GATE – 2015 – Electronics & Communication Engineering (EC)

DATE: 31/01/2015 Time: 2:00 PM - 5:00 PM

01. Choose the word most similar in meaning to the given word?
Awkward
(A) Inept (B) Graceful
(C) Suitable (D) Dreadful

Ans: (A)

02. Choose the appropriate word/phrase, out of the four options given below, to complete the following sentence:
Dhoni, as well as the other team members of Indian team, _____present on the occasion
(A) were (B) was (C) has (D) have

Ans: (B)

03. Ram and Ramesh appeared in an interview for two vacancies in the same department.The probability of Ram's selection is 1/6 and that of Ramesh is 1/8. What is the probability that only one of them will be selected?
(A) 47 / 48 (B) 1 / 4
(C) 13 / 48 (D) 35 / 48

Ans: (B)

04. What is the adverb for the given word below?
MISOGYNOUS
(A) Misogynousness
(B) Mysogynity
(C) Misogynously
(D) Misogynous

Ans: (C)

05. An electric bus has onboard instruments that report the total electricity consumed since the start of the trip as well as the total distance convered. During a single day of operation the bus travels on stretches M,N, O and P, in that order. The cumulative distances travelled and the corresponding electricity consumption are shown in the Table below:

Stretch	Cumulative distance (km)	Electricity used (kWh)
M	20	12
N	45	25
O	75	45
P	100	57

The stretch where the electricity consumption per km is minimum is
(A) M (B) N (C) O (D) P

Ans: (C)

06. Lamenting the gradual sidelining of the arts in school curricula, a group of prominent artists wrote to the Chief Minister last year, asking him to allocate more funds to support arts education in schools. However, no such increase has been announced in this year's Budget. The artists expressed their deep anguish at their request not being approved, but many of them remain optimistic about funding in the future.

Which of the statement(s) below is/are logically valid and can be inferred from the above statements?
(i) The artists expected funding for the arts to increase this year
(ii) The Chief Minister was receptive to the idea of increasing funding for the arts
(iii) The Chief Minister is a prominent artist

(iv) Schools are giving less importance to arts education nowadays.

(A) (iii) and (iv) (B) (i) and (iv)
(C) (i), (ii) and (iv) (D) (i) and (iii)

Ans: (B)

07. If $a^2+b^2+c^2=1$, then ab+bc+ac lies in the interval

(A) $[1, 2/3]$ (B) $[-1/2, 1]$
(C) $[-1, 1/2]$ (D) $[2, -4]$

Ans: (B)

08. In the following sentence certain parts are underlined and marked P, Q, and R. One of the parts may contain certain error or may not be acceptable in standard written communication. Select the part containing an error. Choose D as your answer if there is no error.

The student corrected **<u>all the errors</u>** (P) that **<u>the instructor marked</u>** (Q) on the **<u>answer book.</u>** (R)

(A) P (B) Q (C) R (D) No Error

Ans: (B)

09. Given below are two statements followed by two conclusions. Assuming these statements to be true, decide which one logically follows.

Statements:
I. All film stars are playback singers.
II. All film directors are film stars.

Conclusions:
I. All film directors are playback singers.
II. Some film stars are film directors.

(A) Only conclusion I follows.
(B) Only conclusion II follows.
(C) Neither conclusion I or II follows.
(D) Both conclusion I and II follow.

Ans: (D)

10. A tiger is 50 leaps of its own behind a deer. The tiger takes 5 leaps per minute to the deer's 4. If the tiger and the deer cover 8 metre and 5 metre per leap respectively, what distance in metres will the tiger have to run before it catches the deer?

