

EC: Electronics & Communication Engineering

Duration: Three Hours

Maximum Marks: 100

Read the Instructions carefully.

- 1. This question paper contains 16 pages.**
- 2. All Questions in this Paper are Objective type.**
- 3. There are a total of 65 questions carrying 100 marks.**
- 4. Questions 1 – 25 will carry 1-mark each, questions 26 – 55 carry 2-marks each.**
- 5. Questions 50 – 51 are common data questions and question pairs (52 – 53) and (54 – 55) are linked answer questions. The answer to the second questions of the linked answer question depends on the answer to the first question of the pair. If the first question is wrongly answered or is un-attempted, then the answer to the second question will not be evaluated.**
- 6. Questions 56 – 65 belong to general aptitude (GA). Questions 56 – 60 will carry 1-mark each, and questions 61 – 65 will carry 2-marks each. The GA questions will begin on a fresh page starting from page 15.**
- 7. Un-attempted questions will carry zero marks.**
- 8. Wrong answers will carry NEGATIVE marks. For Questions 1 – 25 and Questions 56 – 60, 1/3 mark will be deducted for each wrong answer. For Questions 26 – 51 and Questions 61 – 65, 2/3 mark will be deducted for each wrong answer.**
- 9. The questions pairs (52 – 53), and (54 – 55) are questions with linked answers. There will be negative marks only for wrong answers to the first question of the linked answer question pair i.e. for Question 52 and 54, 2/3 will be deducted for wrong answer. There is no negative marking for Question 53 and 55.**

Questions 1- 25 carry 1 Mark each.

1. $A^2 = I$, where I is identity, matrix A is

(A) Singular	(B) Idempotent	(C) Orthogonal	(D) Involuntary
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2. Find the value of $\Gamma\left(\frac{1}{2}\right)$

(A) $\frac{\sqrt{\pi}}{2}$	(C) 1.772
(B) $\frac{1}{2}!$	(D) Indeterminate (Can't be found)
3. If $u = x^2y^2 + y^4 + x^4$ then find $x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y}$

(A) $2xy^2 + 2x^2y + 4y^3 + 4x^3$	(C) $4(x^2y^2 + y^4 + x^4)$
(B) $x^2y^2 + y^4 + x^4$	(D) $12(x^2y^2 + y^4 + x^4)$
4. In an IC, the p substrate is connected to

(A) most positive voltage on IC	(C) any value of voltage on IC
(B) most negative voltage on IC	(D) None of the above
5. Band gap of a semiconductor

(A) Increase with temperature	(C) Remains Constant
(B) Decrease with temperature	(D) None of these
6. If input to a delta modulator is $m(t) = 50t[u(t) - u(t - 1)] + (100 - 50t)[u(t - 1) - u(t - 2)]$ and sampling rate is 15,000 samples/sec. Determine the optimum value of step-size,

(A) 33.3 mV	(B) 0.33 mV	(C) 3.33 mV	(D) 3.33 V
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7. A speech signal has a total duration of 10sec. It is sampled at the rate of 8kHz and then encoded. The minimum signal to quantization noise ratio (SNR) required is 40dB. The minimum storage capacity needed to accommodate this digitized speech signal is:

(A) 256 kbits	(B) 118 kbits	(C) 560 kbits	(D) 720 kbits
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8. The instantaneous frequency of the signal $\cos 100\pi t \sin(5 \sin 2\pi t) + \sin 100\pi t \cos(5 \sin 2\pi t)$ at $t = 1$ is:

(A) 55 Hz	(B) 95 Hz	(C) 45 Hz	(D) 105 Hz
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9. For converting SR flip flop into JK flip flop the correct combination is

(A) $S = J\bar{Q}, R = \bar{K}Q$	(C) $S = JQ, R = KQ$
(B) $S = J\bar{Q}, R = KQ$	(D) $S = JQ, R = \bar{K}Q$

10. Four memory chips of size 32×4 are connected together in parallel fashion. The total capacity of combination is

- (A) 128×4 (B) 32×16 (C) 64×8 (D) 256×2

11. Match the following

I. Instructions

- i. AND Logic
- ii. XOR Logic
- iii. DAD
- iv. INR
- v. DCX

II. Status Indicating pins

- A. No flag is affected
- B. AC = set, CY = Reset
- C. AC = CY = Reset
- D. All flags are affected except CY
- E. Only CY is affected
- F. All flags are affected

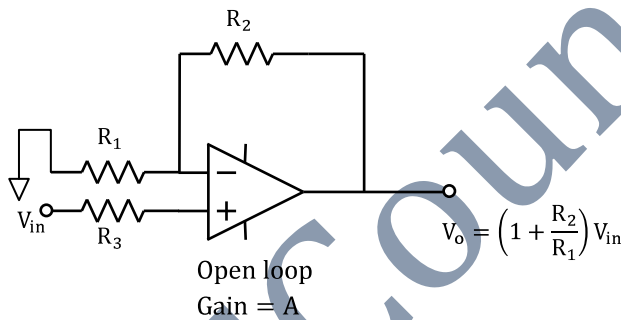
(A) i - C, ii - B, iii - A, iv - E, v - D

(C) i - B, ii - C, iii - E, iv - D, v - A

(B) i - B, ii - C, iii - D, iv - E, v - A

(D) i - C, ii - B, iii - F, iv - E, v - D

12.



