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

23-0009-AK TEST BOOKLET

ELECTRICAL ENGINEERING

PAPER – II

Time Allowed: 3 hours | **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.*

[3 x 50 = 150]

1. A SCHOTKY diode is a:
   (a) both minority and majority carrier diode
   (b) minority carrier device
   (c) fast recovery diode
   (d) majority carrier device

2. The relation between Distortion Factor (DF) and Total Harmonic Distortion (THD) is given by:
   (a) $DF = \sqrt{\frac{1}{1-THD^2}}$
   (b) $THD = \sqrt{\frac{1}{2+DF^2}}$
   (c) $THD = \sqrt{\frac{1}{1-DF^2}}$
   (d) $DF = \sqrt{\frac{1}{DF^2} - 1}$

3. For low power applications, a GTO has _____
   (a) Low on-state gain
   (b) Low ratio of peak surge current to average current
   (c) Higher blocking voltage capability
   (d) Low ratio of peak controllable current to average current

4. What is the lowest ripple frequency in case of a full-wave rectifier, where f is the input frequency?
   (a) $2f$
   (b) $4f$
   (c) $0.5f$
   (d) f

5. A single-phase half-wave rectifier circuit has a freewheeling diode which will conduct only if -
   (i) Load is purely inductive
   (ii) Load is purely resistive
   (iii) Load is a combination of R and L
   (iv) Load is pure inductive

   Select the correct answer from the codes given below:

   (a) Only (iii)
   (b) (iii) or (iv)
   (c) Only (i)
   (d) (i) or (ii)

6. A **J-K flip flop** can be converted to **T flip flop** by connecting:
   (a) J *to* Q
   (b) K *to* Q
   (c) J *to* K
   (d) J *to* $\bar{Q}$

7. The number of flip-flops required for mod-16 counter are:
   (a) 5
   (b) 6
   (c) 3
   (d) 4

8. How many flip flops will be complemented in a 10-bit binary ripple counter to reach the next count after the following count **0111111111**?
   (a) 5
   (b) 10
   (c) 1
   (d) 9

9. The number of flip flops required to implement divide by 20 Johnson counter is:
   (a) 15
   (b) 25
   (c) 20
   (d) 10

10. In a J-K flip flop, if $\boldsymbol{J = \bar{K}}$, then it acts as a/an:
    (a) T flip flop
    (b) D flip flop
    (c) RS flip flop
    (d) Decoder

11. If the carrier of a 100% modulated AM wave is suppressed, the percentage power saving will be equal to ____%.
    (a) 50
    (b) 150
    (c) 100
    (d) 66.67

12. Pre-emphasis in frequency modulated (FM) communication system is generally used for:
    (a) Amplifying low-frequency components
    (b) Amplifying high-frequency components
    (c) Amplifying low and high frequency components
    (d) Amplifying DC component

13. Suppose a communication channel in the presence of additive white Gaussian noise has bandwidth $\mathbf{8}\ \boldsymbol{kHz}$, and signal to noise ratio $(\boldsymbol{SNR}) = \mathbf{7}$ then the channel capacity will be:
    (a) 32 kbps
    (b) 8 kbps
    (c) 24 kbps
    (d) 64 kbps

14. For an ideal $\mathbf{3000}\ \boldsymbol{Hz}$ channel, the **S/N ratio** is:
    (a) 3
    (b) 1.5
    (c) 4
    (d) 2

15. An antenna has a resistance of $\mathbf{50}\ \boldsymbol{ohm}$ and an equivalent noise resistance of $\mathbf{30}\ \boldsymbol{ohm}$. The noise figure in decibels is:
    (a) 1.61 dB
    (b) 2.04 dB
    (c) 3.60 dB
    (d) 6.36 dB

16. A tuned radio frequency receiver has its bandwidth $\mathbf{10}\ \boldsymbol{kHz}$ at the tuned frequency $\mathbf{1100}\ \boldsymbol{kHz}$. The quality factor or the selectivity of the receiver is:
    (a) 110
    (b) 11
    (c) $\frac{1}{110}$
    (d) $\frac{110}{\sqrt{2}}$

17. A message signal with its amplitude uniformly distributed between $-\mathbf{2}\boldsymbol{V}$ and $+\mathbf{2}\boldsymbol{V}$ is transmitted by an 8-bit binary PCM system. The $(\boldsymbol{SNR})_{\boldsymbol{q}}$ would be:
    (a) 37.8 dB
    (b) 49.8 dB
    (c) 43.8 dB
    (d) 25.8 dB

18. For an 8-PSK system, operating with an information bit rate of $\mathbf{24}\ \boldsymbol{kbps}$, the Baud rate will be:
    (a) 16000
    (b) 12000
    (c) 8000
    (d) 6000