Ans: 800

TECHNICAL QUESTIONS

01. In the circuit shown, the average value of the voltage V_{ab} (in Volts) in steady state condition is _____

Ans: 5

02. In the circuit shown, $V_O=V_{OA}$ for switch SW in position A and $V_0=V_{OB}$ for SW in position B. Assume that the opamp is ideal. The value of $\frac{V_{OB}}{V_{OA}}$ is _____

Ans: 1.5

03. Let $f(z) = \frac{az+b}{cz+d}$. If $f(z_1) = f(z_2)$ for all $z_1 \neq z_2$, a = 2, b = 4 and c = 5, then d should be equal to _____

Ans: 10

04. The value of x for which all the eigen-values of the matrix given below are real is

$$\begin{bmatrix} 10 & 5+j & 4 \\ x & 20 & 2 \\ 4 & 2 & -10 \end{bmatrix}$$

(A) 5 +j (B) 5 –j
(C) 1 –5j (D) 1+5j

Ans: (A)

05. If the circuit shown has to function as a clamping circuit, then which one of the following conditions should be satisfied for the sinusoidal signal of period T ?

(A) RC << T

(B) RC = 0.35 T

(C) RC ≈ T

(D) RC >> T

Ans: (D)

06. For the signal flow graph shown in the figure, the value of $\frac{C(s)}{R(s)}$ is

(A) $\frac{G_1G_2G_3G_4}{1-G_1G_2H_1-G_3G_4H_2-G_2G_3H_3+G_1G_2G_3G_4H_1H_2}$

(B) $\frac{G_1G_2G_3G_4}{1+G_1G_2H_1+G_3G_4H_2+G_2G_3H_3+G_1G_2G_3G_4H_1H_2}$

(C) $\frac{1}{1+G_1G_2H_1+G_3G_4H_2+G_2G_3H_3+G_1G_2G_3G_4H_1H_2}$

(D) $\frac{1}{1-G_1G_2H_1-G_3G_4H_2-G_2G_3H_3+G_1G_2G_3G_4H_1H_2}$

Ans: (B)

07. In the figure shown, the output Y is required to be Y = AB + $\overline{C}\,\overline{D}$. The gates G1 and G2 must be, respectively,

(A) NOR, OR
(B) OR, NAND
(C) NAND, OR
(D) AND, NAND

Ans: (A)

08. The general solution of the differential equation $\frac{dy}{dx} = \frac{1+\cos 2y}{1-\cos 2x}$ is

(A) tan y–cot x = c (c is a constant)
(B) tan x–cot y = c (c is a constant)
(C) tan y+cot x = c (c is a constant)
(D) tan x+cot y = c (c is a constant)

Ans: (C)

09. The bilateral Laplace transform of a function f(t) = $\begin{cases} 1 \; if \; a \le t \le b \\ 0 \; otherwise \end{cases}$ is

(A) $\frac{a-b}{s}$
(B) $\frac{e^{s}(a-b)}{s}$
(C) $\frac{e^{-as}-e^{-bs}}{s}$
(D) $\frac{e^{s(a-b)}}{s}$

Ans: (C)

10. By performing cascading and/or summing/differencing operations using transfer function blocks $G_1(s)$ and $G_2(s)$, one CANNOT realize a transfer function of the form

(A) $G_1(s)G_2(s)$
(B) $\frac{G_1(s)}{G_2(s)}$
(C) $G_1(s)\left(\frac{1}{G_1(s)}+G_2(s)\right)$
(D) $G_1(s)\left(\frac{1}{G_1(s)}-G_2(s)\right)$

Ans: (B)

11. An n-type silicon sample is uniformly illuminated with light which generates 10^{20} electron hole pairs per cm^3 per second. The minority carrier lifetime in the sample is 1 μs. In the steady state, the hole concentration in the sample is approximately 10^x, where x is integer. The value of x is _____

Ans: 14

12. The signal $\cos\left(10\pi t+\frac{\pi}{4}\right)$ is ideally sampled at a sampling frequency of 15 Hz. The sampled signal is passed through a filter with impulse response $\left(\frac{\sin(\pi t)}{\pi t}\right)\cos\left(40\pi t-\frac{\pi}{2}\right)$. The filter output is

