General Instructions:

i) *All questions are compulsory*
ii) *There are 26 questions in total. Question Nos. 1 to 5 is very short answers type questions and carry 1 mark each.*
iii) *Question Nos. 6-10 carry 2 marks each, Question No 23 carry 4 marks and question Nos. 24 to 26 carry 5 marks each.*
iv) *Use of calculator is not permitted. However you may use log tables if necessary.*
v) *Internal choices are given.*

Section-A

1. Two identical slabs, of a given metal, are joined together, in two different ways, as shown in the figures (i) and (ii). What is the ratio of the resistances of the two combinations?

2. Draw the equi potential surfaces corresponding to
   a) Two equal charges.
   b) Uniform electric field.

3. An electron beam passes through a region of crossed electric and magnetic fields of strength E and B respectively. For what value of electron speed the beam will remain undeflected?

4. Why does a metallic plate become very hot when it is surrounded by a coil carrying high frequency alternating current?

5. The wavelength of an electromagnetic radiation is doubled. What will happen to the energy of the photon?

Section-B

6. An infinite linear charge produces an electric field of 9×10^4 N/C, at a distance of 2cm. Calculate the linear charge density.

7. A potential difference B is applied across the ends of copper wire of length l and diameter D. what is the effect of drift velocity of the electron if
   i. V is halved.
   ii. l doubled.
   iii. D is halved

$B \frac{\mu_0 n I}{\ell r}$

$N \cdot \frac{\mu_0 N_1 I_1}{l}$

8. How does the self inductance of an air coil change, when
   i. the number of turns in the coil is decreased
   ii. an iron rod is introduced in the coil

9. What are eddy-currents. State any two uses of the eddy current. Give any two methods to minimize eddy current.

OR

Two identical circular wires P and Q each of radius R and carrying current I are kept in a plane perpendicular to each other such that they have a common centre. Find the magnitude and direction of the net magnetic field at the common centre of the two coils.

10. Name the constituent radiation of electromagnetic spectrum which
    a) used in satellite communication
    b) is used for studying crystal structure
    c) is absorbed from the sunlight by the ozone layer
    d) has its wavelength range between 390 nm to 700 nm.

Section-C

11. Draw a circuit diagram showing balancing of Wheatstone bridge. Use Kirchhoff's rules to obtain the balance condition in terms of the resistances of the four arms.

12. The primary coil of an ideal transformer has 100 turns and transformation ratio is also 100. The input voltage and power are 220V and 1100W respectively. Calculate
    a) the number of turns in the secondary coil
    b) current in the primary coil
    c) voltage across the secondary coil
    d) the current in the secondary coil
    e) the power in the secondary coil

13. Draw a neat labeled diagram of an ac generator. State briefly its working principle. Show a plot of variation of
    i. magnetic flux with time
    ii. the alternative emf with time generated by a loop of wire.

14. A resistor R and an element X are connected in series to an ac source. The voltage is found to lead the current by a phase of $\frac{\pi}{4}$. If X is replaced by another element Y the voltage lags behind the current by $\frac{\pi}{4}$.
    i. Identify the elements X and Y
    ii. When both X and Y are connected in series with R to the same source, will the power dissipated in the circuit be maximum or minimum. Justify your answer.

OR

A uniform conducting wire of length 12a and resistance R is wound up as a current carrying coil in the shape of
    a) an equilateral triangle of side a
    b) a square of side a
    c) a regular hexagon of side a

The coil is connected to the voltage source V. Find the magnetic moment of the coils in each case.

15. In a meter bridge the null point is found at a distance of 40 cm from A. If a resistance of 12 ohm is connected in parallel with S, the null point occurs at 50 cm from A. Determine the values R and S connected in the two gaps of the meter bridge (the point A is towards the gap where R is connected).

16. (A) An infinitely long positively charged straight wire has a linear charge density λ C/m. An electron is revolving around the wire as its centre with a constant velocity in a circular plain perpendicular to the wire. Deduce the expression for its kinetic energy.

(B) Plot a graph of the kinetic energy as a function of the charged density.

