made of a perfect electric conductor is given by the following expression
$H_Z(x,y,z,t) = 0.1 \cos(25\pi x) \cos(30.3\,\pi y) \cos(12\pi \times 10^9 t - \beta z)$ (A/m)

The cross-sectional dimensions of the waveguide are given as a = 0.08 m and b = 0.033 m. The mode of propagation inside the waveguide is

(a) TM_{12} (b) TM_{21} (c) TE_{21} (d) TE_{12}

Ans: (c)

43. The Boolean expression $F(X,Y,Z) = \overline{X}Y\overline{Z} + X\overline{Y}\,\overline{Z} + XY\overline{Z} + XYZ$. converted into the canonical product of sum (POS) form is

(a) F = $(X+Y+Z)(X+Y+\overline{Z})(X+\overline{Y}+\overline{Z})(\overline{X}+Y+\overline{Z})$

(b) F = $(X+\overline{Y}+Z)(\overline{X}+Y+\overline{Z})(\overline{X}+\overline{Y}+Z)(\overline{X}+\overline{Y}+\overline{Z})$

(c) F = $(X+Y+Z)(\overline{X}+Y+\overline{Z})(X+\overline{Y}+Z)(\overline{X}+\overline{Y}+\overline{Z})$

(d) F = $(X+\overline{Y}+\overline{Z})(\overline{X}+Y+Z)(\overline{X}+\overline{Y}+Z)(X+Y+Z)$

Ans: (a)

44. For a silicon diode with long P and N regions, the accepter and donor impurity concentrations are 1×10^{17} cm^{-3} and 1×10^{15} cm^{-3}, respectively. The lifetimes of electrons in P region and holes in N region are both 100 μs. The electron and hole diffusion coefficients are 49 cm^2/s and 36 cm^2/s, respectively. Assume kT/q = 26mV, the intrinsic carrier concentration is 1×10^{10} $cm^{-3}$and q = 1.6 $\times 10^{-19}$ C. When a forward voltage of 208 mV is applied across the diode, the hole current density (in nA/cm^2) injected from P region to N region is _____.

Ans: 514.54

45. Which one of the following graphs describes the function $f(x) = e^{-x(x^2+x+1)}$?

(a)

(b)

(c)

(d)

Ans: (b)

46. The pole –zero diagram of a causal and stable discrete-time system is shown in the figure. The zero at the origin has multiplicity 4. The impulse response of the system is h[n]. If h[0] = 1, we can conclude.

(a) h(n) is real for all n

(b) h(n) is purely imaginary for all n

(c) h(n) is real for only even n

(d) h(n) is purely imaginary for odd n

Ans: (c)

47 The transmitted signal in a GSM system is of 200 kHz bandwidth and 8 users share a common bandwidth using TDMA. If at a given time 12 users are talking in a cell, the total bandwidth of the signal received by the base station of the cell will be at least (in kHz) _____.

Ans: 300

48. All the logic gates shown in the figure have a propagation delay of 20 ns. Let A = C = 0 and B =1 until time t = 0. At t = 0, all the inputs flip (i.e, A = C = 1 and B = 0) and remain in that state. For t > 0, output Z =1 for a duration (in ns) of

Ans: 40

49. The built in potential of an abrupt p-n junction is 0.75 V. If its junction capacitance (C_J) at a reverse bias (V_R) of 1.25 V is 5 pF, the value of C_J (in pF) when V_R = 7.25V is_____.

Ans: 2.5

50. In the circuit shown, I_1 = 80 mA and I_2 = 4mA. Transistors T_1 and T_2 are identical. Assume that the thermal voltage V_T is 26 mV at 27°C. At 50°C, the value of the voltage $V_{12} = V_1 - V_2$ (in mV) is _____.`

Ans: 83.85

51. Consider a uniform plane wave with amplitude (E_0) of 10 V/m and 1.1 GHz frequency travelling in air, and incident normally on a dielectric medium with complex relative permittivity (ε_r) and permeability (μ_r) as shown in the figure.

The magnitude of the transmitted electric field component (in V/m) after it has travelled a distance of 10 cm inside dielectric region is _____.

Ans: 0.1

52. A plant transfer function is given as G(s) = $\left(K_p + \frac{K_I}{s}\right)\left(\frac{1}{s(s+2)}\right)$, When the plant operates in a unity feedback configuration, the condition for the stability of the closed loop system is

(a) $K_p > \frac{K_I}{2} > 0$ (b) $2K_I > K_p > 0$ (c) $2K_I < K_p$ (d) $2K_I > K_p$

Ans: (a)

53. The open loop transfer function of a plant in a unity feedback configuration is given as G(s) = $\frac{K(s+4)}{(s+8)(s^2-9)}$. The value of the gain K (>0) for which the point –1 + j2 lies on the root locus is _____.

Ans: 25.54

54. The circuit shown in the figure has an ideal opamp. The oscillation frequency and the condition to sustain the oscillations, respectively, are

(a) $\frac{1}{CR}$ and $R_1 = R_2$ (b) $\frac{1}{CR}$ and $R_1 = 4R_2$

(c) $\frac{1}{2CR}$ and $R_1 = R_2$, (d) $\frac{1}{2CR}$ and $R_1 = 4R_2$

Ans: (d)

55. A source emits bit 0 with probability $\frac{1}{3}$ and bit 1 with probability $\frac{2}{3}$. The emitted bits are communicated to the receiver. The receiver decides for either 0 or 1 based on the received value R. It is given that the conditional density functions of R are as

$$f_{R|0}(r) = \begin{cases} \frac{1}{4}, & -3 \le x \le 1, \\ 0 & \text{otherwise,} \end{cases} \text{ and } f_{R||}(r) = \begin{cases} \frac{1}{6}, & -1 \le x \le 5, \\ 0 & \text{otherwise.} \end{cases}$$

The minimum decision error probability is

(a) 0 (b) 1/12 (c)1/9 (d) 1/6

Ans: (b)