(A) $\frac{15}{2}\cos\left(40\pi t-\frac{\pi}{4}\right)$
(B) $\frac{15}{2}\left(\frac{\sin(\pi t)}{\pi t}\right)\cos\left(10\pi t+\frac{\pi}{4}\right)$
(C) $\frac{15}{2}\cos\left(10\pi t-\frac{\pi}{4}\right)$
(D) $\frac{15}{2}\left(\frac{\sin(\pi t)}{\pi t}\right)\cos\left(40\pi t-\frac{\pi}{2}\right)$

Ans: (A)

13. A unity negative feedback system has an open-loop transfer function G(s) = $\frac{K}{s(s+10)}$. The gain K for the system to have a damping ratio of 0.25 is _____

Ans: 400

14. The magnitude and phase of the complex Fourier series coefficients a_k of a periodic signal x(t) are shown in the figure. Choose the correct statement from the four choices given. Notation C is the set of complex numbers, R is the set of purely real numbers, and P is the set of purely imaginary numbers.

(A) x(t) ∈ R (B) x(t) ∈ P
(C) x(t) ∈ (C – R)
(D) the information given is not sufficient to draw any conclusion about x(t)

Ans: (A)

15. In the bistable circuit shown, the ideal opamp has saturation levels of ±5V. The value of R_1(in kΩ) that gives a hysteresis width of 500 mV is _____

Ans: 1

16. A mod-n counter using a synchronous binary up-counter with synchronous clear input is shown in the figure. The value of n is _____

Ans: 6

17. A sinusoidal signal of amplitude A is quantized by a uniform quantizer. Assume that the signal utilizes all the representation levels of the quantizer. If the signal to quantization noise ratio is 31.8 dB, the number of levels in the quantizer is _____

Ans: 32

18. In an 8085 microprocessor, which one of the following instructions changes the content of the accumulator?
(A) MOV B, M (B) PCHL
(C) RNZ (D) SBI BEH

Ans: (D)

19. Let the signal f(t) = 0 outside the interval [T_1, T_2], where T_1 and T_2 are finite. Furthermore, $|f(t)| < \infty$. The region of convergence (RoC) of the signal's bilateral Laplace transform F(s) is
(A) a parallel strip containing the jΩ axis
(B) a parallel strip not containing the jΩ axis
(C) the entire s-plane
(D) a half plane containing the jΩ axis

Ans: (C)

20. Two casual discrete-time signals x[n] and y[n] are related as y[n] = $\sum_{m=0}^{n} x[m]$. If the z-transform of y[n] = $\frac{2}{z(z-1)^2}$, the value of x[2] is _____

Ans: 0

21. In a source free region in vacuum, if the electrostatic potential $\varphi = 2x^2+y^2+cz^2$, the value of constant c must be _____

Ans: –3

22. The electric field of a uniform plane electromagnetic wave is
$\vec{E} = (\vec{a}_x + j4\vec{a}_y)\exp[j(2\pi\times10^7 t - 0.2z)]$
The polarization of the wave is

(A) right handle circular
(B) right handed elliptical
(C) left handed circular
(D) left handed elliptical

Ans: (D)

23. The voltage (V_C) across the capacitor (in Volts) in the network shown is _____

Ans: 100

24. The 2-port adminittance matrix of the circuit shown is given by

(A) $\begin{bmatrix} 0.3 & 0.2 \\ 0.2 & 0.3 \end{bmatrix}$ (B) $\begin{bmatrix} 15 & 5 \\ 5 & 15 \end{bmatrix}$

(C) $\begin{bmatrix} 3.33 & 5 \\ 5 & 3.33 \end{bmatrix}$ (D) $\begin{bmatrix} 0.3 & 0.4 \\ 0.4 & 0.3 \end{bmatrix}$

Ans: No Answer is correct from the given options. Correct answer Y = $\begin{bmatrix} 0.3 & -0.2 \\ -0.2 & 0.3 \end{bmatrix}$

