

SEAL

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Invigilator's signature

Question Booklet No.

200397

J/EE/R EXAM

2020

ELECTRICAL ENGINEERING

Time : 2 Hours

Maximum Marks : 200

ROLL NO.

INSTRUCTIONS FOR CANDIDATES

1. This Test Booklet consists of two parts—PART-I (Objective) contains 50 multiple choice questions carrying 2 marks each and PART-II (Subjective) is of 100 marks.
2. In PART-I (Objective) each question contains four responses. Choose only one correct answer for each question and darken the bubble on the OMR RESPONSE SHEET. In PART-II (Subjective), answer all questions. Each question carries 20 marks.
3. DO NOT write your Name or anything else except Roll No. and the actual answer to the question, anywhere on the OMR RESPONSE SHEET.
4. DO NOT handle your OMR RESPONSE SHEET in such a manner as to mutilate, fold, etc.
5. Entry into the examination venue shall be closed **10 minutes** before the scheduled commencement of the Examination, i.e. 8:50 AM for Forenoon session and 12:50 PM for the Afternoon session.
6. No candidate shall have in his/her possession, inside the Examination Hall, any book, notebook or loose paper, calculator, mobile phone etc., except his/her Admit Card and other things permitted by the Commission.
7. Immediately after the final bell indicating the closure of the Examination, stop bubbling. Be seated till the OMR RESPONSE SHEET is collected by the Invigilator. Thereafter you may leave the Examination Hall.
8. Violation of any of the above rules will render the candidate liable to expulsion from the examination and disqualification from the examination, and according to the nature and gravity of his/her offence, he/she may be debarred from future examinations and interviews to be conducted by the Commission and other such organizations (i.e. UPSC, SSC and SPSCs).

NB: CANDIDATES ARE ALLOWED TO TAKE THIS QUESTION BOOKLET ONLY AFTER COMPLETION OF 2 (TWO) HOURS EXAMINATION TIME

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SEAL

PART—I

(Objective)

1. The quantum numbers associated with electron motion are designed as
 - [A] h, k, l
 - [B] a, b, c
 - [C] n, m, l
 - [D] h, n, l
2. Materials which lack permanent magnetic dipoles are known as
 - [A] paramagnetic
 - [B] diamagnetic
 - [C] ferromagnetic
 - [D] ferrimagnetic
3. The accuracy of an instrument is measured in terms of its
 - [A] true value
 - [B] error
 - [C] sensitivity
 - [D] drift
4. A basic slide wire potentiometer is used for measurement of current in a circuit. The voltage drop across a standard resistor of 0.1Ω is balanced at 75 cm. If a standard cell of e.m.f. 1.45 V is balanced at 50 cm, then the magnitude of the current through the resistor is
 - [A] 29 A
 - [B] 21.70 A
 - [C] 21.75 A
 - [D] 29.72 A
5. Semiconducting materials are all
 - [A] elements
 - [B] compounds
 - [C] elements or compounds
 - [D] elements or mixtures
6. After the application of an input to an indicating instrument, the pointer moves and then it comes to rest at a position where
 - [A] the deflecting force is balanced by the controlling force
 - [B] the deflecting force is balanced by the damping force
 - [C] the damping force is balanced by the controlling force
 - [D] the sum of all forces is equal to zero

7. Maxwell's inductance-capacitance bridge is used for the measurement of inductance of

- [A] low Q coils
- [B] medium Q coils
- [C] high Q coils
- [D] low and medium Q coils

8. Magnetic hysteresis phenomenon is explained by

- [A] motion of domain walls
- [B] domain rotation
- [C] motion of domain walls and domain rotation
- [D] motion of electron

9. The dielectric loss of a capacitor can be measured by

- [A] Maxwell bridge
- [B] Owen's bridge
- [C] Wien bridge
- [D] Schering bridge

10. The colour code on a carbon resistor is red-red-black-silver. The value of resistor is

- [A] 22000 Ω
- [B] 2200 Ω
- [C] 22 \pm 5% Ω
- [D] 22 \pm 10% Ω

11. The controlling torque in single-phase power factor meters is provided by

- [A] spring control
- [B] gravity control
- [C] stiffness of suspension
- [D] Both [A] and [B]

12. Sulphur hexafluoride is used in

- [A] transformers
- [B] generators
- [C] circuit breakers
- [D] relays

13. An alternator is being synchronized to the busbars whose frequency is 50 Hz. The bulb of the synchroscope flickers at a frequency of 10 Hz. The frequency of the alternator is

- [A] 60 Hz
- [B] 40 Hz
- [C] 50 Hz
- [D] 60 Hz or 40 Hz

14. The ratio of change in output signal to a change in the input quantity is defined as

- [A] sensitivity
- [B] efficiency
- [C] accuracy
- [D] resolution

15. By inserting a dielectric material between the plates of a parallel plate capacitor, the energy stored in the capacitor is increased five times. The dielectric constant of the material inserted between the plates is