In the diagram shown for $V_o = (1 + R_2/R_1)V_{in}$ to hold, the required condition is

- (A) $A \ll 1 + \frac{R_1}{R_2}$ (B) $A \ll 1 + \frac{R_2}{R_1}$ (C) $A \gg 1 + \frac{R_1}{R_2}$ (D) $A \gg 1 + \frac{R_2}{R_1}$

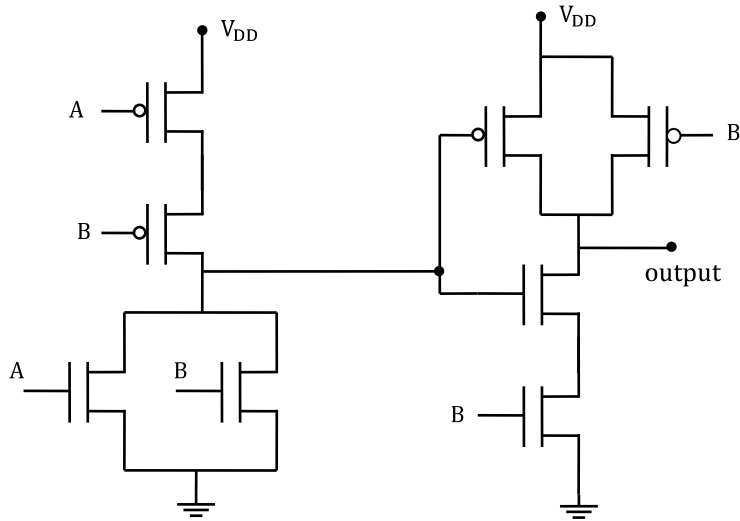
13.



CMRR of an Op Amp is 40dB. If a signal $V_1 = 1050\text{mV}$ and $V_2 = 950\text{mV}$ is applied on non-inverting and inverting terminals respectively, then $\frac{V_o}{\text{differential gain}}$ is

- (A) 0.21 (B) 0.11 (C) 0.41 (D) 0.09

14. The output of the circuit is



- (A) $A+B$ (B) $\bar{A} + \bar{B}$ (C) AB (D) None of above

15. A TEM wave is incident normally upon perfect conductor. **E** and **H** fields at the boundary will be respectively

- (A) Minimum and Minimum (C) Minimum and Maximum
 (B) Maximum and Maximum (D) Maximum and Minimum

16. A rectangular air filled waveguide has cross section of 4×10 cm². The minimum frequency at which wave propagates in waveguide is,

- (A) 1.5 GHz (B) 2 GHz (C) 2.5 GHz (D) 3.0 GHz

17. The ratio of the directivity of an end fire array antenna to that of the broadside array antenna is

- (A) 2 (B) 3 (C) 4 (D) 5

18. Find the Laplace Transform(LT) of $e^{a|t|}$

- (A) $\frac{-2a}{s^2-a^2}, -a < s < a, a < 0$ (C) $\frac{2a}{s^2-a^2}, -a < s < a, a > 0$
 (B) $\frac{2a}{s^2-a^2}, a < s < -a, a < 0$ (D) $\frac{-2a}{s^2-a^2}, -a < s < a, a > 0$

19. Which of the following represents condition for linear phase; where $h[n]$ is a discrete periodic sequence of length $M + 1$.

- (A) $h[n] = h[M - n]$ (C) Both (A) and (B)
 (B) $h[n] = -h[M - n]$ (D) None

20. Match of the following signals

I. Signal

II. Type

i. $\frac{1}{2}^n u[n]$

a. Power

ii. $u[n]$

b. Energy

iii. $2^n u[n]$

c. Neither Energy nor Power

iv. $\frac{1}{2}^n u[n] + u[n]$

d. Both power and energy

(A) i - a, ii - b, iii - c, iv - d

(C) i - b, ii - a, iii - c, iv - d

(B) i - b, ii - a, iv - a, iii - c

(D) i - b, ii - c, iii - c, iv - c

21. A UNFB closed loop system has a plant with the Transfer Function $G(s) = \frac{1}{s^2 + 2s + 2}$ and a controller $G_c(s)$ in the feed forward path. For a unit step input, the Transfer Function of the controller that gives minimum steady state error is,