25. A piece of silicon is droped uniformly with phosphorous with a doping concentration of $10^{16}/cm^3$. The expected value of mobility versus doping concentration for silicon assuming full dopant ionization is shown below. The charge of an electron is 1.6×10^{-19} C. The conductivity (in S cm^{-1}) of the silicon sample at 300 K is _____

Hole and Electron Mobility in Silicon at 300 K

Ans: 1.92

26. If C denotes the counterclockwise unit circle, the value of the contour integral $\frac{1}{2\pi j}\oint_c \boldsymbol{Re}(z)dz$ is _____

Ans: 0.5

27. An LC tank circuit consists of an ideal capacitor C connected in parallel with a coil of inductance L having an internal resistance R. The resonant frequency of the tank circuit is

(A) $\frac{1}{2\pi\sqrt{LC}}$

(B) $\frac{1}{2\pi\sqrt{LC}}\sqrt{1-R^2\frac{C}{L}}$

(C) $\frac{1}{2\pi\sqrt{LC}}\sqrt{1-\frac{L}{R^2C}}$

(D) $\frac{1}{2\pi\sqrt{LC}}\left(1-R^2\frac{C}{L}\right)$

Ans: (B)

28. A function of Boolean variables X, Y and Z is expressed in terms of the min-terms as F(X,Y,Z) = Σ(1, 2, 5, 6, 7)
Which one of the product of sums given below is equal to the function F(X, Y, Z)?

(A) $(\overline{X}+\overline{Y}+\overline{Z})\cdot(\overline{X}+Y+Z)\cdot(X+\overline{Y}+\overline{Z})$

(B) $(X+Y+Z)\cdot(X+\overline{Y}+\overline{Z})\cdot(\overline{X}+Y+Z)$

(C) $(\overline{X}+\overline{Y}+Z)\cdot(\overline{X}+Y+\overline{Z})\cdot(X+\overline{Y}+Z)$
$(X+Y+\overline{Z})\cdot(X+Y+Z)$

(D) $(X+Y+\overline{Z})\cdot(\overline{X}+Y+Z)\cdot(\overline{X}+Y+\overline{Z})$
$\cdot(\overline{X}+\overline{Y}+Z)\cdot(\overline{X}+\overline{Y}+\overline{Z})$

Ans: (B)

29. For the voltage regulator circuit shown, the input voltage (V_{in}) is 20V±20% and the regulated output voltage (V_{out}) is 10 V. Assume the opamp to be ideal. For a load R_L drawing 200 mA, the maximum power dissipation in Q_1 (in Watts) is _____

Ans: 2.8056

30. In a MOS capacitor with an oxide layer thickness of 10 nm, the maximum depletion layer thickness is 100 nm. The permittivities of the semiconductor and the oxide layer are ε_s and ε_{os} respectively. Assuming $\varepsilon_s/\varepsilon_{ox} = 3$, the ratio of the maximum capacitance to the minimum capacitance of this MOS capacitor is _____

Ans: 4.33

31. Let the random variable X represent the number of times a fair coin needs to be tossed till two consecutive heads appear for the first time. The expectation of X is _____

Ans: 1.5

32. Consider the different equation $\frac{dx}{dt} = 10 - 0.2x$ with initial condition x(0) = 1. The response x(t) for t>0 is

(A) $2 - e^{-0.2t}$ (B) $2 - e^{0.2t}$

(C) $50 - 49e^{-0.2t}$ (D) $50 - 49e^{0.2t}$

Ans: (C)

33. In the circuit shown, the Norton equivalent resistance (in Ω) across terminals a–b is _____.

Ans: 1.33

34. An air-filled rectangular waveguide of internal dimension a cm × b cm (a > b) has a cutoff frequency of 6 GHz for the dominant TE_{10} mode. For the same waveguide, if the cutoff frequency of the TM_{11} mode is 15 GHz, the cutoff frequency of the TE_{01} mode in GHz is _____

Ans: 13.75

35. A zero mean white Gaussian noise having power spectral density $\frac{N_0}{2}$ is passed through an LTI filter whose impulse response h(t) is shown in the figure. The variance of the filtered noise at t = 4 is

