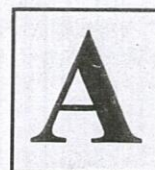


DO NOT OPEN THIS TEST BOOKLET TILL YOU ARE ASKED TO DO SO.

TR/TES/Elect-I/M/Degree-V(A)/24

Test Booklet Series

**TEST BOOKLET
ELECTRICAL ENGINEERING
PAPER-I**



(Signature of the Candidate)

(Invigilator's Signature)

Time allowed – 3 hours (Three hours)

Maximum Marks – 200

INSTRUCTIONS

1. IMMEDIATELY BEFORE THE COMMENCEMENT OF THE EXAMINATION, YOU SHOULD CHECK THAT THIS TEST BOOKLET DOES NOT HAVE ANY UNPRINTED OR TORN OR MISSING PAGES OR ITEMS ETC. IF SO, GET IT REPLACED BY TEST BOOKLET OF SAME SERIES.
2. ENCODE CLEARLY THE TEST BOOKLET SERIES IN THE OMR ANSWER SHEET ONLY IN THE APPROPRIATE PLACE IN THE ANSWER SHEET BY BLACK BALL POINT PEN ONLY.
3. This Test Booklet is divided into three SECTIONS i.e. SECTION-A, SECTION-B and SECTION-C.
 - (A) SECTION-A (MCQ Pattern) contains 40 items (questions). Each question carrying 2(two) marks only, has four responses (answers). You will select the response which you want to mark on the OMR Sheet. In case you feel that there is more than one correct response, mark the response which you consider the most appropriate. In any case, choose ONLY ONE response for each item.
 - (B) Questions under SECTION-B (Conventional method) and SECTION-C (Conventional method) are to be answered in separate Answer Book.
4. You have to mark all your responses of SECTION-A Black Ball Point Pen only on the separate OMR Answer Sheet provided. See directions in the Answer Sheet.
5. Before you proceed to mark in the Answer Sheet the responses to various items of SECTION-A in the Test Booklet, you have to fill in some particulars on the Answer Sheet.
6. On Completion of the Examination, you should handover the OMR Answer Sheet for SECTION-A and Answer Book for SECTION-B and C to the invigilator only. You are permitted to take the Test Booklet with you.
7. Sheets for rough work are appended on the Test Booklet at the end.
8. **Instructions for wrong and multiple answer(s) SECTION-A :**
 - (a) There will be four alternatives for the answer to every question. However there will be no negative marking for wrong answer.
 - (b) 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.

DO NOT OPEN THIS TEST BOOKLET TILL YOU ARE ASKED TO DO SO.

INSTRUCTIONS

1. There are a total of 60 questions. Q. Nos. 1-40 in **SECTION-A** are Multiple Choice Questions having 2 marks each.
2. In **SECTION-B**, there are 15 questions. Q. Nos. 41-55 of 6 marks each, answers to which is restricted to 40 words each.
3. In **SECTION-C**, there are 5 numerical questions. Q. Nos. 56-60 of 6 marks each.
4. All symbols used in the questions have their usual meanings.

SECTION—A

Example : Poise is the unit of

- | | |
|---|-------------------------|
| (A) Surface tension | (B) Buoyant force |
| ☒ (C) Coefficient of viscosity | (D) Gravitational force |

Answer : ☒ (C) Coefficient of viscosity.

- Choose the correct answer of the following :

$$2 \times 40 = 80$$

1. If $10 \text{ kV} = x\text{TV}$, then $x =$

- | | |
|----------------|----------------|
| (A) 10^{-6} | (B) 10^{-8} |
| (C) 10^{-11} | (D) 10^{-14} |

2. In Mason's gain rule given as : $M = \frac{1}{\Delta} \sum_{k=1}^N P_k \Delta_k$, N is the total number of

- | | |
|----------------------|------------------------|
| (A) individual loops | (B) non-touching loops |
| (C) nodes | (D) forward paths |

3. Moving iron ammeters can be used without a shunt upto a current range of

- | | |
|-----------|-----------|
| (A) 20 mA | (B) 50 mA |
| (C) 20 A | (D) 50 A |