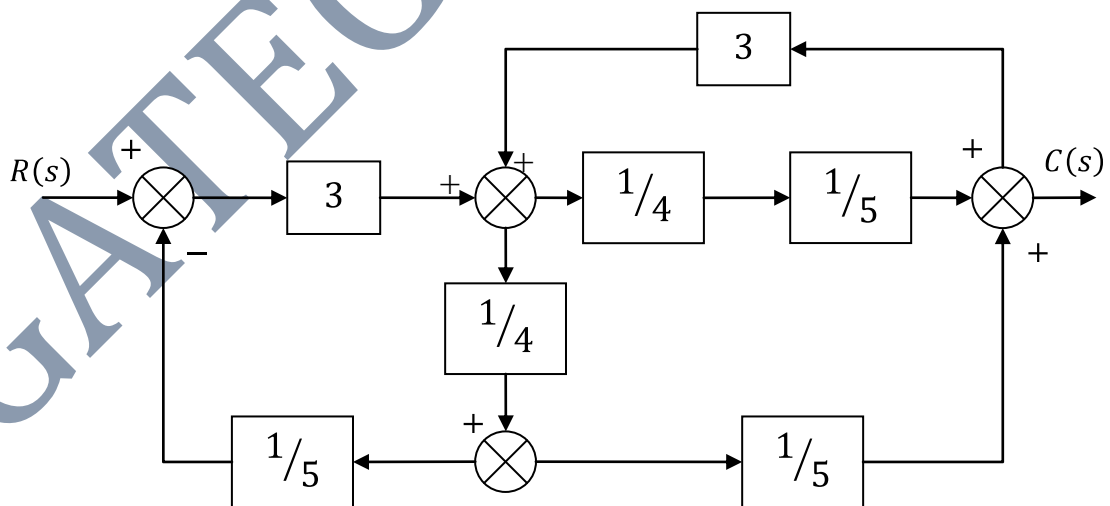
(A) $G_c(s) = \frac{s+1}{s+2}$

(C) $G_c(s) = \frac{(s+1)(s+4)}{(s+2)(s+3)}$

(B) $G_c(s) = \frac{s+2}{s+1}$

(D) $G_c(s) = 1 + \frac{2}{s} + 3s$

22. The system is shown in figure. Its overall gain is



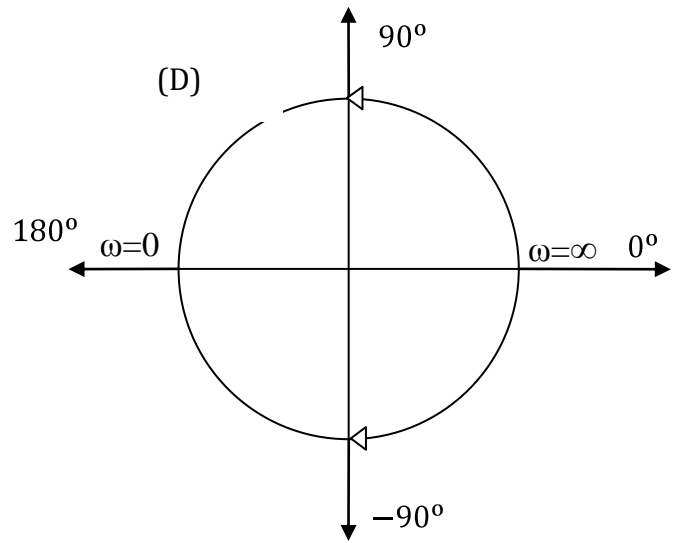
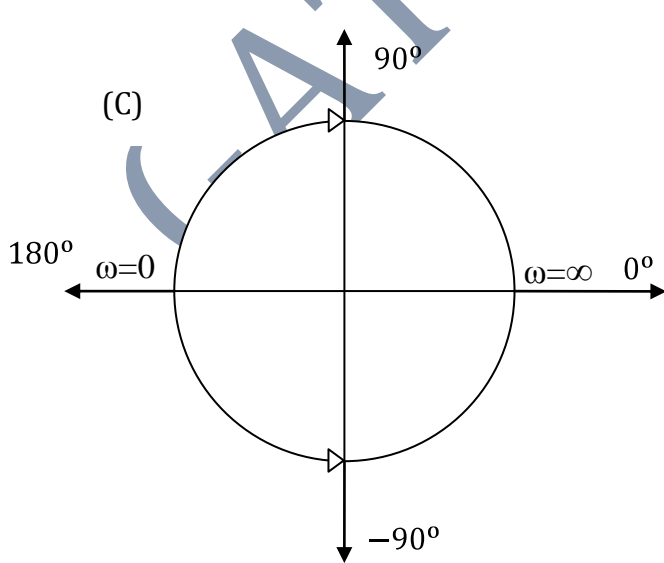
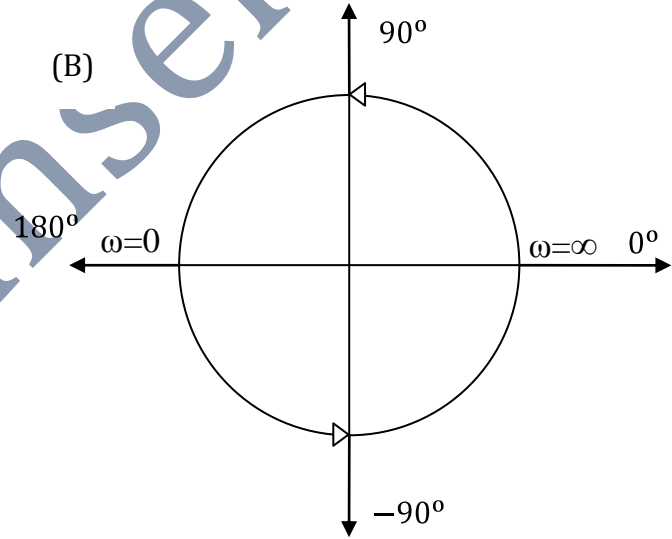
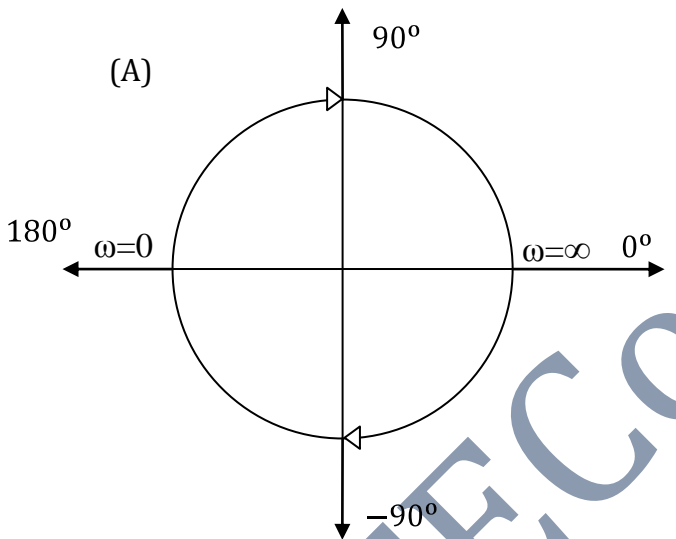
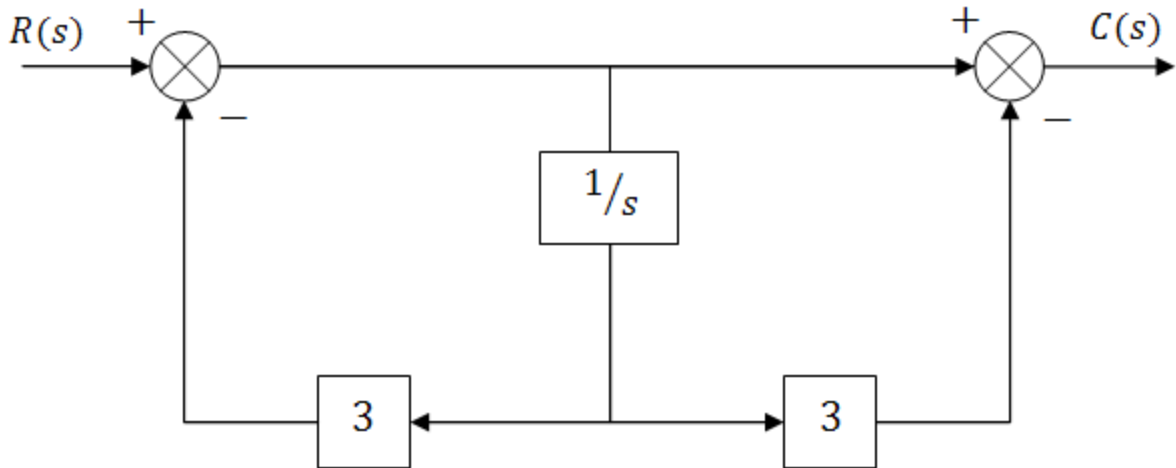
(A) 6/17

(B) 6/23

(C) 3/20

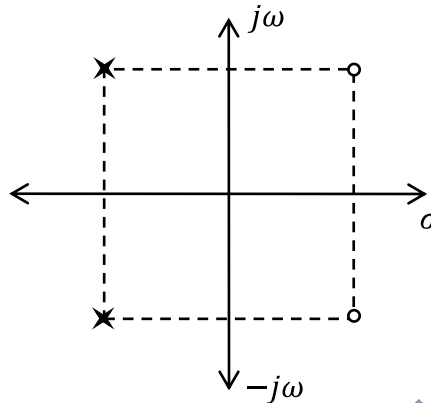
(D) None

23. The Nyquist plot for the system shown below is, (All Circles are of unit magnitude)



24. If network impedance has the pole zero pattern shown in the given figure, it must be composed of

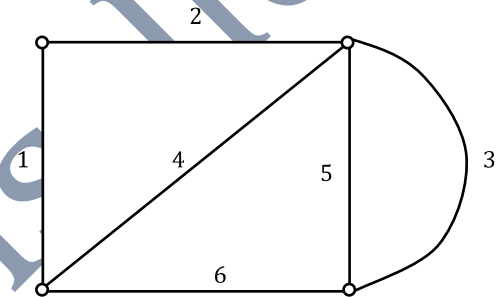
- (A) RC element only
- (B) RL element only
- (C) LC element only
- (D) RLC element only



25. For the following graph it is stated that

- I. {2,4,5,6} is cut-set
- II. This is a complete graph
- III. The graph has 2 nodes with odd degree

- (A) All are true
- (B) Only I and II are true
- (C) I is true only
- (D) III is true only



Questions 26- 55 carry 2 Marks each.

