(3 page) Max. Marks : 70

General Instructions: - The question paper is divided into four sections

(1) Section A:- Q. No.1 contain **TEN** multiple choice type of questions carrying **ONE** mark each.
Q.No.2 Contains **EIGHT** very short answer type of question carrying **ONE** marks each.

(2) Section B:- Q.No.3 to Q.No.14 contains **TWELVE** short answer type of questions carrying **TWO** marks each.
(Attempt any Eight)

(3) Section C:- Q.No. 15 to Q.No. 26. contains **TWELVE** short answer type questions carrying **THREE** marks each.
(Attempt any Eight)

(4) Section D:- Q. NO. 27 to 31 contains **FIVE** long answer type of questions carrying **FOUR** marks each.
(Attempt any Three)

(5) Use of log table is allowed. Use of calculator is not allowed.

(6) Figures to the right indicates full marks.

(7) For each MCQ, correct answer must be written along with its alphabets, e.g. (a)...../(b)...../(c)...../(d)..... only first attempt will be considered for evaluation.

(8) Physical constants :- (i) $\pi = 3.142$ (ii) $h = 6.63\times10^{-34}\ J.S$ (iii) $e = 1.6\times10^{-19}\ C$

(iv) $\epsilon_0 = 8.85\times10^{-12}\ \frac{C^2}{Nm^2}$ (v) $\mu_0 = 4\pi\times10^{-7}\ wb/Am$

Section - A (MCQ & VSA)

Q.No.1. Select and write the correct answer to the following questions: [10]

(i) A conductor rod of length (l) is moving with velocity (v) in a direction normal to a uniform magnetic field (B). What will be the magnitude of induced emf produced between the ends of a moving conductor?

(a) Blv (b) Blv^2 (c) $\frac{Blv}{2}$ (d) $\frac{2Bl}{v}$

(ii) Which of the following materials is diathermanous?

(a) Iron (b) Wood (c) Dry air (d) Water vapour

(iii) Which of the following is / are state variables(s)?

(a) Internal energy (b) Heat (c) Work (d) Both (b) and (c)

(iv) Two open organ pipes of length 49 cm and 50 cm sounded together beat at 7 per second. The speed of sound in air is

(a) 336 m/s (b) 343 m/s (c) 350 m/s (d) 357 m/s

(v) A 30-turn coil of diameter 2 cm carries a current of 10 mA. When it is placed in a uniform magnetic field of induction 0.05T, the maximum torque that could be exerted on the coil by the field is about

(a) $1.88\times10^{-5}\ Nm$ (b) $4.7\times10^{-6}\ Nm$ (c) $4.7\times10^{-7}\ Nm$ (d) $1.88\times10^{-4}\ Nm$

(vi) A series LCR resonant circuit is used as

(a) a potential divider (b) a radiowave transmitter

(c) a source of wattless current (d) a tuning circuit in a wireless receiver

(vii) The frequency of revolution of an electron in the nth Bohr orbit of an H-atom is proportionl to

(a) $\frac{1}{n^3}$ (b) $\frac{1}{n^2}$ (c) n (d) n^2

(viii) If μ_0 is the permeability of free space and χ_m is the magnetic susceptibility of a medium, the relati permeability of the medium is

(a) $1+\chi_m$ (b) $\frac{\mu_0}{1+\chi_m}$ (c) $\frac{\mu_0}{\chi_m}$ (d) $\mu_0(1+\chi_m)$.

(ix) A parallel plate capacitor is charged and then isolated. On decreasing the plate separation, the potential difference and capacitance respectively.

(a) Increases, increases (b) Increases, decreases

(c) decreases, increases (d) decreases, decreases

(x) A body of mass 2kg performs linear SHM. The restoring force acting on it is 3N when it is 0.06m from the mean position. The differential equation of motion is.

(a) $\frac{d^2x}{dt^2}+100x=0$ (b) $\frac{d^2x}{dt^2}+25x=0$ (c) $50\frac{d^2x}{dt^2}+x=0$ (d) $2\frac{d^2x}{dt^2}+3x=0$

Q.No.2. Answer the following : (VSA) **[08]**

(i) State the factors which control the wavelength of light emitted by an LED.

(ii) What are harmonics and overtones?

(iii) A system dissipates 125 kJ of heat while 104 kJ of work is done on the system. Calculate the change in its internal energy.

(iv) For photoelectric effect, is it possible to use (a) red light (b) microwaves?

(v) State the Stefan-Boltzmann law.

(vi) The emf of the cell balances against a length of 217 cm of a potentiometer wire. When the cell is shunted by a resistane of 15Ω, the balancing length is 200 cm. Find the internal resistance of the cell.

