MIZORAM PUBLIC SERVICE COMMISSION

COMPETITIVE EXAMINATIONS FOR JUNIOR GRADE OF M.E.S.
UNDER PUBLIC WORKS DEPARTMENT, AUGUST, 2018.

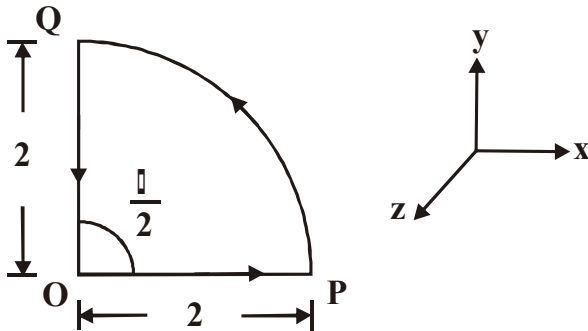## ELECTRICAL ENGINEERING PAPER-I

Time Allowed : 3 hours

FM : 200
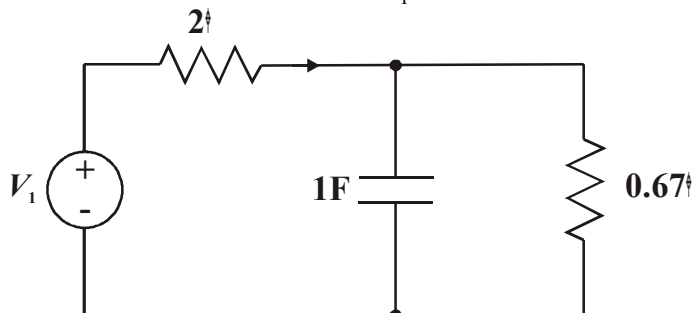
SECTION - A *(Multiple Choice questions)*

(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. If $\overline{A}=\hat{a}_r+\hat{a}_\varphi+\hat{a}_z$, the value of $\oint \overline{A}\,\overline{dl}$ around the closed circular quadrant shown in the figure is
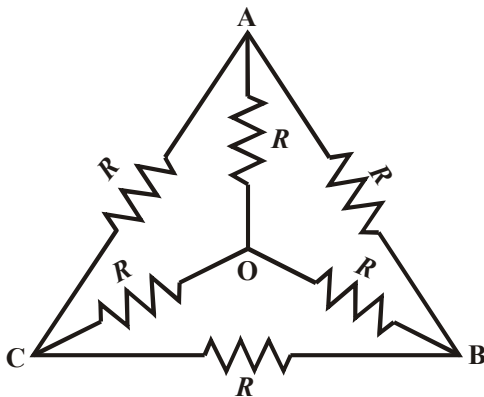

    (a) p
                (b) $\dfrac{\pi}{2}+4$

    (c) $p+4$
            (d) $\dfrac{\pi}{2}+2$

2. Which of the following material is preferred for transformer cores operating in microwave range?
    (a) Ferrite
              (b) Silicon steel
    (c) Super alloy
         (d) Copper

3. A transmission line has R, L, G, C distributed parameters per unit length of line. If g is the propagation constant of the line, which one of the following expressions represents the characteristic impedance of the line?

    (a) $\dfrac{\gamma}{R+j\omega L}$
            (b) $\dfrac{R+j\omega L}{\gamma}$

    (c) $\dfrac{G+j\omega C}{\gamma}$
           (d) $\sqrt{\dfrac{G+j\omega C}{R+j\omega L}}$

4. If $V^2 = 1 - e^{-2t}$, then value of V_1 is given by`

    (a) 4
                (b) $3+e^{-2t}$
    (c) $1+e^{-2t}$
         (d) $4-2e^{-2t}$

5. Which of these ceramic materials have relative permittivity e_r between 3 to 6 and loss angle $\tan d$ between 50×10^{-4} to 100×10^{-4}?

   (a) Strontium Zirconate ($SrZrO_3$)

   (b) Titanium Oxide (TiO_2)

   (c) Calcium Titanate ($CaTiO_3$)

   (d) Barium Utanate ($BaTiO_3$)

6. A parallel plate capacitor is filled with two dielectrics of e_1 and e_2 lengthwise equally. The capacitance of the combination is