- [A] $1/25$
- [B] $1/5$
- [C] 5
- [D] 25

16. Ferrites have

- [A] low copper loss
- [B] low eddy current loss
- [C] low resistivity
- [D] low copper loss and high eddy current loss

17. The damping of a ballistic galvanometer is kept small to get

- [A] critically damped system
- [B] minimum overshoot
- [C] first deflection small
- [D] first deflection large

18. In a piezoelectric crystal, the application of mechanical force will cause

- [A] plastic deformation of the crystal
- [B] magnetic dipoles in the crystal
- [C] electrical polarization in the crystal
- [D] shift in Fermi level

19. Superposition theorem can be applied in a linear circuit to calculate the

- [A] voltage and power
- [B] voltage and current
- [C] current and power
- [D] voltage, current and power

20. In case of flux meter, which of the following statements is true?

- [A] Controlling torque is provided by spring.
- [B] It has heavy electromagnetic damping and very small controlling torque.
- [C] Controlling torque is provided by weight attached to the moving coil.
- [D] It has small electromagnetic damping and small controlling torque.

21. An equivalent circuit consists of a 2 A current source in parallel with a $5\ \Omega$ resistor. Thévenin's equivalent of this circuit is a

- [A] 10 V voltage source in series with a $5\ \Omega$ resistor
- [B] 5 V voltage source in series with a $2\ \Omega$ resistor
- [C] 5 V voltage source in parallel with a $2\ \Omega$ resistor
- [D] 10 V voltage source in parallel with a $5\ \Omega$ resistor

22. Wagner's earthing in a.c. bridge is required

- [A] to eliminate the effect of stray electromagnetic field
- [B] to eliminate the effect of earth capacitance
- [C] to eliminate the effect of intercomponent capacitance
- [D] All of the above

23. In a two-element series circuit, the applied voltage and resultant current are respectively

$$v(t) = 20 \sin \omega t \text{ V and}$$

$$i(t) = 10 \sin(\omega t - 60^\circ) \text{ A}$$

The nature of the elements in the circuit would be

- [A] R-L
- [B] R-C
- [C] L-C
- [D] R only

24. High frequency inductors are commonly plated with silver. The main purpose of this is to

- [A] reduce d.c. resistance
- [B] reduce a.c. resistance
- [C] increase d.c. resistance
- [D] increase a.c. resistance

25. The maximum power that a 6 V d.c source with an internal resistance of 1Ω can supply to a resistive load is
- [A] 6 W
 - [B] 9 W
 - [C] 18 W
 - [D] 24 W
26. The range of a voltmeter can be increased by connecting a
- [A] low resistance in series with the voltmeter
 - [B] low resistance in parallel with the voltmeter
 - [C] high resistance in series with the voltmeter
 - [D] high resistance in parallel with the voltmeter
27. Which of the following equations summarizes the laws of electromagnetic induction?
- [A] $e = IR$
 - [B] $e = L \frac{di}{dt}$
 - [C] $e = -\frac{dv}{dt}$
 - [D] $e = \frac{1}{C} \int i dt$
28. An air gap is usually inserted in magnetic circuit so as to
- [A] prevent saturation
 - [B] increase in mmf
 - [C] increase in flux
 - [D] increase in inductance
29. The d.c. motor most suitable for applications requiring high starting torque is
- [A] shunt
 - [B] series
 - [C] cumulative compound
 - [D] differential compound
30. In the interval $0 \leq t \leq \left(\frac{\pi}{50}\right)$ s, an inductance of 30 mH has a current $i = 10 \sin 50t$ A. At all other times the current is zero. The voltage across the inductance is
- [A] 75 sin 100t V
 - [B] 10 sin 50t V
 - [C] 15 cos 50t V
 - [D] 75 cos 50t V

31. The rated voltage of a 3-phase balanced system is given as

- [A] rms phase voltage
- [B] peak phase voltage
- [C] rms line-to-line voltage
- [D] peak line-to-line voltage

32. DC shunt motors are used for driving

- [A] machine tools
- [B] lathes
- [C] centrifugal pumps
- [D] All of the above

33. Three equal impedances of value Z_Y each are connected in Y. The equivalent Δ impedances of value Z_Δ each is given by

- [A] $Z_\Delta/Z_Y = 3$
- [B] $Z_Y/Z_\Delta = 3$
- [C] $(Z_\Delta + Z_Y)/Z_Y = 3$
- [D] $(Z_\Delta + Z_Y)/Z_\Delta = 3$

