Roll No. .... **Total No. of Pages : 7**

1(CCE.M)3

Physics–II

(18)

Time : Three Hours] [Maximum Marks : 300

INSTRUCTIONS

(i) Answers must be written in English.

(ii) The number of marks carried by each question is indicated at the end of the question.

(iii) The answer to each question or part thereof should begin on a fresh page.

(iv) Your answer should be precise and coherent.

(v) The part/parts of the same question must be answered together and should not be interposed between answers to other questions.

(vi) Candidates should attempt **all** the questions.

(vii) If you encounter any typographical error, please read it as it appears in the text-book.

(viii) Candidates are in their own interest advised to go through the General Instructions on the back side of the title page of the Answer Script for strict adherence.

(ix) No continuation sheets shall be provided to any candidate under any circumstances.

$$\psi(x) = \sqrt{\frac{15}{a}}\,A(a^2 - x^2) \quad \text{for } -a \le x \le 0$$
$$= 0 \quad \text{for } |x| > a.$$

Find the value of A that will normalize $\psi(x)$ and calculate the expectation values of x and p. 25

OR

(a) Draw a graph showing variation of binding energy per nucleon with mass number and explain it. 25

(b) A current flows through a wire shaped in the form of a square of side L. Obtain the magnetic field at the centre of the square. 25

6\. (a) The radius of a carbon nucleus is about 3×10^{-15} m and its mass is 12u. Find the average density of the nuclear material. How many more times dense than water is this ? 20

(b) A 6V Zener diode alongwith a series resistance is connected across a 9V supply. Calculate the minimum value of the resistance required, if the maximum Zener current is 40 mA. 20

(c) Define the terms : semiconductor diode, rectifier, amplification factor, voltage gain and transistor. 10

OR

(a) In the transistor circuit given here, the base current is 35 μA. Find the value of the resistor R_b.

(c) Use Maxwell's equation to show that $\vec{\nabla}.\left(\vec{j} + \frac{1}{E_o}\frac{\partial \vec{E}}{\partial t}\right) = 0$. 10

2\. (a) Write down Maxwell's equations in differential and integral forms. Mention the law each equation represents. 20

(b) A plane e.m. wave E = 100 cos $(6 \times 10^8 t + 4x)$ V/m propagates in a medium. What is the dielectric constant of the medium ? 20

(c) A condenser of 0.01 μF is charged to 100 Volt. Find the peak current that flows when the charged condenser is connected across an inductance of 10 mH. 10

OR

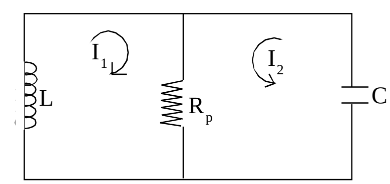
(a) State and prove Poynting's theorem. Interpret the equation :

$$\text{div.}(\vec{E} \times \vec{H}) + \vec{E}.\frac{\partial \vec{D}}{\partial t} + \vec{H}.\frac{\partial \vec{E}}{\partial t} + \vec{E}.\vec{J} = 0. \quad 20$$

(b) Given that for a series LCR circuit the equation is

$$\frac{d^2v}{dt^2} + \frac{R}{L}\frac{dv}{dt} + \frac{1}{LC}V = 0$$

If a similar equation is to be used for a parallel LCR circuit shown below, find R_p.



20

(c) Prove that if a charged particle moves in a uniform magnetic field :

(i) it will experience no force if it moves along the magnetic field.

(ii) magnetic field performs no work if it moves normal to the magnetic field. 10

3. (a) State Bohr's postulates. Using Bohr's quantum condition, find an expression for frequency in wavenumber unit when electron jumps from n_2 orbit to n_1 orbit. 20

(b) Calculate the Zeeman pattern of $^2P_{½} - {}^2S_{½}$ transition in Sodium atom. 10

(c) Find the terms and energy levels arising out from the configuration np^2. 20

OR

(a) Discuss L-S and j-j coupling schemes for nsnp electron configuration. 20

(b) Assuming the ionization potential of atomic hydrogen to be 13.6 eV, calculate the wavelength of the first member of the Lyman Series. 10

(c) State Lande's interval rule. Draw an energy level diagram for $^3D \rightarrow {}^3P$ transitions assuming the Lande's interval rule to hold for both triplet states. Mark the allowed transitions and show

the spectrum on a frequency scale as it would be seen in spectrometer. 20

4. (a) Describe briefly the photon concept, including expressions for the energy and momentum of a photon. 20

(b) Find the energy of the photons in a beam whose wavelength is 526 nm. 15

(c) Find the de Broglie wavelength of a thermal neutron of mass 1.67×10^{-27} kg travelling at a speed of 2200m/s. 15

OR

(a) What is photoelectric effect ? What potential difference must be applied to stop the fastest photoelectrons emitted by a nickel surface under the action of ultraviolet light of wavelength 2000 Å ? The work function of nickel is 5 eV. 20

(b) How are the elementary particles classified on basis of their masses and interactions ? 15

(c) What are characteristics of strong and weak interactions ? Give their relative strength, time of interaction and intermediate particles for these interactions. 15

5. (a) Write down three basic postulates of wave mechanics and explain them. What is the significance of wave function ? 25

(b) The wave function of a particle moving in one dimension is given to be :

(x) Candidates shall put a cross (x) on blank pages of Answer Script.

(xi) No blank page be left in between answer to various questions.

(xii) No programmable Calculator is allowed.

(xiii) No stencil (with different markings) is allowed.

1. (a) Establish Coulomb's Law for Maxwell's equations. 20

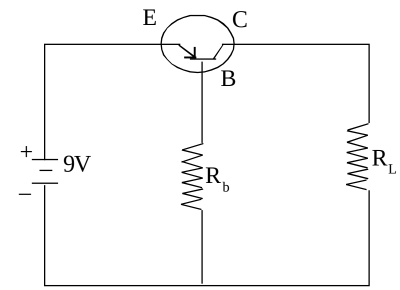
(b) An infinite number of charges, each equal to q, are placed along the x-axis at positions x = 1, x = 2, x = 4, x = 8, etc. Find the potential and electric field at the point x = 0 due to the set of charges. 20

(c) A uniform electric field is in the negative x-direction. Point A and B are at x = 2 m and x = 6 m respectively on the x-axis. Is the potential difference $V_B - V_A$ positive or negative ? If the magnitude of $V_B - V_A$ is 10^5 V, find the magnitude E of the electric field. 10

OR

(a) State Gauss's Law in differential and integral form. 20

(b) The central part of a uniformly charged solid sphere is hollowed by creating a cavity of radius ½R concentric with the original sphere of radius R. If the charge density of the hollowed sphere remains unchanged, find the electric field at the surface of the sphere now in terms of the original value on the surface. 20



20

(b) In an npn transistor, the collector current is 15 mA. If 95 percent of the electrons emitted reach the collector, find the base current. 20

(c) What are Logic Gates ? Describe functioning of one of the Logic Gates. 10