26. Find the values of λ and μ for which the system of equations

$$\begin{aligned} x + \lambda y + z &= 3 \\ x + 2y + 2z &= \mu \\ x + 5y + 3z &= 9 \end{aligned}$$

has infinite consistent solution.

- (A) $\mu = 6, \lambda = -1$
- (B) $\mu = -6, \lambda = -1$
- (C) $\mu = -6, \lambda = 1$
- (D) $\mu = 6, \lambda = 1$

27. $\frac{dy}{dx} = \frac{-(x-y)}{y+x}$, $y(0) = 1$, find the value of y for $x = 0.15$ up to first step by Picard's method

- (A) 0.9714
- (B) 1.2714
- (C) 0.7088
- (D) None of the above

28. Find the value of integral

$$\int_0^x e^{-t^2} dt$$

When value of $x = \infty$ and 0

- (A) $0, \frac{\sqrt{\pi}}{2}$ (B) $0, \sqrt{\pi}$ (C) $\frac{\sqrt{\pi}}{2}, 0$ (D) $\sqrt{\pi}, 0$

29. A major VLSI firm of world has four foundries of OPAMP 741 IC at Singapore unit manufacturing 20%, 15%, 25% and 40% of the total output respectively. Of their outputs 5%, 4%, 3% and 2% in the same order are defective ICs. An IC is chosen at random from the Singapore unit production and is found defective. What is the probability that the IC was manufactured by foundry A or foundry D?

- (A) 0.3175, 0.0254 (C) 0.3175, 0.254
(B) 0.254, 0.1375 (D) 0.03175, 0.0254

30. In BJT fabrication

- (A) base width is generally made longer than diffusion length to reduce recombination
(B) base width is generally made smaller than diffusion length to enhance breakdown voltage
(C) base width is generally made smaller than emitter width to increase capacitance between the two materials.
(D) base width is generally made smaller than diffusion length to reduce recombination

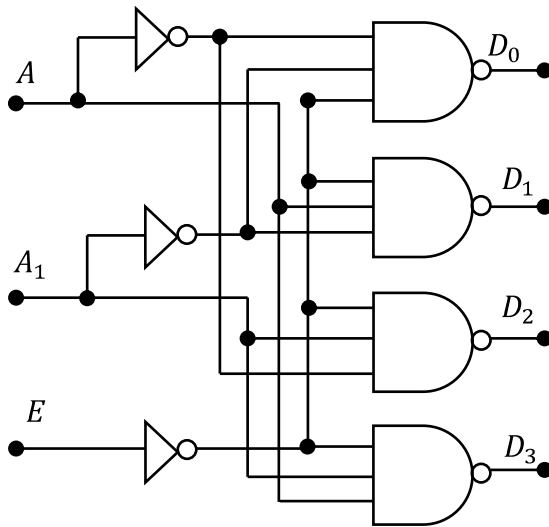
31. The relaxation time of an electron scattering in a lattice by mechanism 'X' is 5 ns and by 'Y' is 15 ns. Then effective relaxation time in presence of both mechanisms present at same time is

- (A) 20 ns (B) 10 ns (C) 3.75 ns (D) 5.5 ns

32. The GSM system uses a frame structure where each frame consists of 8 time slots and each time slot contains 150 bits and data is transmitted at 270 kbps in the channel. The time duration of a frame and the time a user occupying a single slot has to wait between two simultaneous transmissions are respectively:

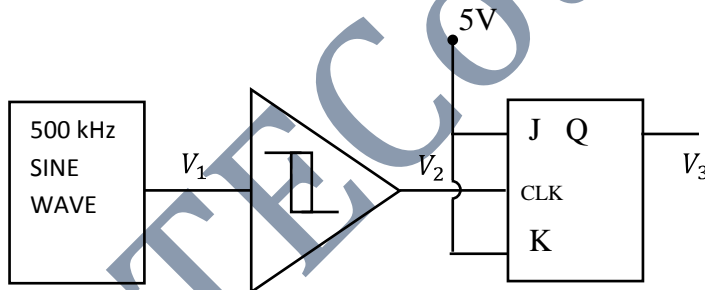
- (A) 4.6 ms and 4.6 ms (C) 4.34 ms and 4.6 ms
(B) 4.34 ms and 4.34 ms (D) 4.6ms and 4.34 ms

33. The logic diagram shown is known as



- (A) 2 to 4 line encoder with NAND Gate
 (B) 2 to 4 line decoder with NAND Gate
 (C) 3 to 8 line encoder with NAND Gate
 (D) None of these

34. In the figure below the output of the oscillator V_1 has 10V Peak to Peak amplitude with zero DC value. The Schmitt trigger has upper trip point 3.5V and lower trip point 2.5V. Assuming JK flip flop is reset at time $t=0$, determine the duty cycle of the waveform V_2 and period of waveform V_3 .