4. The Poisson's ratio for all metals is between
- (A) 0 and 50 (B) 0 and 5
(C) 0 and 0.5 (D) 0 and 0.05
5. In a series R-L-C circuit, at frequencies below resonance, the power factor is
- (A) always leading (B) always lagging
(C) always unity (D) can be either leading or lagging
6. In a storage tank hydraulic system, with tank's sides being vertical, the hydraulic capacitance (C) is given in terms of the surface area of tank's bottom (A), liquid density (ρ), and acceleration due to gravity (g), as
- (A) $C = \frac{A}{\rho g}$ (B) $C = \frac{A\rho}{g}$
(C) $C = \frac{\rho}{Ag}$ (D) $C = \frac{g}{A\rho}$
7. Eddy current damping torque (T_D) of a metallic former is related to the resistivity (ρ) of the material of the former and the angular speed (ω) of the former, as
- (A) $T_D \propto \rho$ and $T_D \propto 1/\omega$ (B) $T_D \propto \omega$ and $T_D \propto 1/\rho$
(C) $T_D \propto \rho$ and $T_D \propto \omega$ (D) $T_D \propto 1/\rho$ and $T_D \propto 1/\omega$
8. The unit of dipole moment per unit volume is
- (A) Coulomb (B) Coulomb/metre
(C) Coulomb/metre² (D) Coulomb/metre³

9. The Laplace Transform pair of $\lim_{t \rightarrow 0} f(t)$ is

(A) $\lim_{s \rightarrow 0} sF(s)$

(B) $\lim_{s \rightarrow 0} F(s)$

(C) $\lim_{s \rightarrow \infty} sF(s)$

(D) $\lim_{s \rightarrow \infty} F(s)$

10. In mechanical system models, the unit of damping coefficient is

(A) Newtons/m

(B) Newtons/(m/sec)

(C) Newtons/(m/sec²)

(D) Newtons/(m²/sec)

11. The total susceptance B of a parallel R-L-C circuit is

(A) $\frac{1}{X_C} - \frac{1}{X_L}$

(B) $\frac{1}{X_C} + \frac{1}{X_L}$

(C) $X_C - X_L$

(D) $X_C + X_L$

12. Wagner earthing devices are used in bridge networks to eliminate the effects of

(A) inter-turn capacitances only

(B) earth capacitances only

(C) both inter-turn and earth capacitances

(D) None of these

13. The susceptibility of a diamagnetic material is near about

(A) 10^5

(B) -10^5

(C) 10^{-5}

(D) -10^{-5}

14. In an AC servomotor, to make the system less susceptible to low-frequency noise, the minimum frequency of the reference phase supply should be chosen as

(A) 100 Hz

(B) 250 Hz

(C) 400 Hz

(D) 1000 Hz

15. Laplace transform of $\sin at$ is

(A) $\frac{a}{s^2 - a^2}$

(B) $\frac{a}{s^2 + a^2}$

(C) $\frac{s}{s^2 - a^2}$

(D) $\frac{s}{s^2 + a^2}$

16. The basic circuit of a balanced bridge triode vacuum tube voltmeter contains

(A) one triode tube and a PMMC meter

(B) one triode tube and a moving iron meter

(C) two triode tubes and a PMMC meter

(D) two triode tubes and a moving iron meter

17. Which of the following statements about the equivalent resistance (R) of three resistors (R_1, R_2, R_3) connected in parallel is always true?

(A) $R < \text{smallest among } (R_1, R_2, R_3)$

(B) $(R > \text{smallest among } (R_1, R_2, R_3)) \text{ and } (R < \text{largest among } (R_1, R_2, R_3))$

(C) $R > \text{largest among } (R_1, R_2, R_3)$

(D) R can have any value

18. Introduction of integral control for a type 1 system leads to

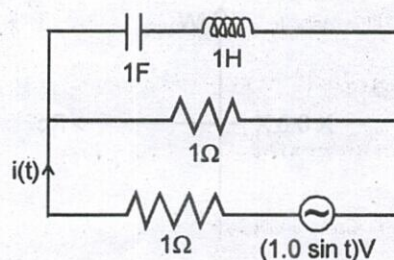
(A) decreasing the type of the system by one

