DO NOT OPEN THIS TEST BOOKLET UNTIL YOU ARE ASKED TO DO SO

23-0009-AK TEST BOOKLET

ELECTRICAL ENGINEERING

Time Allowed: 3 hours | **PAPER – I** | **Maximum Marks: 300**

INSTRUCTIONS TO CANDIDATES

Read the instructions carefully before answering the questions: -

1. This Test Booklet consists of **16(sixteen) pages and has 75 (seventy-five) items (questions).**
2. IMMEDIATELY AFTER THE COMMENCEMENT OF THE EXAMINATION, YOU SHOULD CHECK THAT THIS BOOKLET *DOES NOT* HAVE ANY UNPRINTED OR TORN OR MISSING PAGES OR ITEMS ETC. IF SO, GET IT REPLACED BY A COMPLETE TEST BOOKLET.
3. **Please note that it is the candidate's responsibility to fill in the Roll Number and other required details carefully and without any omission or discrepancy at the appropriate places in the OMR Answer Sheet and the Separate Answer Booklet. Any omission/discrepancy will render the OMR Answer Sheet and the Separate Answer Booklet liable for rejection.**
4. Do not write anything else on the OMR Answer Sheet except the required information. Before you proceed to mark in the OMR Answer Sheet, please ensure that you have filled in the required particulars as per given instructions.
5. Use only **Black Ball Point Pen** to fill the OMR Answer Sheet.
6. This Test Booklet is divided into 4 (four) parts – **Part – I, Part – II, Part - III and Part – IV.**
7. All the parts are Compulsory.
8. **Part-I consists of Multiple Choice-based Questions.** The answers to these questions have to be marked in the OMR Answer Sheet provided to you.
9. **Part-II, Part-III and Part-IV consist of Conventional Essay-type Questions.** The answers to these questions have to be written in the separate Answer Booklet provided to you.
10. In Part-I, each item (question) comprises of 04 (four) responses (answers). You are required to select the response which you want to mark on the OMR Answer Sheet. In case you feel that there is more than one correct response, mark the response which you consider the best. In any case, choose *ONLY ONE* response for each item.
11. After you have completed filling in all your responses on the OMR Answer Sheet and the Answer Booklet(s) and the examination has concluded, you should hand over to the Invigilator *only the OMR Answer Sheet and the Answer Booklet(s).* You are permitted to take the Test Booklet with you.
12. **Penalty for wrong answers in Multiple Choice-based Questions:**

THERE WIL BE **PENALTY** FOR WRONG ANSWERS MARKED BY A CANDIDATE.

(i) There are four alternatives for the answer to every question. For each question for which a wrong answer has been given by the candidate, one-third of the marks assigned to the question will be deducted as penalty.

(ii) If a candidate gives more than one answer, it will be treated as a **wrong answer** even if one of the given answers happens to be correct and there will be same penalty as above to the question.

(iii) If a question is left blank. i.e., no answer is given by the candidate, there will be **no penalty** for that question.

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PART-I
(Multiple Choice-based Questions)

Instructions for Questions 1 to 50:

- *Choose the correct answers for the following questions.*
- *Each question carries 3 marks.*
- *No Data Books/Tables are allowed; assume the data if required anywhere.*

[3x50=150]

1. Ripple factor of a diode rectifier is given by:
   (a) V_{dc}/V_{ac}
   (b) V_{rms}/V_{dc}
   (c) V_{ac}/V_{dc}
   (d) V_{max}/V_{rms}

2. For a UJT, if $V_{BB} = 20\ V$, $\eta = 0.65$, $R_{B1} = 2\ k\Omega$ and $R_{B2} = 1080\ \Omega$, then V_P will be given by:
   (a) $13.7\ V$
   (b) $12.2\ V$
   (c) $10.6\ V$
   (d) $11.4\ V$

3. The form factor of a pure sinewave is:
   (a) 1.414
   (b) 1
   (c) 1.11
   (d) 0

4. The snubber circuit is used in a thyristor circuit for _____
   (a) triggering
   (b) dv/dt protection
   (c) di/dt protection
   (d) phase Shifting