- (A) 0.105, 4usec
 (B) 0.707, 4usec
 (C) 0.105, 2usec
 (D) 0.707, 2usec

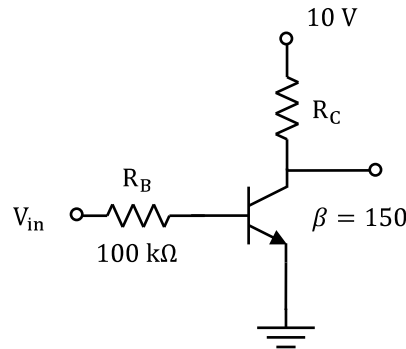
35. LXI SP, 1000 H

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PUSH H
PUSH D
CALL 2050 H
POP D
HLT
```

After the execution of this program the contents of the stack pointer would be

- (A) 0FFC H
 (B) 0FFE H
 (C) 1000 H
 (D) 1002 H

36.



$I_{CSAT}=10\text{mA}$, $V_{BE,ON}=0.7\text{V}$, $V_{BE,SAT}=0.8\text{V}$, $V_{CE,SAT} = 0.2\text{V}$

In above circuit if $V_{in} = 10\text{V}$, the value of R_c is,

- (A) $0.92\text{k}\Omega$ (B) $0.98\text{k}\Omega$ (C) $1.02\text{k}\Omega$ (D) $1.5\text{k}\Omega$

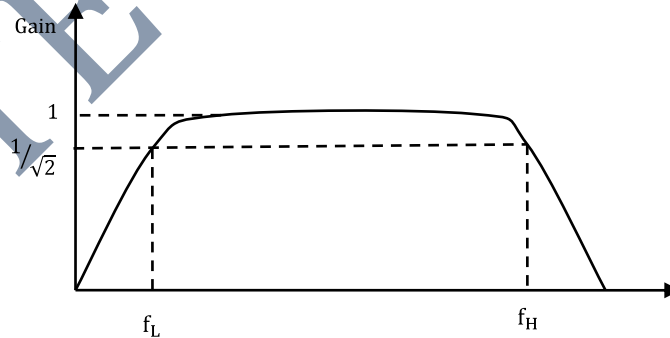
37. In a BJT I_{CO} , β and V_{BE} are reverse saturation current in collector base region, dc current gain in common emitter mode and base emitter voltage respectively.

- I. β increases with temperature
- II. I_{CO} increases with temperature
- III. V_{BE} increases with temperature

The correct statements are

- (A) I & II (B) II & III (C) I & III (D) I, II and III

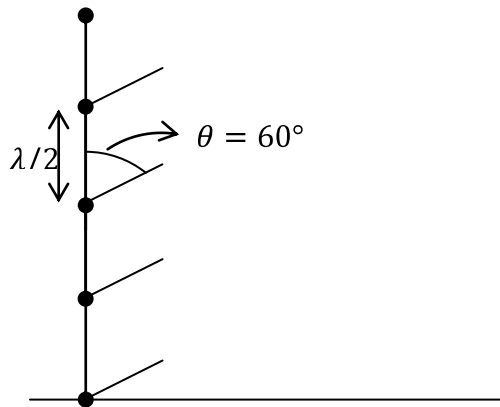
38. An amplifier has a frequency response as shown such that $f_L \ll f_H$



Now n stages of such amplifier are cascaded. Then approximate equivalent bandwidth is

- (A) $f_H \sqrt{2^{1/n} - 1}$ (B) $f_H \sqrt{2^n - 1}$ (C) $n f_H$ (D) $2^n f_H$

39. Give five element antenna array Antenna Factor is



- (A) AF= 1 (B) AF= $2\sqrt{3}$ (C) AF = $\sqrt{3}$ (D) AF= 2

40. A plane wave is characterized by $E = \left(0.5\hat{x} + \hat{y}e^{\frac{j\pi}{2}}\right) e^{j(\omega t - kz)}$. The wave is

- (A) Lineally polarized (C) Elliptically polarized
 (B) Circularly polarized (D) Unpolarized

41. The output of the casual all pass system is $y(t) = e^{-2t}u(t)$, for which the system transfer function is $H(s) = \frac{(s-1)}{(s+1)}$. Then corresponding stable input signal is

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

42. An input $x[n]$ with length M is applied to a linear time invariant system having an impulse response of length N and $Y(\omega)$ is the DTFT of the output $y[n]$ of the system. If $h[n] \leq L$ and $|x[n]| \leq B$ for all n, the maximum value of $Y[0]$ can be

- (A) $MNLB$ (C) $MN(L + B)$
 (B) $(M + N)LB$ (D) $(M + N - 1)LB$

43. $X(z) = e^z + e^{\frac{1}{z}}$, $|z| \neq 0$, Then find $x[n]$

- (A) $\frac{1}{n!}$ (C) $\sum_{k=0}^{\infty} 2\delta[n + k]$
 (B) $\delta[n] + \frac{1}{n!}$ (D) $\sum_{k=0}^{\infty} 2\delta[n - k]$

44. The open loop transfer function of a system is $(s)H(s) = \frac{100(s+100)}{s(s+10)}$. In the straight line approximation of Bode plot, magnitude (in dB) and phase (in radians) of $G(s)H(s)|_{s=j\omega}$ at $\omega = 100$ rad/sec are
- (A) 0 dB and $-\frac{3\pi}{4}$ rad (C) 20 dB and $-\frac{3\pi}{4}$ rad
 (B) 0 dB and $\frac{\pi}{4}$ rad (D) 20 dB and $\frac{\pi}{4}$ rad

45. The state-space representation of a system is given by

$$\dot{x} = \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u, \quad y = [1 \quad 1]x + u$$

The TF of the system $Y(s)/U(s)$ is

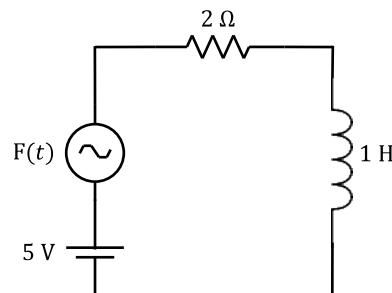
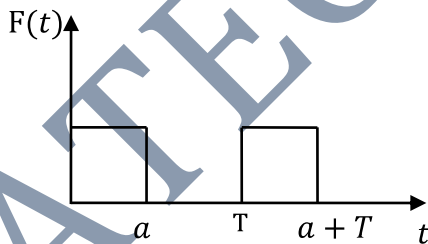
- (A) $\frac{1}{s+1}$ (B) $\frac{1}{s-1}$ (C) $\frac{s+2}{s+1}$ (D) $\frac{(s+2)}{(s+1)(s-1)}$