(A) $\frac{3}{2}A^2N_0$ (B) $\frac{3}{4}A^2N_0$

(C) A^2N_0 (D) $\frac{1}{2}A^2N_0$

Ans: (A)

36. A 1-to-8 demultiplexer with data input D_{in}, address inputs S_0, S_1, S_2 (with S_0 as the LSB) and $\overline{Y}_0$ *to* $\overline{Y}_7$ as the eight demultiplexed outputs, is to be designed using two 2-to-4 decoders (with enable input $\overline{E}$ and address inputs A_0 and A_1) as shown in the figure. D_{in}, S_0, S_1 and S_2 are to be connected to P,Q,R and S , but not necessarily in this order. The respective input connections to P ,Q,R and S terminals should be

(A) S_2, D_{in}, S_0, S_1 (B) S_1, D_{in}, S_0, S_2
(C) D_{in}, S_0, S_1, S_2 (D) D_{in}, S_2, S_0, S_1

Ans: (D)

37. The transfer function of a mass-spring damper system is given by $G(s) = \dfrac{1}{Ms^2 + Bs + k}$

The frequency response data for the system are given in the following table.

ω in rad/s	$\lvert G(j\mu)\rvert indB$	Arg(G(jω) in deg
0.01	–18.5	–0.2
0.1	–18.5	–1.3
0.2	–18.4	–2.6
1	–16	–16.9
2	–11.4	–89.4
3	–21.5	–151
5	–32.8	–167
10	–45.3	–174.5

The unit step response of the system approaches a steady state value of____.

Ans: 0.12

38. $\{X_n\}_{n=-\infty}^{n=\infty}$ is an independent and distributed (i.i.d) random process with X_n equally likely to be +1 or –1. $\{Y_n\}_{n=-\infty}^{n=\infty}$ is another random process obtained as $Y_n = X_n + 0.5X_{n-1}$. The autocorrelation function of $\{Y_n\}_{n=-\infty}^{n=\infty}$, denoted by $R_Y[K]$, is

(A)

(B)

(C)

(D)

Ans: (B)

39. Let x(t) = a s(t) +s(–t) with s(t) = βe^{-4t} u(t) , where u(t) is unit step function . If the bilateral Laplace transform of x(t) is

$$X(S) = \frac{16}{S^2 - 16} - 4 < \mathrm{Re}\{s\} < 4;$$

Then the value of β is_____.

Ans: –2

40. The energy band diagram and the electron density profile n(x) in a semiconductor are shown in figures. Assume that n(x) $=10^{15}e^{\left(\frac{qax}{KT}\right)}cm^{-3}$, with α = 0.1 V/cm and x expressed in cm. Given $\frac{kT}{q}=0.026V$, D_n = 36cm^{2}s^{-1} , and $\frac{D}{«}=\frac{KT}{q}$. The electron current density (in A/cm^2) at x = 0 is

(A) -4.4×10^{-2}
(B) -2.2×10^{-2}
(C) 0
(D) 2.2×10^{-2}

Ans: (D)

41. In the circuit shown, the initial voltages across the capacitors C_1 and C_2 are 1V and 3V, respectively. The switch is closed at time t =0. The total energy dissipated (in Joules) in the resistor R until steady state is reached, is _____

Ans: 1.5

42. The electric field of a plane wave propagating in a lossless non-magnetic medium is given by the following expression

$$E(z,t)=a_x 5\cos(2\pi\times10^9 t+\beta z)$$
$$+a_y 3\cos\left(2\pi\times10^9 t+\beta z-\frac{\pi}{2}\right)$$

The type of the polarization is
(A) Right hand circular
(B) Left hand elliptical
(C) Right hand elliptical
(D) Linear

Ans: (B)

43. The figure shows a binary counter with synchronous clear input. With the decoding logic show, the counter works as a

(A) mod - 2 counter
(B) mod - 4 counter
(C) mod - 5 counter
(D) mod - 6 counter

Ans: (B)

44. A dc voltage of 10V is applied across an n-type silicon bar having a rectangular cross-section and a length of 1cm as shown in figure. The donor doping concentration N_D and the mobility of electrons μ_n are 10^{16} cm^{-3} and 1000 cm^2 V^{-1}s^{-1} , respectively . The average time (in μs) taken by the electrons to move from one end of the bar to other end is_____.