5. Reverse recovery time of a diode should be considered for _____
   (a) Low Frequency Circuits
   (b) High Frequency Circuits
   (c) Both Low and High Frequency Circuits
   (d) None of the above

6. What is the hexadecimal equivalent of the octal number $(734)_8$?
   (a) $(C1D)_{16}$
   (b) $(DC1)_{16}$
   (c) $(1CD)_{16}$
   (d) $(1DC)_{16}$

7. The binary representation of the decimal number $(1.375)_{10}$ is:
   (a) $(1.111)_2$
   (b) $(1.010)_2$
   (c) $(1.011)_2$
   (d) $(1.001)_2$

8. The range of signed decimal numbers that can be represented by a **6-bit 1's complement number** is:
   (a) -31 to 31
   (b) -63 to 64
   (c) -64 to 63
   (d) -32 to 31

9. Excess-3 code is also known as the _____
   (a) weighted code
   (b) cyclic redundancy code
   (c) self-complementary code
   (d) algebraic code

10. The minimum number of NAND gates required to implement $A \oplus B \oplus C$ is:
   (a) 8
   (b) 10
   (c) 9
   (d) 6

11. In constructing a K-map, the order is obtained by using a _____
   (a) Gray code progression
   (b) Binary coded decimal code
   (c) Excess-3 code
   (d) Binary code progression

12. Which of the following can be used to design a 2-bit adder?
   (a) 1 (one) full-adder and 1 (one) half-adder
   (b) 1 (one) full-adder
   (c) 2 (two) half-adders
   (d) 1 (one) half-adder

13. FM signals are always generated at:
    (a) High level and then attenuated by a series of highly efficient attenuators.
    (b) Low level and then amplified by aseries of highly efficient class C, D, E or F amplifiers.
    (c) Zero level.
    (d) Oscillator Frequency.

14. The maximum deviation allowed in an FM broadcast system is 75 kHz. If the modulating signal is of 10 kHz, find the bandwidth of the FM signal.
    (a) 85 kHz
    (b) 170 kHz
    (c) 75 kHz
    (d) 340 kHz

15. For a FM wave represented by the voltage equation $\boldsymbol{v(t) = 12\sin(6 \times 10^8 t + 5\sin 1250t)}$. The modulation index and the maximum frequency deviation respectively of the resultant FM wave are given by:
    (a) 5 and 995 Hz.
    (b) 2.5 and 995 Hz.
    (c) 5 and 1250 Hz.
    (d) 10 and 995 Hz.

16. An FM signal has a carrier frequency of 105 MHz and upper frequency 105.007 MHz when modulated by a signal of frequency 5 kHz. The carrier swing is:
    (a) 105 MHz
    (b) 310 MHz
    (c) 7 kHz
    (d) 14 kHz

17. For a signal amplitude-modulated to a depth of 90% by a sinusoidal signal, what will be the ratio of transmitted power to the power of unmodulated carrier?
    (a) 1.405
    (b) 0.5
    (c) 1.5
    (d) 0.81

18. In a purely capacitive circuit, the instantaneous power curve is a sinusoidal of _____ the frequency of V and I.
    (a) $^1/_{\sqrt{3}}$ times
    (b) half
    (c) equal
    (d) double

19. Determine the capacitance of a parallel plate capacitor composed of thin foil sheets, $\mathbf{20}\ \boldsymbol{cm^2}$ for plates separated through a glass dielectric $\mathbf{0.4}\ \boldsymbol{cm}$ thick with relative permittivity **6**.
    (a) $46.562 \times 10^{-12} F$
    (b) $36.562 \times 10^{-12} F$
    (c) $26.562 \times 10^{-12} F$
    (d) $20.200 \times 10^{-12} F$

20. If a change in the current from $\mathbf{4}\ \boldsymbol{A}$ to $\mathbf{6}\ \boldsymbol{A}$ in $\mathbf{1}\ \boldsymbol{second}$ induces $\mathbf{40}\ \boldsymbol{V}$ in a coil, its inductance would be equal to:
    (a) $20\ H$
    (b) $6\ H$
    (c) $4\ H$
    (d) $40\ mH$