   (a) $\dfrac{2 \in_0 \in_1 \in_2 A}{d}$

   (b) $\dfrac{2 \in_0 \in_1 \in_2 A^2}{d^2}$

   (c) $\dfrac{\in_0 (\in_1 + \in_2) A}{2d}$

   (d) $\dfrac{\in_1 \in_2 A}{d}$

7. In the circuit;

   The value of i_x is

   (a) 2A

   (b) -0.6A

   (c) 2.6A

   (d) 1.4A

8. A material with unequal anti-parallel atomic magnetic moments is

   (a) an anti-ferromagnet

   (b) ferrimagnet

   (c) a ferrite

   (d) non-magnetic

9. What is the magnetic field due to an infinite linear current carrying conductor?

   (a) $H = \dfrac{\mu I}{2\pi r}$ A/m

   (b) $H = \dfrac{I}{2\pi r}$ A/m

   (c) $H = \dfrac{\mu I}{2r}$ A/m

   (d) $H = \dfrac{I}{r}$ A/m

10. For the parallel RLC circuit to be overdamped.

   (a) $R < 2\sqrt{\dfrac{L}{C}}$

   (b) $R > 2\sqrt{\dfrac{L}{C}}$

   (c) $R < \dfrac{1}{2}\sqrt{\dfrac{L}{C}}$

   (d) $R > \dfrac{1}{2}\sqrt{\dfrac{L}{C}}$

11. Which one of the following statements is correct? A ferrite core has lower specific eddy current loss compared to an iron core because the iron core has

   (a) higher electrical resistance

   (b) lower electrical resistance

   (c) higher permeability

   (d) lower permeability

12. A plane slab of dielectric having dielectric constant 5, placed normal to a uniform field with a flux density of 2 C/m^2, is uniformly polarized. The polarization of the slab is

   (a) 0.4 C/m^2

   (b) 1.6 C/m^2

   (c) 2.0 C/m^2

   (d) 6.4 C/m^2

13. A series resonant circuit has an inductive reactance of 1000W, a capacitive reactance of 1000W and a resistance of 0.1W. If the resonant frequency is 10MHz, then the bandwidth of the circuit will be
   (a) 1kHz
   (b) 10 kHz
   (c) 1MHz
   (d) 0.1 kHz

14. All magnetic materials lose their magnetic properties when
   (a) Cooled to low temperature
   (b) Heated to high temperature
   (c) Kept in an aluminium box
   (d) Kept in vacuum

15. A pole of driving point admittance function implies
   (a) zero current for a finite value of driving voltage
   (b) zero voltage for a finite value of driving current
   (c) an open circuit condition
   (d) None of these

16. Which of the following field equations indicate that the free magnetic charges do not exist?
   (a) $H = \frac{1}{\mu}(\nabla \times A)$
   (b) $H = \int \frac{ldl \times r}{4\pi R^2}$
   (c) $\nabla \times H = 0$
   (d) $\nabla \times H = J$

17. The material for the core in a power transformer must have
   (a) High resistivity and low permeability
   (b) Low value of saturation magnetization and high resistivity
   (c) High permeability and low resistivity
   (d) High permeability and saturation magnetization

18. In a two port network, the condition for reciprocity in terms of h parameter is
   (a) $h_{12} = h_{21}$
   (b) $h_{11} = h_{21}$
   (c) $h_{11} = -h_{22}$
   (d) $h_{12} = -h_{21}$

19. An unshielded moving iron voltmeter is used to measure the voltage in an ac circuit. If a stray dc magnetic field having a component along the axis of the meter coil appears, the meter reading would be
   (a) unaffected
   (b) decreased
   (c) increased
   (d) either decreased or increased depending on the direction of the dc field

20. For a perfect conductor, the field strength at a distance equal to the skin depth is X% of the field strength at its surface. The value X% is
   (a) Zero
   (b) 50%
   (c) 36%
   (d) 26%

21. For a series RLC circuit, the power factor at the lowest half power frequency is
   (a) 0.5 lagging
   (b) 0.5 leading
   (c) unity
   (d) 0.707 leading

22. Wagner Earth devices in AC bridge circuits are used for
   (a) shielding all the bridge elements from external magnetic field
   (b) eliminating the effect of stray capacitance
   (c) minimizing the effect of inter-component capacitance
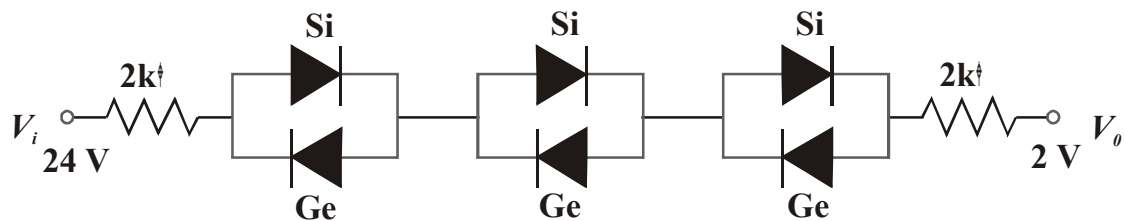   (d) eliminating all the node to earth capacitances