46. Which of the following statements is correct?

- I. Effect of adding a pole to the function $G(s)H(s)$ in the left half of s -plane is moving the root-loci towards the right half plane.
 II. Effect of adding a zero to the function $G(s)H(s)$ has the effect of moving the root-loci towards the LH s -plane.

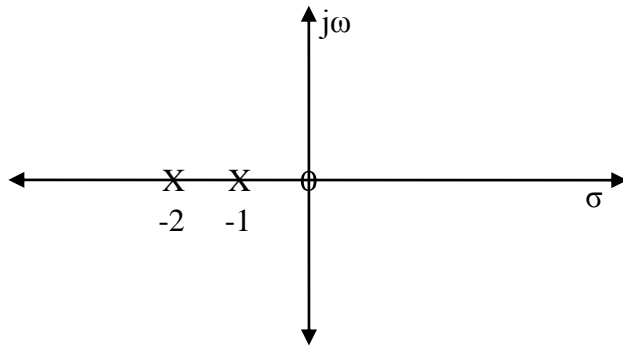
- (A) I only correct (C) Both I & II correct
 (B) II only correct (D) None

47. Find the Laplace transform of the periodic waveform and calculate the final current value of the system.



- (A) 0.5 Amp (B) $2a/T$ Amp (C) $-2a/T$ Amp (D) $4a/T$ Amp

48. The pole zero plot for series RLC circuit driving point admittance is as shown in figure. Find value of R, L and C.



(A) $C=0.5F, L=1H, R=3\Omega$

(C) $C=0.01F, L=1/3H, R=10\Omega$

(B) $C=0.01F, L=1/3H, R=1\Omega$

(D) $C=0.1F, L=1/3H, R=1\Omega$

49. The Network Function $\frac{s^2 + 10s + 24}{(s+1)(s+3)}$ represents a

(A) RC admittance

(C) LC impedance

(B) RL admittance

(D) None of these

Common Data Questions:

Common Data Questions 50 and 51:

In a *pn* junction diode, the doping levels are $N_D = 10^{16}$ and $N_A = 10^{17} \text{ cm}^{-3}$. The diffusion length & diffusion constants for both electron holes are given below on both sides of junction

<i>n side</i>	$D_h^n = 10 \text{ cm}^2/\text{s}$	$L_h^n = 5 \mu\text{m}$	for holes
	$D_e^n = 15 \text{ cm}^2/\text{s}$	$L_e^n = 10 \mu\text{m}$	for electrons
<i>p side</i>	$D_h^n = 20 \text{ cm}^2/\text{s}$	$L_h^n = 12 \mu\text{m}$	for holes
	$D_e^n = 10 \text{ cm}^2/\text{s}$	$L_e^n = 5 \mu\text{m}$	for electrons

50. The hole current density due to diffusion at junction at bias voltage $V_D = 0.5V$ is (given $n_i = 1.5 \times 10^{10} \text{ cm}^{-3}$)

(A) 16.2 mA/cm^2

(B) 18.3 mA/cm^2

(C) 25 mA/cm^2

(D) 11.4 mA/cm^2

51. In Q50, the ratio of total hole current due to diffusion to the total diode current is

(A) $9/10$

(B) $8/9$

(C) $11/12$

(D) $10/11$

Linked Questions**Statement for Linked Answer Questions 52 and 53.**

52. Consider the random process $X(t) = A \cos(2\pi f_c t + \theta)$ where θ is a uniformly distributed random variable over the interval $[-\pi, \pi]$. The autocorrelation function will be

- (A) $\frac{A^2}{4} \cos(2\pi f_c \tau)$ (C) $\frac{A^2}{2}$
 (B) $\frac{A^2}{2} \sin(\frac{\pi}{2} - 2\pi f_c \tau)$ (D) $\frac{A^2}{2} \sin(2\pi f_c \tau)$

53. The process will be:

- (A) Stationary in mean sense only (B) Stationary in correlation sense only
 (C) Both (D) Not stationary

Statement for Linked Answer Questions 54 and 55.

54. A MOSFET has following parameters

$$\mu_n = 500 \frac{cm^2}{vs}, t_{ox} = 10 \text{ nm}, \epsilon_{ox} = 3.9 \epsilon_0, \frac{w}{L} = 5, V_T = 1.5 \text{ volts and } \lambda = 0.01$$

If the transistor is in saturation and $V_{GS} = 5V$, then if channel length modulation is ignored, the drain current is

- (A) 5.28mA (B) 8.64mA (C) 4.12mA (D) 1.82mA

55. The output resistance of MOSFET in Q54 is

- (A) 48k Ω (B) 19k Ω (C) 25k Ω (D) 56 k Ω

General Aptitude (GA) Questions

Questions 56 - 60 carry one mark each.

56. The _____ requirements by client for approval of new design, do not _____ designers when it comes to research & development because of the profit potential.