21. Two voltage sources, $\boldsymbol{V_1 = 90\sin(\omega t + 45°)}$ and $\boldsymbol{V_2 = 90\sin(\omega t + 225°)}$ are connected in series. What is the $\boldsymbol{rms}$ value of the resultant voltage?
    (a) $Zero$
    (b) $90\ volts$
    (c) $180\ volts$
    (d) $45\ volts$

22. A capacitor $\boldsymbol{C}$ connected to a $\boldsymbol{single\ phase}$, $\mathbf{50}\ \boldsymbol{Hz}$,$\mathbf{240}\ \boldsymbol{V}$ AC supply draws a current of $\mathbf{24}\ \boldsymbol{A}$. What would be the current if the voltage applied is charged to $\mathbf{200}\ \boldsymbol{V}$ at $\mathbf{60}\ \boldsymbol{Hz}$?
    (a) $6\ A$
    (b) $12\ A$
    (c) $24\ A$
    (d) $10\ A$

23. The average power consumed by any network composed of an ideal inductor and capacitoris:
    (a) ∞
    (b) $\mathbf{0}$
    (c) $\frac{1}{2}VI\cos\emptyset$
    (d) VI

24. Permittivity is expressed in:
    (a) $farad/m^2$
    (b) $farad/m$
    (c) $weber/m$
    (d) $weber/m^2$

25. Determine the constant c such that the vector $\vec{F} = (2x + 3ay)\hat{\imath} + (2y + 3bx)\hat{\jmath} + (2x + cz)\hat{k}$ is a solenoidal vector.
    (a) -2
    (b) -4
    (c) -6
    (d) -8

26. Divergence of a vector field is
    (a) zero
    (b) a constant
    (c) a vector field
    (d) a scalar field

27. The magnitude of the vector product of two vectors is $\sqrt{3}$ times their scalar product. The angle between vectors is:
    (a) $\pi/2$
    (b) $\pi/6$
    (c) $\pi/3$
    (d) $\pi/4$

28. Which of the following statements is correct for a linear electromagnetic circuit?
    (a) Field energy is equal to the co-energy.
    (b) Field energy is greater than the co-energy.
    (c) Field energy is lesser than the co-energy.
    (d) Co-energy is zero.

29. The electric flux density is _____ to the electric flux lines and the electric field is_____ to the electric potential lines.
    (a) normal; tangential
    (b) tangential; normal
    (c) tangential; tangential
    (d) normal; normal

30. Human system is _____
    (a) an open-loop control system
    (b) a closed -loop control system
    (c) a multivariable feedback control system
    (d) a complex control system

31. In control systems excessive bandwidth is not employed, because _____
    (a) noise is proportional to bandwidth
    (b) noise is proportional to the square of bandwidth
    (c) it leads to low relative stability
    (d) it leads to slower response

32. Which one of the following devices would be used for providing the rate-feedback voltage in position control system?
    (a) Potentiometer
    (b) Synchro-transmitter
    (c) Synchro-transformer
    (d) Tachogenerator

33. A transfer function has a second order denominator and constant gain in the numerator. Which of the following is true for this system?
    (a) The system has two zeros at the origin
    (b) The system has two finite zeros
    (c) The system has two zeros at infinity
    (d) The system has one zero at infinity

34. If the unit step response of a system is a unit impulse function, then the transfer function of such a system will be-
    (a) $1/s^2$
    (b) $1/s$
    (c) 1
    (d) s

35. Which of the following converts an irregularly shaped waveform into a regular-shaped waveform?
    (a) Schmitt trigger
    (b) Comparator
    (c) Voltage limiter
    (d) MOSFET

36. Three amplifiers, each having higher cut off frequency $f_h = 10\ kHz$ are cascaded. What is the higher cut off frequency of cascaded system?
    (a) $10\ kHz$
    (b) $6.4\ kHz$
    (c) $5.1\ kHz$
    (d) $20\ kHz$