23. On increasing the 'Q' of the coil
  (a) its power factor increases
  (b) its power factor decreases
  (c) its power factor remains unaltered
  (d) its power may increase or decreases

24. In electrodynamometer type wattmeter, the inductance of pressure coil produces error. The error is
  (a) constant irrespective of the power factor of the load
  (b) higher at higher power factor load
  (c) higher at lower power factor loads
  (d) highest at unity power factor loads

25. Driving point impedance $Z(s) = \dfrac{s(s^2+1)}{s^2+4}$ is not realizable because the
  (a) number of Zeros is more than the number of pole.
  (b) poles and Zeros lie on the imaginary axis.
  (c) poles and zeros do not alternate on imaginary axis.
  (d) poles and zeros are not located on the real axis.

26. In calibration of a dynamometer wattmeter by potentiometer, phantom loading arrangement is used because
  (a) the arrangement gives accurate results
  (b) the power consumed in calibration work is minimum
  (c) the method gives quick results
  (d) the onsite calibration is possible

27. Poles and zeros of a driving point function of a network are simple and interlace on the jv axis. The network consists of elements
  (a) R and C
  (b) L and C
  (c) R and L
  (d) R, L and C

28. An imperfect capacitor is represented by a capacitance C in parallel with a resistance R. the value of its dissipation factor $\tan\delta$ is
  (a) vCR
  (b) v^2CR
  (c) $1/v^2CR$
  (d) $1/vCR$

29. The effective resistance between the terminals A and B in the circuit shown in the figure is

  (a) R
  (b) R-1
  (c) R/2
  (d) 6/11R

30. Chopper stabilized dc amplifier type electronic voltmeter overcomes the effect of
  (a) Amplifier CMRR
  (b) Amplifier sensitivity
  (c) Amplifier drift
  (d) Electromagnetic interference

31. Which of the following theorems can be applied to any network-linear or non-linear, active or passive, time-variant or time-invariant?
  (a) Thevenin theorem
  (b) Norton theorem
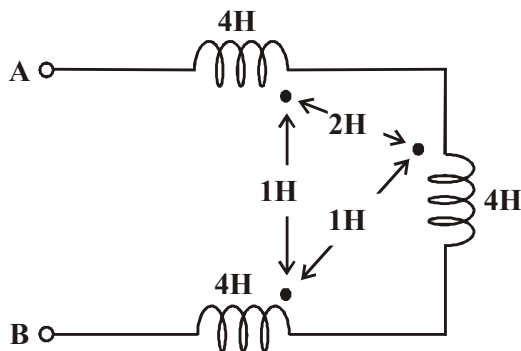 (c) Tellegen theorem
  (d) Superposition theorem

32. The deflection express $\theta \alpha V^2 \dfrac{dc}{d\theta}$ corresponds

    (a) moving iron type instrument   (b) electrodynamic type instruments

    (c) electrostatic type instrument   (d) induction type instruments

33. If the source impedance is capacitive, for maximum transfer of power from the source to the load, the load should be

    (a) capacitive

    (b) complex conjugate of complex source impedance

    (c) resistive

    (d) exactly the same as the source impedance

34. The resistance of a circuit is found by measuring current flowing and the power fed into the circuit. If the limiting errors in the measuring of power and current are ±1.5% and ±1.0% respectively, the limiting error in the measurement of resistance will be

    (a) ± 1 %   (b) ± 1.5 %

    (c) ± 2.5 %   (d) ± 3.5 %

35. Determine the current in the network

    (a) 1.675mA   (b) 1.575mA

    (c) 1.557mA   (d) None of these

36. A digital voltmeter uses a 10MHz clock and has a voltage controlled generator which provides a width of 10m sec per volt of unit signal. 10 volt of input signal would correspond to a pulse count of

    (a) 500   (b) 750

    (c) 1000   (d) 1500

37. With the increase in frequency of an electromagnetic wave in free space, how do the velocity V_c and characteristic impedance Z_c change?