(B) keeping the type of the system unchanged

(C) increasing the type of the system by one

(D) None of these

19. Which of the following statements is incorrect about a volt-ratio box ?
- (A) It is used to increase the voltage range of measurement of a DC potentiometer
 - (B) Its resistance cannot be chosen high because of instability problems
 - (C) Its resistance cannot be chosen low to keep the power consumption low
 - (D) Its resistance cannot be chosen low as it reduces galvanometer sensitivity
20. Ferrites have
- (A) low dielectric loss and small permeability
 - (B) low dielectric loss and large permeability
 - (C) high dielectric loss and small permeability
 - (D) high dielectric loss and large permeability
21. A balanced load of $5 + j4$ is connected in delta. What is the impedance per phase of the equivalent star connection ?
- (A) $5 + j4$
 - (B) $1.66 + j1.33$
 - (C) $15 + j12$
 - (D) $2.5 + j2$
22. The rms value of the current $i(t)$ in the circuit shown in the figure below is



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

23. In a series resonance circuit, at resonance, selectivity Q is equal to

- (A) $\frac{1}{R\sqrt{LC}}$ (B) $\frac{1}{R}\sqrt{\frac{C}{L}}$
(C) $\frac{1}{R}\sqrt{\frac{L}{C}}$ (D) $\frac{1}{R}\sqrt{LC}$

24. To detect the position error in a Position Control System which of the following may be used ?

1. Potentiometers 2. Synchros
3. LVDT

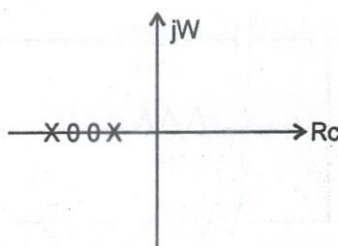
Select the correct answer.

- (A) 1 and 2 only (B) 1 and 3 only
(C) 2 and 3 only (D) 1, 2 and 3.

25. What is represented by State Transition Matrix of a system ?

- (A) Free response (B) Impulse response
(C) Step response (D) Forced response

26. The Pole zero plot shown in the figure is that of which one of the following ?



- (A) PD controller (B) Log-lead compensator
(C) Integrator (D) PID controller

27. Root locus of $S(s+2) + K(s+4) = 0$ is a Circle. What are the co-ordinates of the centre of this Circle?

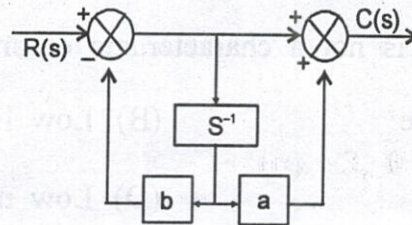
(A) -2, 0

(B) -3, 0

(C) -4, 0

(D) -5, 0

28. What is the transfer function $C(s)/R(s)$ for the system as shown in figure below?



(A) $\frac{s+a}{s-b}$

(B) $\frac{s+a}{s+b}$

(C) $\frac{s-b}{(s+a)}$

(D) $\frac{s+b}{s+a}$

29. The transfer function of zero Order Hold is

(A) $1 - e^{-Ts}$

(B) $1 - e^{-Ts}$

(C) $\frac{1 - e^{-Ts}}{s}$

(D) $\frac{1 - e^{-Ts}}{s}$

30. What will be the gain margin in dB of the system having the following open-loop transfer function?

$$G(s).H(s) = \frac{2}{s(s+1)}$$

(A) ∞

(B) 0

(C) $\frac{1}{2}$

(D) 2

31. The Phase cross-over frequency of the transfer function $G(s) = \frac{100}{(s+1)^3}$ in rad/s is
- (A) $\sqrt{3}$ (B) $\frac{1}{\sqrt{3}}$
(C) 3 (D) $3\sqrt{3}$
32. Which of the following is not a characteristic of an ideal transducer?
- (A) High dynamic range (B) Low linearity
(C) High repeatability (D) Low noise
33. Which of the following is a digital transducer?
- (A) Strain gauge (B) LVDT
(C) Thermistor (D) Encoder
34. A thermometer has a resistance of 125 ohm at 20°C. Determine the value of resistance at -50°C. If sensitivity is 0.2 ohm/°C.
- (A) 111 ohm (B) 139 ohm
(C) 131 ohm (D) 119 ohm
35. The 0-10 V A/D converter has to have a resolution of 0.025%. Find the r.m.s. value of quantization error.
- (A) 176 μ V (B) 352 μ V
(C) 705 μ V (D) 1410 μ V

