MIZORAM PUBLIC SERVICE COMMISSION

TECHNICAL COMPETITIVE EXAMINATIONS FOR
JUNIOR GRADE OF MIZORAM ENGINEERING SERVICE, P&E CADRE (ELECTRICAL WING)
UNDER POWER & ELECTRICITY DEPARTMENT,
GOVERNMENT OF MIZORAM, JUNE-2022

ELECTRICAL ENGINEERING
PAPER-I

Time Allowed : 3 hours   FM : 200

SECTION - A *(Multiple Choice questions)*
(100 Marks)
All questions carry equal mark of 2 each. Attempt all questions.

*This Section should be answered only on the **OMR Response Sheet** provided.*

1. The electric field on equipotential surface is :
   - (a) Unity
   - (b) Always perpendicular to the surface
   - (c) Always parallel to the surface
   - (d) Zero

2. The magnitude of electric field strength 'E' on a spherical surface of radius 'r' enclosing a charge 'q' is given by the expression :
   - (a) $E = \dfrac{q}{4\varepsilon r^2}$
   - (b) $E = \dfrac{q}{4\pi r^2}$
   - (c) $E = \dfrac{q}{4\pi\varepsilon r^2}$
   - (d) $E = \dfrac{q}{r}$

3. The electric field at the centre of a circular loop of radius 'r' and carrying current 'I' is given by the expression :
   - (a) $\dfrac{I}{r}$
   - (b) $\dfrac{I}{2r}$
   - (c) $\dfrac{I^2}{2r}$
   - (d) $\dfrac{I^2}{2\varepsilon r}$

4. In a conductor the static electric field is :
   - (a) unity
   - (b) always perpendicular to the surface
   - (c) always parallel to the surface
   - (d) zero

5. Select the equation which is not Maxwell :
   - (a) $D = \varepsilon E$
   - (b) $E = \varepsilon D$
   - (c) $J = \sigma E$
   - (d) $B = \mu H$

6. When a charge 'q' moves with velocity 'v' in an electric field 'E' and magnetic field 'B' the Lorentz force 'F' is given by :
   - (a) $F = q E$
   - (b) $F = v B q$
   - (c) $F = q E + v B q$
   - (d) $F = Zero$

7. A uniform plane wave has components :
    (a) E and H existing only in direction perpendicular to direction of propagation
    (b) in the direction of propagation, E existing while H is zero
    (c) in the perpendicular direction, E existing while H is zero
    (d) both E and H existing in all directions

8. The attenuation in wave guide near the cut off frequency is :
    (a) high   (b) low
    (c) zero   (d) negative

9. The relative permeability of paramagnetic materials is :
    (a) very high   (b) slightly more than one
    (c) equal to one   (d) less than one

10. Magnetisation is nonlinearly related to the applied field in case of :
    (a) diamagnetic material   (b) paramagnetic material
    (c) ferromagnetic material   (d) diamagnetic & paramagnetic material

11. In ceramic insulators, glazes are used to improve :
    (a) mechanical properties   (b) chemical properties
    (c) electrical properties   (d) physical properties

12. The impurity atoms in semiconductors :
    (a) reduce the energy gap   (b) increase the kinetic energy of valence electrons
    (c) inject more charge carriers   (d) increase the energy release

13. Fermi energy is the amount of energy which :
    (a) a valence electron can have at room temperature
    (b) must be given to an electron to move it to conduction band
    (c) must be given to a hole to move it to valence band
    (d) a hole can have at room temperature

14. Ceramic loses its insulating properties above a temperature called :
    (a) Melting point   (b) Solidification point
    (c) Curie point   (d) Flash point

15. A capacitor with initial charge q_o at $t=0^+$ acts as a :
    (a) short circuit   (b) open circuit
    (c) current source   (d) voltage source

16. In series as well as parallel resonant circuit, increasing the value of resistance would lead to :
    (a) Increase in band-width of both the circuits
    (b) Decreasing in the band-width of both the circuits
    (c) Increase in band-width in series circuit and decrease in parallel circuit
    (d) decrease in band-width in series circuit and increase in parallel circuit