    (a) V_c increases and Z_c decreases   (b) V_c decreases and Z_c increases

    (c) Both V_c and Z_c increases   (d) Both V_c and Z_c remain unchanged

38. Cauer and Foster forms of realizations are used only for

    (a) driving point reactance functions   (b) transfer reactance functions

    (c) driving point impedance functions   (d) transfer impedance functions

39. Measurement of flow, thermal conductivity and liquid level using thermistors make use of

    (a) Resistance decreases with temperature   (b) Resistance increase with temperature

    (c) Self-heating phenomenon   (d) Change of resistivity

40. When two-Wattmeter method of measurement of power is used to measure power in a balanced three phase circuit; if the Wattmeter reading is zero, then

    (a) power consumed in the circuit is zero   (b) power factor of the circuit is zero

    (c) power factor is unity   (d) power factor is 0.5

41. A system is represented by $\dfrac{dy}{dt} + 2y = 4u(t)$. The ramp component in the forced response will be

    (a) tu(t)   (b) 2tu(t)

    (c) 3tu(t)   (d) 4tu(t)

42. Pair of active transducers is

    (a) Thermistor, Solar cell   (b) Thermocouple, Thermistor

    (c) Thermocouple, Solar cell   (d) Solar cell, LVDT

43. Plane defined by z=0 carry surface current density $2\hat{a}_x$ A/m. The magnetic intensity 'H_y' in the two regions -a<z<0 and 0<z<a are respectively

    (a) $\hat{a}_y$ and $-\hat{a}_y$ (b) $-\hat{a}_y$ and $\hat{a}_y$

    (c) $\hat{a}_x$ and $-\hat{a}_x$ (d) $-\hat{a}_x$ and $\hat{a}_x$

44. A 3-phase delta-connected symmetrical load consumes P watt of power from a balanced supply. If the same load is connected in star to the same supply, then what is the power consumption?

    (a) P/3   (b) P

    (c) $\sqrt{3}$P   (d) 3P

45. A 12 bit A/D converter has a range 0-10V. What is the approximate resolution of the converter?

    (a) 1 mV   (b) 2.5 mV

    (c) 2.5mV   (d) 12mV

46. In an analog data acquisition unit, what is correct sequence of the blocks starting from the input?

    (a) Transducer-Recorder-Signal conditioner   (b) Transducer-Signal conditioner-Recorder

    (c) Signal conditioner- Transducer-Recorder   (d) Signal conditioner-Recorder -Transducer

47. In which one of the following ways can the Hall voltage across an impurity semiconductor crystal be increased?

    (a) By increasing the thickness of the crystal

    (b) By increasing the concentration of impurity atoms in the crystal

    (c) By increasing the width of the crystal

    (d) By increasing the current flowing through the crystal

48. The equivalent inductance seen at terminals AB is

    (a) 16H   (b) 10H

    (c) 8H   (d) 12H

49. Under the influence of an external electric field an insulator undergoes the process of polarization. There are four contributing factors to the total polarization viz. electronic, ionic, orientational and space charge. At the optical frequencies, the only contribution to total polarization is from

    (a) Space charge polarization   (b) Ionic Polarization

    (c) Orientational Polarization   (d) Electronic polarization

50. Two milimeters, with a full scale current of 1mA and 10mA are connected in parallel and they read 0.5 mA and 2.5 mA respectively. Their internal resistance are in the ratio of

    (a) 1:10   (b) 10:1

    (c) 1:5   (d) 5:1

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. What is magnetic dipole? Derive an expression for the vector potential and magnetic field due to a small loop of current.

2. Derive magnetic torque and moment for a rectangular loop placed in a magnetic field B.

3. Define the expression for electric field intensity due to infinite sheet of charge located in x=0 plane.

4. Discuss the phenomenon of hysteresis associated with ferromagnetic materials.

5. Deduce an expression for the capacitance of a parallel plate capacitor having two dielectric media.

6. Explain that single phase induction type of energy meter can measure the true energy consumed only if the phase angle between the applied voltage and the pressure coil flux is 90°. Describe a method for making this adjustment.

7. What are the various methods of measurement of level of liquids? Explain any one of them in detail.

8. Explain the basic principle of inductive and capacitive transducer.

9. Explain with block diagram the operation of electronic energy meter.

10. Derive the expression for torque for a moving iron instrument.

11. What are the criteria for selection of insulating materials used for cables? Explain with neat sketches.

12. Derive the expression for transient response of a Sinusoidal excitation based series R-L circuit.

13. Classify the magnetic material and explain each class with respect to its properties and applications.

14. What is ceramic? Explain the AC properties of ceramics as capacitor.

15. Define Hall Effect. With necessary sketch, explain the concept of hall-effect and arrive at an equation for hall voltage V_H.