37. Which of the following can be used to detect a missing heart-beat?
    (a) Monostable multivibrator
    (b) Bistable multivibrator
    (c) Schmitt trigger
    (d) Astable multivibrator

38. A mono-stable multi vibrator can have the following state(s) -
    (a) Single stable state
    (b) Single Quasi-stable State
    (c) Both a and b
    (d) None of the above

39. An ideal op-amp offers -
    (a) Zero Output Impedance
    (b) Infinite Bandwidth Differential Mode Gain
    (c) Infinite Input Resistance and Infinite CMRR
    (d) All of the above

40. An op-amp has open-loop gain 100000 and the open-loop upper cut-off frequency of 20 Hz.The unity-gain frequency of the op-amp is:
    (a) 2 MHz
    (b) 1 MHz
    (c) 3 kHz
    (d) 2 kHz

41. The minimum number of R-C networks to be connected in cascade in an R-C phase shift oscillator is -
    (a) One
    (b) Two
    (c) Three
    (d) Four

42. Which of the following is a non-causal system?
    (a) $y(t) = 2x(t) + \frac{dx(t)}{dt}$
    (b) $y(t) = x(t) - x(t-1)$
    (c) $y(t) = tx(t)$
    (d) $y(t) = x(t) + 2x(3-t)$

43. Determine average power of the signal $\boldsymbol{x(t) = \cos(2\pi f_o t)}$. Where $\boldsymbol{f_o}$ is the fundamental frequency and $\boldsymbol{t}$ indicates the continuous time domain.
    (a) $1.0\ W$
    (b) $2.0\ W$
    (c) $10.0\ W$
    (d) $0.5\ W$

44. If all poles of H(z) lies inside the unit circle, the discrete time system is necessarily:
    (a) A Stable System
    (b) An Unstable System
    (c) Damping System
    (d) None of the above

45. Evaluate $\frac{d}{dt}sgn(t)$.

(e) $-2\delta(t)$
(f) 0
(g) $2\delta(t)$
(h) $\delta(t)$

46. A continuous time input signal $x(t)$ is an eigen function of an LTI system, if the output is

(a) $kH(\omega)$, where k is the eigen value and $H(\omega)$ is the frequency response of the system.
(b) $kx(t)$, where k is an eigen value.
(c) $x(t)e^{j\omega t}$, where $e^{j\omega t}$ is a complex exponential signal.
(d) $ke^{j\omega t}x(t)$, where k is an eigen value and $e^{j\omega t}$ is a complex exponential signal.

47. Given two continuous-time signals $x(t) = e^{-t}$ and $y(t) = e^{-2t}$ which exist for $t > 0$. The convolution $z(t) = x(t) * y(t)$ is-

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

48. Let the impulse response of an LTI system be $h(t) = e^{-t}u(t)$. Find the output $y(t)$ if the input $x(t) = u(t)$.

(a) $y(t) = e^{-t}u(t)$
(b) $y(t) = e^{t}u(t)$
(c) $y(t) = (1 - e^{t})u(t)$
(d) $y(t) = (1 - e^{-t})u(t)$

49. A system is defined by its impulse response $h(n) = 2^{n}u(n-2)$. The system is:

(a) Stable & causal.
(b) Causal but not stable.
(c) Stable but not causal.
(d) Unstable and non-causal.

50. Energy of a discrete time signal x(n) = (-0.4)n u(n) in Joule is :

(a) 1/36
(b) 25/21
(c) 1/16
(d) 5/3

PART-II
(Short Answer-type Questions)

Instructions for Questions 51 to 63:

- *Write the answers in short for any 10 (TEN)out of the thirteen questions.*
- *Each question carries 5 marks.*
- *No Data Books/Tables are allowed; assume the data if required anywhere.*
- *Unless otherwise mentioned, symbols and notations have their usual meaning.*

[5x10=50]

51. The impulse response of a continuous time causal system is h (t) = e-t. Find out the steady state value of the output if unit step signal was applied as an input.

52. Draw the circuit of closed-loop differential amplifier using one op-amp. Derive the expression of its output voltage.