(vii) State Faraday's qualitative law of electromagnetic induction.

(viii) State the expression for the total energy of SHM interms of acceleration.

Section - B (SA-I)

Attempt any EIGHT : **[16]**

Q.3. Draw a neat, labelled energy level diagram for the hydrogen atom.

Q.4. Derive an expression for the equation of a stationary wave on a stretched string.

Q.5. Find the time required for a 50 Hz alternating current to change from zero to its rms value.

Q.6. What are eddy currents? State any two applications of eddy currents.

Q.7. The de Broglie wavelength associated with an electron is the same as that of a proton. Given that a porton is 1836 times as massive as an electron, find the ratio of their momenta and their kinetic energies. [Assume norelativistic regime]

Q.8. A voltmeter has a resistnace of 100Ω. What will it read when connected across a cell of emf 2 V and internal resistance 20Ω?

Q.9. Define magnetization. Give it's unit and dimensions.

Q.10. A hole in an electric furnace at a temperature of 727°C can be considered to be a blackbody radiator. If energy is emitted from the hole at the rate of 20 W at this temperature, find the area of the hole.

Q.11. Give the logic Symbol and Boolean expression of OR and NAND gate.

Q.12. What is a cyclic process? Explain with a P-V diagram

Q.13. A bar magnet of moment $7.5Am^2$ experiences a torque of magnitude $1.5\times10^{-4}N\text{-}m$ when placed inclued at 30° in a uniform magnetic field. Find the magnitude of the magnetic induction of the field.

Q.14. Explain any two examples of conservation of angular momentum.

Section C (SA-II)

Attempt any EIGHT : [24]

Q.15. Find the work done when a drop of mercury of radius 2 mm breaks into 8 indentical droplets. [Surface tension of mercury =0.4855J/m²]

Q.16. Obtain an expression for the magnetic induction produced by a current in a wire in the shape of a circular arc at its cente of curvature.

Q.17. In a bprism experiment, the slit and eyepiece are respectively 10 cm and 80 cm from the biprism. When the slits is illuminated by a monochromatic light, lthe distance of the 4th dark fringe from the central fringe is 0.63mm. When a convex lens was interposed at 30 cm from the slit, the separation of the two magnified images of the slit was 4.8mm. Find the wavelength of the light used.

Q.18. A gas inside a cylinder fitted with a frictionless piston absorbs 400 J from its surrrondings and expands by 5 litres against a constant external pressure of 1 atm. Determine the change in the internal energy of the gas. What is the significance of the sign in the answer?

Q.19. A narrow air-cored toroid of circumference 1 m has a circular cross section of diameter 1 cm which is tightly wound with 100 turns/cm. Calculate (a) the magnetic field inside the toroid when the current through the turns is 20 A (b) the self inductance of the coil.

Q.20. Assuming the expression for the pressure exertd by an ideal gas, show that the rms speed of a gas molecule is directly proportional to the square root of its absolute temperature.

Q.21. Obtain an expression for the electric field intensity at a point outside an infinitely long chargd cylindrical conductor.

Q.22. Explain with a neat circuit diagram, how you will determine the unknown resistance using a metre bridge.

Q.23. Determine the series limit of the Balmer, paschen series, given the limit for the lyman series is 912 A°.

Q.24. Derive an expression for the maximum safe speed for a vehicle on a horizontal circular road without skidding off. State its significance.

Q.25. Show that in an a circuit containing a pure inductor, the voltage is ahead in phase by $\pi/2$ rad.

Q.26. Obtain the expression for the period of a simple pendulum performing SHM.

Section D (LA)

Attempt any THREE : [12]

Q.27. Explain what is meant by the terminal speed of a body falling through a viscous fluid. Hence obtain the expression for the terminal speed.

Q.28. State Huygen's principle. Hence derive the laws of reflection of light using Huygen's principle.

Q.29. (a) With a neat labelled diagram, explain the woking of a photodiode.

(b) Calculate the gyromagnetisc ratio of electron (given $e=1.6\times10^{-19}c$, $me=9.1\times10^{-31}kg$)

Q.30. Write Einstein's photoelectric equation. hence explain the inverse linear dependence of the stopping potential on the wavelength of the incident radiation.

A sonometer wire, 36 cm long, virates with a frequency of 288 Hz in the fundamental mode when it is under a tension of 24.5 N. Calculate the linear density of the material of the wire.

Q.31. State the theorem of parallel axis and perpendicular axis.

One hundred and twenty five small merecury drops, each carrying a charge of 0.5 μc and of diameter 0.1m coalesce to form a larger drop. Calculate the potential at the surface of the larger drop.