16. Find I_L (t), from the circuit shown in Fig.1, for t>0 if the circuit is in steady state at t=0⁻. Sketch V_x(t) for -4<t<4ms.
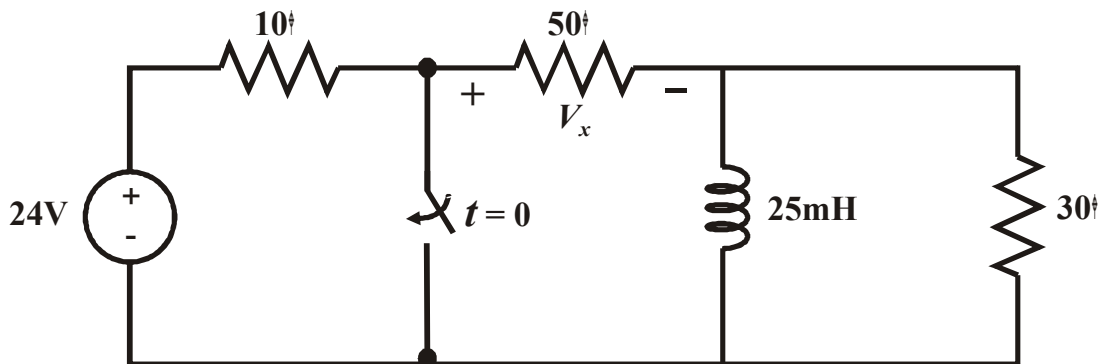

Fig.1

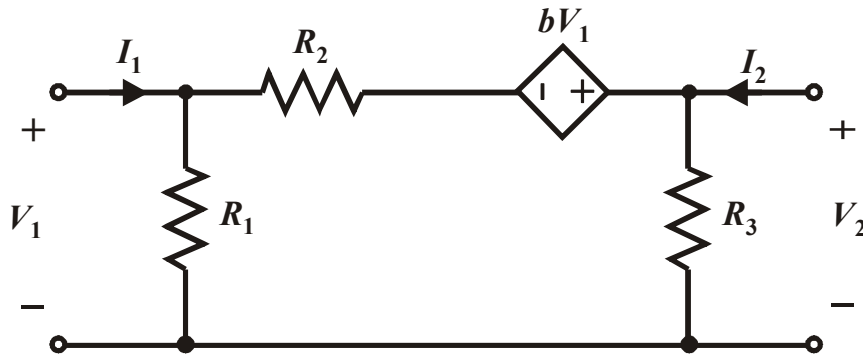**17.** Calculate the ABCD parameters of the network shown in Fig.2.

Fig.2

18. Determine the current through $R_L = 10W$ in the circuit shown in Fig.3 using Thevenin's theorem.
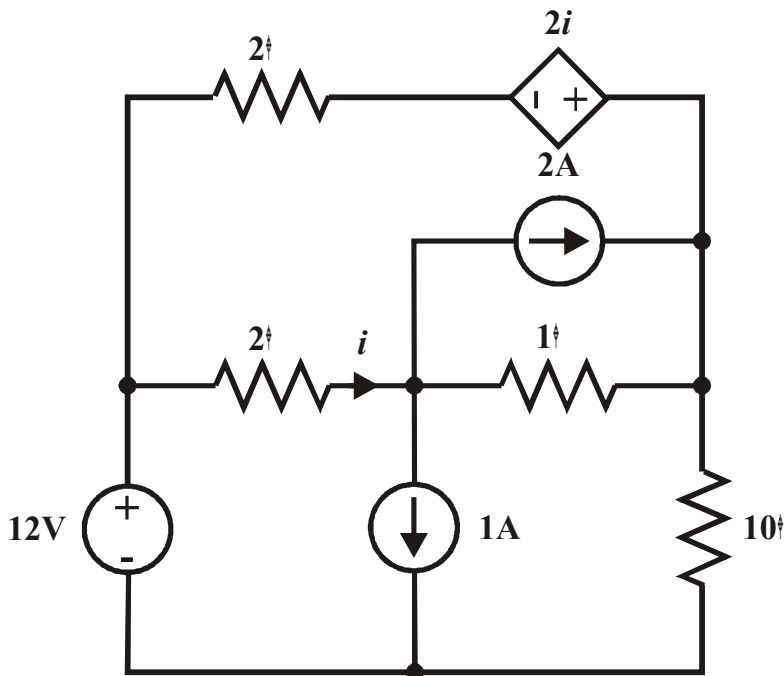

Fig.3

19. A 5mF capacitor is discharged suddenly through a coil having an inductance of 2 H and a resistance of 200 W. The capacitor is initially charged to a voltage of 10 V. Find

   (a) an expression for the current

   (b) the additional resistance required to give critical damping.

20. Synthesize a network having impedance function

$$Z(s) = \frac{s^2 + 7s + 70}{s(s+10)}$$

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