Ans: 100

45. Let X ∈ {0,1} and Y ∈ {0,1} be two independent binary random variables.
If P(X =0) =p and P(Y = 0) =q , then P(X+Y≥1) is equal to

(A) pq + (1–p)(1–q) (B) pq

(C) p(1–q) (D) 1–pq

Ans: (D)

46. Two half –wave dipole antennas placed as shown in the figure are excited with sinusoidally varying currents of frequency 3Mhz and phase shift of π/2 between them (the element at the origin leads in phase) . If the maximum radiated E –field at the point P in the x-y plane occurs at an azimuthal angle of 60°, the distance d (in meters) between the antennas is_____

Ans: 50

47. Consider two real sequences with time – origin marked by the bold value,
$x_1[n] = \{1,2,3,0\}$, $x_2[n] = \{1,3,2,1\}$
Let $X_1(k)$ and $X_2(k)$ be 4-point DFTs of $x_1[n]$ and $x_2[n]$, respectively . Another sequence $x_3[n]$ is derived by taking 4-point inverse DFT of $x_3(k) = X_1(k)X_2(k)$. The value of $x_3[2]$ is_____.

Ans: 11

48. Consider a binary, digital communication system which uses pulses g(t) and – g(t) for transmitting bits over AWGN channel. If the receiver uses a matched filter, which one of the following pulses will give the minimum probability of bit error?

Ans: (A)

49. Assuming that the opamp in the circuit shown below is ideal, the output voltage V_0 (in volts)

Ans: 12

50. The diode in the circuit given below has V_{ON} = 0.7 V but is ideal otherwise. The current (in mA) in the 4 kΩ resistor is

Ans: 0.6

51. The output of a standard second-order system for a unit step input is given as $y(t) = 1 - \frac{2}{\sqrt{3}} e^{-t} \cos\left(\sqrt{3}\, t - \frac{\pi}{6}\right)$. The transfer function of the system is

(A) $\frac{2}{(s+2)(s+\sqrt{3})}$ (B) $\frac{1}{s^2+2s+1}$

(C) $\frac{3}{s^2+2s+3}$ (D) $\frac{4}{s^2+2s+4}$

Ans: (D)

52. Input x(t) and output y(t) of an LTI system are related by the differential equation $y''(t) - y'(t) - 6y(t) = x(t)$. If the system is neither causal nor stable, the impulse response h(t) of the system is

(A) $\frac{1}{5} e^{3t} u(-t) + \frac{1}{5} e^{-2t} u(-t)$

(B) $\frac{-1}{5} e^{3t} u(-t) + \frac{1}{5} e^{-2t} u(-t)$

(C) $\frac{1}{5} e^{3t} u(-t) + \frac{1}{5} e^{-2t} u(t)$

(D) $-\frac{1}{5} e^{3t} u(-t) - \frac{1}{5} e^{-2t} u(t)$

Ans: (B)

53. In the ac equivalent circuit shown, the two BJTs are biased in active region and have identical parameters with β > > 1. The open circuit small signal voltage gain is approximately _____.

Ans: –1

54. The state variable representation of a system is given as

$$\dot{x} = \begin{bmatrix} 0 & 1 \\ 0 & -1 \end{bmatrix} x; \quad x(0) = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

$$y = [0 \quad 1]x$$

The response y(t) is

(A) sin(t) (B) $1 - e^{t}$

(C) 1 – cos(t) (D) 0

Ans: (D)

55. The value of the integral $\int_{-\infty}^{\infty} 12 \cos(2\pi t) \frac{\sin(4\pi t)}{4\pi t} dt$ is _____.

Ans: 3