17. An electric dipole is held in a uniform electric field.
(a) Using suitable diagram , show that it does not undergo any translatory motion and
(b) Derive an expression for torque acting on it and specify it's direction
(c) Derive an expression for the work done in rotating an electric dipole in a uniform electric field

18. (a) Plot a graph comparing the variation of potential V and the electric field E due to a point charge Q as a function of distance R from the point charge.
(b) Find the ratio of potential differences that must be applied across the parallel and the series combination of two identical capacitors so that the energy stored, in the two cases, becomes the same.

19. A galvanometer can be converted in to a voltmeter to measure upto
a. V volts by connecting a resistance R_1 in series with the coil.;
b. V/2 volts by connecting a resistance R_2 in series with the coil
Find the resistance R_x in terms of R_1 and R_2 required to convert it into a voltmeter that can read upto 2V volts

20. a) State the condition for resonance to occur in series LCR a.c. circuit and derive an expression for resonant frequency. b) Draw a plot showing the variation of the peak current with frequency of the AC source used ; c) define the quality factor Q of the circuit.

21.
a. Write the generalized expression for the Ampere's Circuital Law in terms of conduction current and the displacement current. Mention the situation when there is: a) Only conduction current and no displacement current;
b) Only displacement current and no conduction current.

22. (a) Define the three components of the earth's magnetic field
(b) The horizontal component of the earth's magnetic field at a given place is 0.4×10^{-4} wb/m and angle of dip is 30^0.
Calculate the value of (a) vertical component and
(b) total intensity of earth's magnetic field

Section D

23. Vijay carries out a Physics project on electric energy consumption and the electricity bill for 50 houses in the vicinity of his residence. The survey also includes the list of electrical appliances regularly used in different houses and the general awareness and precautions observed by families to save electric energy and excessive expenditure incurred on payment of electricity bills. The findings of his study were shared with his residents as well as his class mates. He highlighted the importance of saving electrical energy and explained how the consumptions can be minimized. Answer the following questions :
a. Two different electric irons A and B are rated 750W -220V and 1000W-220V respectively. Which of the two has lower resistance? Which of the two you will prefer for saving electric energy?
b. What values are reflected by Vijay
c. How can such values be inculcated in the lifestyles of individuals and particularly the students

Section E

24. (a) Derive an expression for the capacitance of a parallel plate capacitor, whose plates are separated by a dielectric medium of relative permittivity K.
(b) X and Y are two parallel plate capacitor having the same area of plates and same separation between the plates. X has air between the plates and Y contains a dielectric medium of dielectric constant K=4.
    i. Calculate the capacitance of each capacitor if the equivalent capacitance of the combination is 4 μF.
    ii. Calculate the potential difference between the plates X and Y

OR

State the Gauss Law and obtain the expression for the electric field due to a uniformly charged thin spherical shell of radius R at a point outside the shell. Draw a graph showing the variation of the electric field with r, for $r > R$ and $r < R$.

25. (a) State the Biot-Savart's law' giving the mathematical expression for it. Use this law to derive the expression for the magnetic field due to a circular current carrying coil at a point along it's axes.
(b) A Cyclotron's oscillator frequency is 10 MHz. What should be the operating magnetic field for accelerating the protons? If the radius of it's 'Dees' is 60 cms , calculate the kinetic energy in MeV of the proton beam produced by the accelerator.

OR

With the help of a labelled diagram, state the underlying principle of a Cyclotron . Explain clearly how it works to accelerate the charged particles. Show that Cyclotron frequency is independent of the energy of the particle. Is there an upper limit on the energy acquired by the particle? Give reasons.

26. (a) Describe an activity to show that the polarity of emf induced in a coil is always such that it tends to produce an induced current which opposes the change of the magnetic flux that produces it.
(b) The current flowing through an inductor of self inductance L is continuously increasing. Plot a graph showing the variation of
    i. Magnetic flux vs current
    ii. Induced emf vs rate of change of current
    iii. Magnetic potential energy stored vs current

OR

(a) What is Impedance? Derive and expression for impedance of an AC circuit consisting of resistor, capacitor and inductor in series.
(b) Give the expression for instantaneous current and its phase relationship to the applied voltage.

(c) In an LCR circuit L=200 mH, R=10 ohm, calculate the capacitance of the capacitor if the power factor is unity. Also, calculate Q factor of the circuit.