(A) toilsome....provoke

(C) complex....encourage

(B) onerous....dissuade

(D) vague....support

57. In the following question one word-part is given with example, followed by four options. Choose the most appropriate word which best describes the meaning of the given word-part in a word.

Drome(Ex. syndrome)

(A) hard

(B) lasting

(C) break

(D) step

58. In the following question, a word is given in bold which precedes four more words. Pick the word from the four options which most nearly opposite in meaning to the bold word.

ULTERIOR

(A) uncompromising

(C) corrugated

(B) sparking

(D) stated

59. In the following question, a word is given in bold which precedes four more words. Pick the word from the four options which most nearly similar in meaning to the bold word.

INTRACTABLE

(A) culpable

(B) unruly

(C) flexible

(D) efficient

60. Three pipes A,B and C can fill a tank from empty to full in 30 minutes, 20 minutes and 10 minutes respectively. When the tank is empty, all the three pipes are opened. A, B and C discharge chemical solutions P, Q and R respectively. What is the proportion of solution R in the liquid in the tank after 3 minutes?

(A) 5/11

(B) 6/11

(C) 7/11

(D) 8/11

Questions 61 - 65 carry two marks each.

61. It had promised to be a real treat for the cinemagoers. However, when the film released, one was disappointed to see a hackneyed plot and wooden faced actors. It was dubbed the worst film of the decade: no the century. In the above sentence extract, hackneyed may refer to all of the following except:

(A) clichéd (B) weak (C) trite (D) banal

62. How many zeros are there at the end of the number obtained from $999!$

(A) 246 (B) 247 (C) 248 (D) 249

63. Five players prashant, prabhu, prince, prem, piyush played five overs of cricket among themselves. Each of the five players bowled exactly one over and also batted exactly for one over.

The runs conceded by the five bowlers in the respective overs bowled by them are 1, 2, 3, 4 and 5, not necessarily in the same order. Prashant bowled to prem and conceded 1 run and he scored 2 runs in prabhu's over. Prince neither scored 3 runs nor conceded 3 runs. Prem did not bowled to Prince. Prabhu batted when Prince bowled, then he scored 5 runs.

Which of the following statement cannot be true?

- (A) Piyush conceded 4 runs to Prince.
- (B) Prem neither bowled to Prince nor batted in Prince's over.
- (C) Piyush did not score 3 runs
- (D) None of the above

64. A certain amount of sum is invested at simple interest. If the sum becomes k times itself in 16 years and $2k$ times itself in 40 years, in how many years will it become $4k$ times of itself?

(A) 96 years (B) 88 years (C) 80 years (D) 64 years

65. The question given below contains six statements followed by four groups of three statements. Which of the group of statements are logically related?

- I. Some birds are fish
- II. Some birds lay eggs
- III. No mammal lays eggs
- IV. Some fish are mammals
- V. All fish lay eggs
- VI. Some mammals are birds

(A) I-II-V (C) II-III-VI
(B) III-IV-V (D) None of these

END OF THE QUESTION PAPER