17. If a capacitor is charged by a square wave current source, the voltage across the capacitor is :
    (a) a square wave   (b) triangular wave
    (c) step function   (d) zero

18. Pick the correct statement.

    (a) Delta connection draws same current as star connection

    (b) Delta connection draws 3 times as much current as star connection

    (c) Delta connection draws $\dfrac{1}{\sqrt{3}}$ times as much current as star connection

    (d) Delta connection draws $\dfrac{1}{3}$ times as much current as star connection

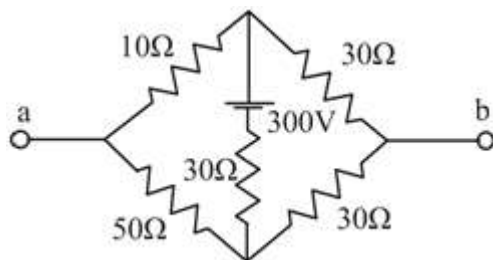**19.** In the given circuit, current I in the 3 ohm resistor is given by :
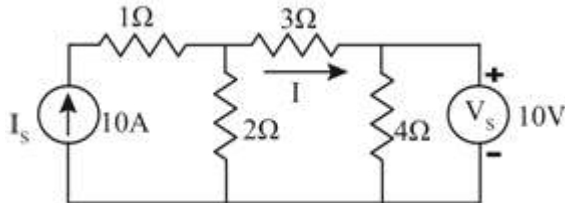
    (a) -2A   (b) 2A

    (c) 4A   (d) 6A

20. In the circuit shown below, when $V_s=0$, $I=3A$. When $V_s=12V$, the value of I becomes:
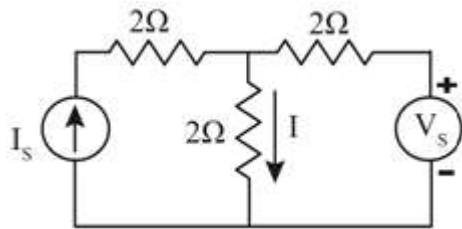
    (a) 3A   (b) 6A

    (c) 7A   (d) 9A

21. The equivalent resistance R_{ab} will be :

    (a) 120 ohm   (b) 150 ohm

    (c) 25 ohm   (d) 30 ohm

22. The current in the RLC series circuit at resonance is :

    (a) maximum   (b) minimum

    (c) infinity   (d) zero

23. Regarding Thevenin equivalent, which of the following is not correct?
    (a) The voltage source in the Thevenin equivalent circuit is the open circuit voltage of the network when load is disconnected.
    (b) The Thevenin equivalent resistance (impedance) is the resistance (impedance) of the network when all voltage sources are short circuited.
    (c) Thevenin equivalent resistance is calculated when all voltage sources are open circuited.
    (d) Thevenin equivalent is the voltage equivalent of the network.

24. The accuracy of moving coil instruments as compare to moving iron instruments is :
    (a) high
    (b) low
    (c) same
    (d) reasonable accurate

25. For increasing the range of an ammeter, connect :
    (a) a high value resistance in series with the ammeter coil
    (b) a high value resistance in parallel with the ammeter coil
    (c) a low value resistance in parallel with the ammeter coil
    (d) a low value resistance in series with the ammeter coil

26. Wattmeter measures :
    (a) apparent power
    (b) true power
    (c) volt ampere
    (d) volt ampere reactive

27. Inductance is measured by :
    (a) Wien bridge
    (b) Schering bridge
    (c) Maxwell's bridge
    (d) Hay bridge

28. In two wattmeter method of measuring 3-phase power, power factor is 0.5, then one of the wattmeter will read :
    (a) $\dfrac{W}{2}$
    (b) Zero
    (c) $\sqrt{2}\, W$
    (d) $\dfrac{W}{\sqrt{2}}$

29. Pick up false statement.
    (a) The degree of closeness with which a given value can be repeatedly measured is called reproducibility
    (b) When for a given input the measured value does not vary with time, it is said to have zero drift
    (c) Any signal conveying no useful information is called noise
    (d) The nature of repeatability is deterministic