36. Which component is not used in smart DAQ ?

(A) ADC

(B) MUX

(C) S/H

(D) None of these

37. A barium titanate crystal has a thickness of 2 mm. Its voltage sensitivity is 0.012 Vm/N. It is subjected to a pressure of 0.5 MN/(mm). Calculate the voltage generated.

(A) 3V

(B) 6V

(C) 12V

(D) 5V

38. The sensitivity factor of semiconductor strain gauge is normally of the order of

(A) 1 – 1.5

(B) 1.5 – 2

(C) 0.5 – 1

(D) 150 – 200

39. Which is not a type of ADC ?

(A) Ramp Type

(B) R-2R Type

(C) Flash Type

(D) Dual Slope Type

40. Energy meter is _____ type of the instrument.

(A) Intergrating

(B) Indicating

(C) Recording

(D) Comparison type.

SECTION – B

● Answer *all* questions :

6×15=90

41. In root locus technique, how is the angle of arrival of a locus at a complex zero computed ?
42. “For a two-port network, if the z-parameters are known, we can directly obtain the open-circuit voltage transfer function but we cannot obtain the short-circuit current transfer function.”– Justify or correct this statement citing suitable reasons.
43. Why and how turns compensation is carried out in current transformers ?
44. “Both diamagnetism and paramagnetism exist for all systems containing electrons.”– Justify or correct this statement citing suitable reasons.
45. How a rotating magnetic field is created in an AC servomotor ?
46. What happens when a DC voltage source is connected with a current source (i) in series and (ii) in parallel ?
47. Why are spark gaps employed in a high voltage Schering bridge ?
48. What are the conditions to be met when Ampere’s law is utilized to determine H and how is a path selected meeting these conditions ?
49. Why and how is similarity transformation employed in state variable based representation of the dynamics of a system ?

50. For a vector field A , show explicitly that $\nabla \cdot \nabla \times A = 0$; that is divergence of the curl of any vector field is zero.
51. State and explain Gauss's Law. Derive an expression for the potential at a point outside a hollow sphere having a uniform charge density.
52. Define Hall effect and discuss its application for Flux Density Measurement.
53. Distinguish Ferro and Ferri magnetism of the magnetic material, and what are their applications.
54. Find the range of value of 'a' so that $P(s) = s^4 + s^3 + as^2 + 2s + 3$ is Hurwitz.
55. Explain the working of PC based Data Acquisition system with the help of suitable diagram.

SECTION - C

- Answer *all* questions :

6×5=30

56. In a circuit, a $6 \mu\text{F}$ capacitor is connected in parallel with a coil, having a resistance of 60Ω in series with an inductance of 0.35 H . Determine the supply current and the current in each branch, in resonance condition, when the voltage applied to this circuit is 230 V .
57. Prove that, in designing a permanent magnet, the minimum volume of the magnetic material required is inversely proportional to the quantity $(-H_m B_m)$.
58. For a unity-feedback system with open-loop transfer function $G(s) = \frac{1}{s(0.8s+1)(0.6s+1)}$, determine the steady-state errors to unit-step, unit-ramp, and unit-parabolic inputs.
59. A strain gauge having a resistance of 100Ω and a gauge factor of 2.4 is subjected to $(25 + 20 \sin 314t)$ micro-strain. Find the expression for the output voltage when the strain gauge is connected in one arm of Wheatstone bridge having resistance of 100Ω and an input voltage of 10 V .
60. Obtain the time response of the following system : $\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u$ where $u(t)$ is a unit step occurring at $t=0$ and $x^T(0) = [1 \ 0]$.

(Space for rough work)