34. The power factor in an $R-L-C$ series circuit will be lagging if

- [A] $\omega L > \frac{1}{\omega C}$
- [B] $\omega L < \frac{1}{\omega C}$
- [C] $\omega L = \frac{1}{\omega C}$
- [D] $\omega L = \omega C$

35. When one coil of a magnetically coupled pair has a current 5 A, the resulting fluxes ϕ_{11} and ϕ_{12} are 0.2 mWb and 0.4 mWb respectively. If the turns are $N_1 = 500$ and $N_2 = 1500$, then the coefficient of coupling is

- [A] 0.866
- [B] 0.887
- [C] 0.97
- [D] 0.667

36. The component of a d.c. generator which plays vital role in providing d.c. is

- [A] brush
- [B] armature winding
- [C] commutator
- [D] field winding

37. The flux created by the current flowing through the primary winding of a transformer induces e.m.f. in
- [A] primary winding only
 - [B] secondary winding only
 - [C] both primary and secondary windings
 - [D] core only
38. The current drawn by a 120 V d.c. motor of armature resistance 0.4Ω and back e.m.f. 112 V is
- [A] 20 A
 - [B] 28 A
 - [C] 30 A
 - [D] 18 A
39. Dummy coils in d.c. machines are used to
- [A] increase the efficiency
 - [B] reduce the cost of the machine
 - [C] maintain mechanical balance of the armature
 - [D] improve the commutation
40. In a series $R-L-C$ resonance circuit
- [A] voltage amplitude is maximum
 - [B] current amplitude is maximum
 - [C] impedance of the circuit is maximum
 - [D] All of the above
41. In d.c. machine, armature is laminated to reduce
- [A] copper loss
 - [B] iron loss
 - [C] eddy current loss
 - [D] All of the above
42. The bandwidth of a series $R-L-C$ circuit depends on
- [A] C only
 - [B] R only
 - [C] L only
 - [D] quality factor
43. Waveform of armature mmf in d.c. machine is
- [A] square
 - [B] triangular
 - [C] rectangular
 - [D] sinusoidal
44. In a transformer, zero voltage regulation at full load is possible
- [A] at unity power factor load
 - [B] at lagging power factor load
 - [C] at leading power factor load
 - [D] All of the above

45. In two-wattmeter method of measurement of power, if the readings of the meters are equal with opposite sign then the power factor of the load is

[A] 0.7

[B] 0.5

[C] unity

[D] zero

46. Which of the following types of generators is used for arc welding purposes?

[A] Series generator

[B] Shunt generator

[C] Cumulatively compounded generator

[D] Differentially compounded generator

47. A single-phase transformer is working at maximum efficiency. If the copper losses are 100 W, then the iron losses would be

[A] 25 W

[B] 50 W

[C] 100 W

[D] 200 W

48. Which of the following is the result of the cross-fertilization between electronics and molecular biology?

[A] ECG machine

[B] EEG machine

[C] EMG machine

[D] Biosensors

49. If the transformation ratio of an ideal two-winding transformer is α , then the transformation ratio of an autotransformer having the same turn ratio as in the two winding transformer is

[A] $\alpha - 1$

[B] $\alpha + 1$

[C] $\alpha + 2$

[D] α

50. The nominal ratio of a current transformer is defined as

[A] rated primary winding current / rated secondary winding current

[B] rated secondary winding current / rated primary winding current

[C] primary winding current / secondary winding current

[D] secondary winding current / primary winding current

PART—II

(Subjective)

1. Show that in a symmetrical balanced 3-phase star-connected system, the line voltage is equal to $\sqrt{3}$ times of phase voltage. A balanced star-connected load of $(8 + j6) \Omega$ per phase is connected to a 3-phase, 230 V, 50 Hz supply. Find the (a) line current and (b) power factor.
2. A 3-phase 440 V, 50 hp, 50 Hz induction motor delivers rated output power at 1440 rpm. Calculate (a) number of poles of the induction machine, (b) synchronous speed and (c) slip.
3. A 3-phase star-connected synchronous generator is rated at 1600 kVA, 13.5 kV. The per phase armature effective resistance and synchronous reactance are 1.5Ω and 30Ω respectively. Calculate voltage regulation for a load of 1.280 MW at a power factor of 0.8 leading.
4. A 3-phase, 50 Hz overhead short transmission line 30 km long has 33 kV between lines and it has the following constants :
Resistance per km per conductor = 0.2Ω
Inductance per km per conductor = 1.8 mH
The load at the receiving end is 3750 kVA and has a power factor of 0.8 lagging.
Determine the receiving end line voltage. Neglect the capacitance of the line
5. A 3-phase fully controlled bridge converter is connected to a resistive load of 100Ω . Input voltage is 400 V (line-to-line). Power supplied to the load is 400 W. Find (a) firing angle and (b) rms value of input current. Assume ripple free load current.