53. List the guidelines for construction of state graphs.

54. Minimize the following Boolean function using K-map:
$$F(A,B,C,D) = \Sigma m(0,3,4,5,7,9,13,14,15)$$

55. Explain the concept of serial adder with accumulators.

56. A discrete memoryless source X has five symbols $(s_0, s_1, s_2, s_3, s_4)$ and their probabilities of occurrence are given as $0.40, 0.20, 0.20, 0.10, 0.10$ respectively. Construct aHuffman code for this source and calculate its efficiency.

57. Explain T1 carrier system with the help of a block diagram.

58. Write down various rules involve in Block Diagram Reduction method.

59. Check the periodicity of the signal given below:
$$x(t) = \sin(8t-1) - \sin(3t-1)$$

60. Find the ROC of $x(t) = e^{-2t}u(t) + e^{-3t}u(t)$.

61. Define self-loop & non-touching loop in signal flow graph with the help of suitable examples.

62. Draw the polar plot of the transfer function $G(s) = 1/(s+2)$.

63. Write a short note on RMS value of AC waveforms.

PART-III
(Long Answer-type Questions)

Instructions for Questions 64 to 71:

- *Answer any 5 (FIVE) out of the eight questions.*
- *Each question carries 10 marks.*
- *No Data Books/Tables are allowed; assume the data if required anywhere.*
- *Unless otherwise mentioned, symbols and notations have their usual meaning.*

[10x5=50]

64. Explain in detail about merits, demerits and characteristics of a transducer.

65. What are the selection criteria of a transducer? Explain in detail.

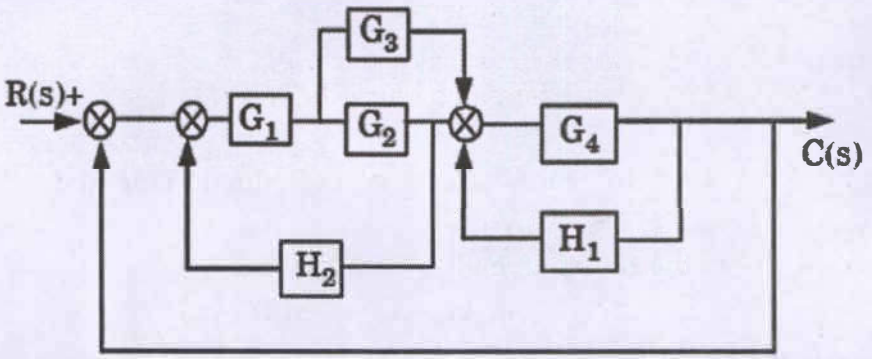
66. Draw and explain CRT display in detail.

67. Prove that the balance modulator removes the carrier and gives the two sidebands only.

68. Write short notes on ASK, FSK and PSK.

69. Explain the strengths of frequency response approach. Establish the correlation between frequency domain response and time domain response.

70. State and explain Mason's gain formula. For the system shown in the figure below, find the overall transfer function of system using block diagram reduction.



71. Discuss the concept of Lossless and Distortionless line.

PART-IV
(Essay-type Questions)

Instructions for Questions 72 to 75:

- ***Answer any 2 (TWO) out of the four questions.***
- ***Each question carries 25 marks.***
- ***Candidates are required to give their answers in their own words as far as practicable.***
- ***No Data Books/Tables are allowed; assume the data if required anywhere.***
- ***Unless otherwise mentioned, symbols and notations have their usual meaning.***

[25x2= 50]

72. Derive the wave equation for electric field.

73. Explain the methods of equalizing the potential across the string insulator. A string of 8 suspension insulators is to be fitted with a grading ring. If the pin-to-earth capacitancesare all equal to C, find the values of line-to-pin capacitances that would give a uniform voltage distribution over the string.

74. Derive the formula to calculate the ratio of copper volume used in a two-phase four-wire AC system and a two-wire DC system. Also draw phasor diagram of a nominal T transmission line and find its A,B,C,D constants.

75. Discuss the concept of multi-level inverter.

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