19. Typical power factor of Incandescent lamps is:
    (a) 0.5 lagging
    (b) 0.5 leading
    (c) 1
    (d) 0.6 lagging

20. Twelve $\mathbf{1\ \Omega}$ resistors are used as edge to form a cube. The resistance between two diagonally opposite corners of the cube is -
    (a) $\mathbf{5/6\ \Omega}$
    (b) $\mathbf{6/5\ \Omega}$
    (c) $\mathbf{1\ \Omega}$
    (d) $\mathbf{5\ \Omega}$

21. Which of the following cells produces a highly stable voltage?
    (a) Weston cell
    (b) Leclanché cell
    (c) Both (a) and (b)
    (d) None of the above

22. A charge $\boldsymbol{Q}$ is located at $(\mathbf{0,0,3})$ and $\boldsymbol{-Q}$ is located at $(\mathbf{0,0,-3})$. The electric field intensity $(\boldsymbol{E})$ at the point $(\mathbf{4,0,0})$ is:
    (a) Negative x-Direction
    (b) Positive y-Direction
    (c) Positive z-Direction
    (d) Negative z-Direction

23. The mathematical expression of the Gauss's Law indicates that:
    (a) The total flux passing through a closed surface is equal to the $\frac{1}{\epsilon_0}$ times the total charge enclosed by the surface.
    (b) The total flux passing through a closed surface is equal to $\frac{1}{2\epsilon_0}$ times the total charge enclosed by the surface.
    (c) The total flux passing through a closed surface is equal to $\frac{1}{3\epsilon_0}$ times the total charge enclosed by the surface.
    (d) The total flux passing through a closed surface is equal to $\mathbf{2}\epsilon_0$ twice of the total charge enclosed by the surface.

24. Two charges are placed at a distance apart. Now, if a glass slab is inserted between them, then the force between the charges would _____
    (a) reduce to zero
    (b) increase
    (c) decrease
    (d) not change

25. Poynting vector gives the _____
    (a) rate of energy flow
    (b) intensity of the electric field
    (c) intensity of magnetic field
    (d) direction of polarization

26. The frequencies in ultra-high frequency range propagate through:
    (a) Sky wave
    (b) Space wave
    (c) Surface wave
    (d) Ground wave

27. If r is the radius of a circular orbit then the orbital period of the satellite is directly proportional to:
    (a) $r^{3/2}$
    (b) $r^{1/3}$
    (c) $r^{1/2}$
    (d) $r^{2/3}$

28. **If I(s) = (s2 + 8s + 8)/ (s2 + 4s), The final value of the signal i(t) is:**
    (a) 1
    (b) 2
    (c) 4
    (d) 8

29. The delay time for a system having a unit step response $c(t) = 1 - e^{-2t}$ is:
    (a) 0.693
    (b) 0.173
    (c) 0.086
    (d) 0.346

30. An impulse response of a causal system is 5. The step response of the system will be :
    (a) 5 u(t)
    (b) 5t u(t)
    (c) 5(1-e-10t)
    (d) 0.5(11- e-10t)

31. The unit step error coefficient of a system $G(s) = \frac{1}{\{(s+6)(s+1)\}}$ with unity feedback is:
    (a) 1
    (b) $1/6$
    (c) 0
    (d) ∞

32. Find the damping ratio of a 2nd order underdamped impulse response $e(t) = 1.8e^{-8t} \sin 6t$
    (a) 0.707
    (b) 0
    (c) 0.8
    (d) 1

33. The steady-state error due to step and ramp inputs for a Type-1 system are _____ respectively.
    (a) $zero$ and 1
    (b) $zero$ and $^1/_{K_v}$
    (c) $zero$ and K_v
    (d) $infinite$ and $^1/_{K_v}$

34. A system with gain margin close to unity or a phase margin close to zero is:
    (a) Conditionally stable
    (b) Relatively stable
    (c) Highly stable
    (d) Highly oscillatory

35. While forming a Routh array, the situation of a row of ***zeroes*** indicates that the system
    (a) has symmetrically located roots
    (b) is stable
    (c) is insensitive to variations in gain
    (d) has asymmetrically located roots

36. Which of the following is the best method to determine the stability and the transient response of the system?
    (a) Routh-Hurwitz criterion
    (b) Bode plot
    (c) Nyquist plot
    (d) Root locus

37. The op-amp can amplify _____
    (a) AC signals only
    (b) DC signals only
    (c) both AC and DC signals
    (d) neither AC nor DC signals

38. Frequency compensation is used in op-amps to improve its:
    (a) Stability
    (b) Frequency gain
    (c) Amplitude gain
    (d) Power consumption

39. An ideal differential amplifier has a CMRR equalling:
    (a) $Unity$
    (b) -1
    (c) ∞
    (d) $Zero$

40. A virtual ground in an op-amp is a ground for:
    (a) Voltage only
    (b) Current only
    (c) Both voltage and current
    (d) None of these

41. The gain stability of an amplifier can be improved by using:
    (a) Positive feedback
    (b) Negative feedback
    (c) Both positive and negative feedback
    (d) None of these