30. The Maxwell equation $V x \bar{H} = J + \dfrac{\partial \bar{D}}{\partial t}$ is based on :
    (a) Ampere's law
    (b) Gauss's law
    (c) Faraday's law
    (d) Coulomb's law

31. The depth of penetration of wave in a lossy dielectric increases with increasing :
    (a) Conductivity
    (b) Permeability
    (c) Wavelength
    (d) Permittivity

32. Two semi-infinite dielectric regions are separated by a plane boundary at $y = 0$. The dielectric constants of region 1 ($y < 0$) and region 2 ($y > 0$) are 2 and 5, respectively. Region 1 has uniform electric field $\bar{E} = 3\hat{a}_x + 4\hat{a}_y + 2\hat{a}_z$, where $\hat{a}_x$, $\hat{a}_y$ and $\hat{a}_z$ are unit vectors along the x, y and z axes, respectively. The electric field in region 2 is :

(a) $3\hat{a}_x + 1.6\hat{a}_y + 2\hat{a}_z$　　　　　　　(b) $1.2\hat{a}_x + 4\hat{a}_y + 2\hat{a}_z$

(c) $1.2\hat{a}_x + 4\hat{a}_y + 0.8\hat{a}_z$　　　　　　(d) $3\hat{a}_x + 10\hat{a}_y + 0.8\hat{a}_z$

33. Consider the following statements in connection with boundary relations of electric field:

    i. In a single medium electric field is continuous.

    ii. The tangential components are the same on both sides of a boundary between two dielectrics.

    iii. The tangential electric field at the boundary of a dielectric and a current carrying conductor with finite conductivity is zero.

    iv. Normal component of the flux density is continuous across the charge-free boundary between two dielectrics.

Which of these statements is/are correct?

(a) i only　　　　　　　　　　　　　　　(b) i, ii and iii

(c) i, ii and iv　　　　　　　　　　　　　(d) iii and iv only

34. Fields are said to be circularly polarized if their magnitudes are :

(a) Equal and they are in phase　　　　　　(b) Equal and they differ in phase by $\pm 90^0$

(c) Unequal and they differ in phase by $\pm 90^0$　　(d) Unequal and they are in phase

35. When impurities tend to remain in the liquid rather than the solid, the impurities are :

(a) impossible to remove by normal freezing　　(b) impossible to remove by zone refining

(c) more soluble in the solid than in the liquid　　(d) more soluble in the liquid than in the solid

36. Magnetic susceptibility of an ideal type I superconductor in the superconductivity state is :

(a) $-\infty$　　　　　　　　　　　　　　　(b) -1

(c) Between 0 and -1　　　　　　　　　　(d) Zero

37. Soft iron is used to manufacture electromagnets because it has :

(a) High retentivity　　　　　　　　　　　(b) High coercive field

(c) Low retentivity　　　　　　　　　　　(d) Low coercive field

38. For intrinsic GaAs, the room-temperature electrical conductivity is 10^{-6} (ohm-m)$^{-1}$, the electron and the hole mobilities are, respectively, 0.85 and 0.04 m^2/V-s. What is the intrinsic carrier concentration n_i at the room temperature?

(a) 10^{21} m^{-3}　　　　　　　　　　　(b) 10^{-20} m^{-3}

(c) $7.0 \times 10^{+12}$ m^{-3}　　　　　　　(d) 7.0×10^{-20} m^{-3}

39. High permittivity ceramic is used for capacitors of

(a) a few pF to a few hundred pF　　　　　(b) a few µF to a few hundred µF

(c) A few nF to a few hundred nF　　　　　(d) A few mF to a few hundred mF

40. Two port networks are connected in cascade. The combination is to be represented as a single two-port network. The parameters of the network are obtained by multiplying the individual

(a) z-parameter matrix　　　　　　　　　(b) h-parameter matrix

(c) y-parameter matrix　　　　　　　　　(d) ABCD parameter matrix

41. The circuit given below is in steady state for a long time with switch S open. The switch is closed at t=0. The current through R at t=0 will be :
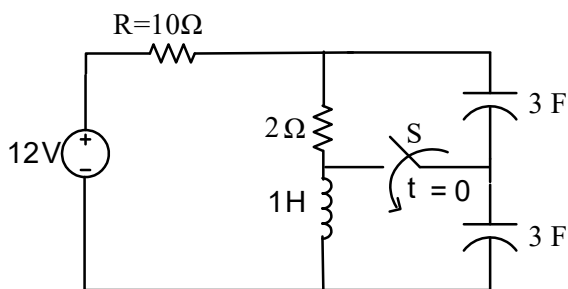
(a) 1/3 A

(b) 2/3 A

(c) 1 A

(d) 2 A

42. Two wattmeters are connected to measure the input power to a three phase balanced load in two-wattmeter method. If the two wattmeters read 8kW and 4kW then power factor is

(a) 0.5

(b) 0.866

(c) 1

(d) 0.7

43. A 0.2 H inductor with an initial current of 4 A is in parallel with a resistor of 100 Ω. The current at 0.8ms is :

(a) $4e^{-0.4}$ A

(b) $4e^{-16\times10^{-6}}$ A

(c) $4e^{-0.4\times10^{-3}}$ A

(d) $4e^{-16\times10^{-3}}$ A

44. The current i (in ampere) in the 2 Ω resistor of the given network is :
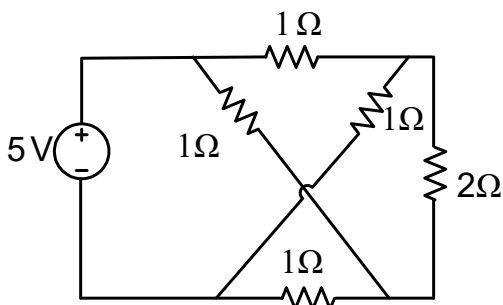
(a) 0 A

(b) 1.2 A

(c) 2 A

(d) 4.5 A

45. A digital –to-analog converter with a full-scale output voltage of 3.5V has a resolution close to 14mV. Its bit size is :

(a) 4

(b) 8

(c) 16

(d) 32

46. Suppose that resistors R_1 and R_2 are connected in parallel to give an equivalent resistor R. If resistors R_1 and R_2 have tolerance of 1% each, the equivalent resistor R for resistors R_1=300 Ω and R_2 =200 Ω will have tolerance of :

(a) 0.5%

(b) 1%

(c) 1.2%

(d) 2%

47. Which one of the following is the main cause of creeping in the induction type energy meters?

(a) Friction compensation

(b) Lag/lead compensation

(c) Overload compensation

(d) Braking torque producing system

48. A moving iron ammeter produces a full scale torque of 240 μNm with a deflection of 1200 at a current of 10 A. The rate of change of self inductance (μH/radian) of the instrument at full scale is :

    (a) 2.0 μH/radian   (b) 4.8 μH/radian

    (c) 12.0 μH/radian   (d) 114.6μH/radian

49. Which one of the following transducers is an active transducer?

    (a) Piezo-electric pressure transducer   (b) Metallic strain gauge

    (c) Semi-conductor strain gauge   (d) Platinum resistance thermometer

50. A popular method of increasing the range of an AC instrument is the use of :

    (a) shunt   (b) multiplier

    (c) AC potentiometers   (d) instrument transformer

SECTION - B *(Short answer type question)*
(100 Marks)
*All questions carry equal marks of 5 each.*
*This Section should be answered only on the **Answer Sheet** provided.*

1. Define electric field intensity. Derive the equation for electric field intensity at a distance 'r' from a point charge of Q coulombs.

2. Discuss the attenuation of waveguides.

3. Explain boundary conditions for Electric field and Magnetic field.

4. Explain the concept of superconductivity. Also draw the magnetic field Vs Temperature characteristics.

5. What do you mean by insulating materials? Explain its classification based on temperature.

6. Explain the difference in conduction properties of conductors, semiconductors and insulators on the basis of energy band diagram?