42. The transfer function of a system is given by $H(s) = \frac{a_1 s^2 + b_1 s + c_1}{a_2 s^2 + b_2 s + c_2}$. If $a_1 = b_1 = 0$, and all the other coefficients are positive, then the transfer function represents a:
    (a) High pass filter
    (b) Notch filter
    (c) Low pass filter
    (d) Band pass filter

43. A system described by y(t) = x(et) is:
    (a) Linear and Causal
    (b) Non-linear and Non-Causal
    (c) Linear and Non-Causal
    (d) Non-linear and Causal

44. The value of the autocorrelation function for a power signal at zero-lag ($\tau = 0$) is equal to
    (a) the mean value of that signal
    (b) the average power of that signal
    (c) the average voltage of that signal
    (d) zero

45. The wave shape of a standard lightning impulse voltage wave is given by _____
    (a) $\frac{1}{50}\mu s$
    (b) $\frac{1.2}{25}\mu s$
    (c) $\frac{1}{25}\mu s$
    (d) $\frac{1.2}{50}\mu s$

46. Which one of the following statements is correct?
    (a) An LTI system is said to be causal if and only if its impulse response is non-zero for negative values of n.
    (b) An LTI system is said to be causal if and only if its impulse response is non-zero for positive values of n.
    (c) An LTI system is said to be causal if and only if its impulse response is zero for negative values of n.
    (d) An LTI system is said to be causal if and only if its impulse response is zero for positive values of n.

47. Fourier Transform of a complex signal $x(t) = e^{j\omega ot}$ is :
    (a) An Impulse function
    (b) A rectangular Gate function
    (c) Impulse Train
    (d) Constant function

48. Which of the following modulation techniques uses the sampling theorem?
    (a) Pulse Code Modulation (PCM)
    (b) Amplitude Modulation (AM)
    (c) Frequency Modulation (FM)
    (d) Phase Modulation (PM)

49. The effective value of a periodic signal is its _____
    (a) Average Value
    (b) Maximum Value
    (c) Root Mean Square Value
    (d) Peak – Peak Value

50. If a signal is folded about the origin in time-domain then its:
    (a) Phase spectrum undergoes change in sign and magnitude spectrum remains unchanged.
    (b) Phase spectrum remains unchanged and magnitude spectrum undergoes change in sign.
    (c) Both phase spectrum and magnitude spectrum remain unchanged.
    (d) Both phase spectrum and magnitude spectrum undergo change in sign.

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.*
- *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.*

[5 x 10 = 50]

51. State and prove the initial and final value theorem for $\boldsymbol{Z}$ transform.

52. Prove that power of energy signal is zero over infinite time.

53. Explain the principle of linearity of DT system.

54. Discuss the working of a Digital Storage Oscilloscope (DSO) with its block diagram.

55. Define pinch-off voltage. In an n-channel FET, why do the depletion regions not touch each other at pinch-off voltage?

56. Simplify the Boolean expression $\boldsymbol{F(A,B,C) = AB + BC + A'}$ using K- Map.

57. Define ASM and FSM.

58. Draw and explain block diagram of Moore model and Mealy model.

59. Write the difference between ripple counter and synchronous counter.

60. Design a mod-11 ripple up-counter using T-Flip Flop.

61. Why is energy conservation important? Explain different schemes / initiatives started by the Government to conserve energy.

62. Describe the working principle of Automatic Power Factor Controller and its importance. What are the effects of poor power factor on energy efficiency?

63. What is pulse code modulation (PCM)? Explain briefly the generation and detection of PCM.

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.***
- ***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.***

[10 x 5 = 50]

64. Explain single phase circuits with relevant diagrams.

65. Explain Star and Delta connected three-phase balanced circuits.

66. Write Short notes on any two the following:

    (a) Auadag in CRT

    (b) Lissajous Pattern

    (c) Deflection Sensitivity and Deflection Factor

67. Explain the working of a DSB-SC modulator and demodulator?

68. Calculate the SNR for single sideband suppressed carrier system.

69. Derive the expression for step response (underdamped case) of a second order control system.

70. What is a lag compensator? What are the characteristics of lag compensation? Explain the frequency response of a lag compensator system.

71. Discuss the structure of Smith chart. How is it used for measurement of impedances and VSWR?

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.*

[25 x 2 = 50]

72. Derive the relation between reflection coefficient and voltage standing wave ratio (VSWR). What would the input impedance of transmission line be when output impedance is shorted?

73. Show that the most economical size of conductor in a single core cable is obtained when radius of cable sheath (R) equals $e.r$ where 'e' is the base of natural log and 'r' is the radius of conductor. Explain dielectric loss and heating of a cable.

74. Find the inductance per phase of a symmetrically-spaced double-circuit 3-phase line.

75. Describe with a neat circuit diagram, a 3-phase commutated current source inverter.

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