7. Draw the block diagram of generalized digital data acquisition system and describe the function of each component.

8. Using Schering bridge show how capacitance and dissipation factor of unknown capacitor is measured.

9. What is meant by creeping? What are the causes of creeping and how it can be eliminated?

10. How the range of DC ammeter and DC voltmeter can be extended. Derive the expression to find the shunt resistance and multiplier resistance?

11. An electron is not deflected while passing through a certain region. Can we be sure that there is no magnetic field in the region? Explain.

12. What is Hall Effect? Briefly explain any one of the applications of a Hall Effect transducer with a neat diagram. **(1+4=5)**

13. What is a semiconductor? How does it differ from conductor and insulator? Write some properties of semiconductors. **(1+2+2=5)**

14. (a) How are materials classified according to their magnetic behaviour? Explain with examples. **(3)**

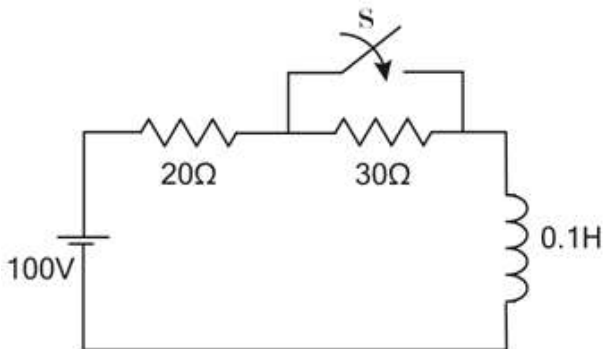   (b) What is indicated by the hysteresis loop of a ferromagnet? **(2)**

15. For the network shown below, find the voltage reading on voltmeter, if voltmeter sensitivity is 1kΩ/Volt. If the voltmeter is replaced by another voltmeter having sensitivity 25kΩ/volt, find the new reading. Comment on the answer.
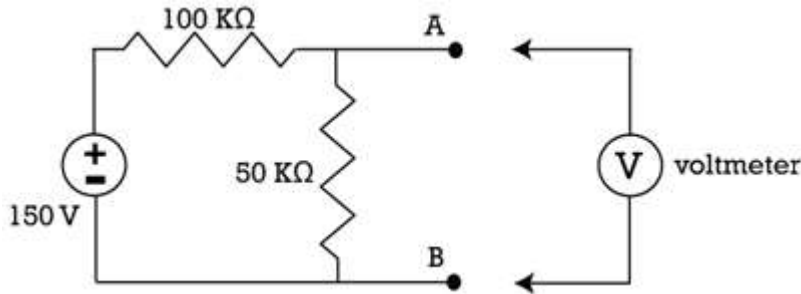
16. (a) What are passive and active transducers? Discuss with suitable examples. **(2.5)**

(b) Explain with an example the difference between primary and secondary transducers. **(2.5)**

17. What is a thermocouple? Briefly explain the thermoelectric laws. **(1+4=5)**

18. Draw and explain the operation of a 2 bit flash type analog-to-digital converter.

19. Determine the Thevenin's equivalent circuit across terminals AB of the circuit shown below.
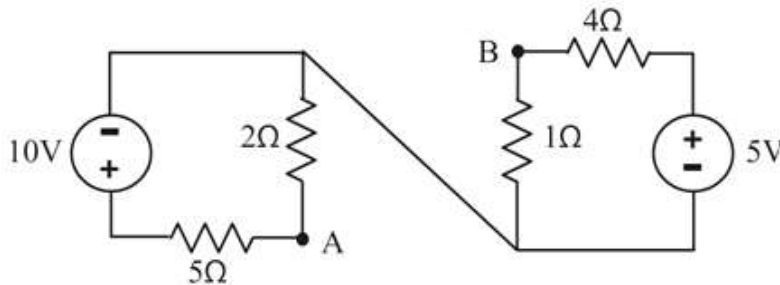
20. For the circuit shown below, find the complete expression for the current when the switch is closed at t=0.

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