

JL – 30/14

Physics

Paper – II

Time : 3 hours

Full Marks : 200

The figures in the right-hand margin indicate marks.

Answer all questions.

1. (a) Outline the theory of WKB approximation method. 10
- (b) Explain, in detail, how the α -decay of radioactive nucleus is accounted for by the WKB approximation method. 15
- (c) Develop the theory of time dependent perturbation for transition probability. State and prove "Fermi's Golden Rule" and comment on selection rules. 15

OR

- (d) Discuss the Born approximation for calculation of the scattering of a particle by a centre of force. 15

- (e) Apply the Born approximation to the problem of α -particle scattering from the Coulomb field of nuclei. 15
- (f) Write short notes on the following : 5+5 = 10
- (i) Einstein's A and B coefficients
 - (ii) Symmetric and anti-symmetric wave functions of two electrons
2. (a) Discuss Klein-Gordon equation and mention its successes and drawbacks. 15
- (b) "The prediction of magnetic moment, spin-orbit interaction and the concept of hole are the remarkable successes of Dirac's theory." – Discuss. 15
- (c) Set up Dirac's relativistic wave equation and solve for a free electron. 10

OR

- (d) State and prove Noether's theorem. 15
- (e) Write about quantization of electromagnetic field and discuss the properties of photons. 15

- (f) Write short notes on the following : 5+5 = 10
- (i) Covariance of Dirac's equation
 - (ii) Second quantization
3. (a) Draw the equivalent circuit of transformer coupled amplifier in the mid frequency range, low frequency range and high frequency range. Derive expressions for the voltage gain in all the above ranges of frequency. What do you mean by amplifier pass band? 15
- (b) Mention the characteristics of an ideal operational amplifier. Why are these different from those of practical op-amps? Construct the operational amplifier as a differential amplifier and as an integral amplifier. 15
- (c) Explain how the operational amplifier can be used as a summing amplifier. Write about comparators. 10

OR

- (d) Explain feedback and circuit requirements for oscillation. 10

- (e) Discuss astable, monostable and bistable multivibrators. 10
- (f) Why flip-flops are called memory elements ? Draw the circuit diagrams of RS flip-flop and JK flip-flop and explain them with the help of respective truth tables. 10
- (g) State and prove De Morgan's theorem. Using De Morgan's law show how to implement an OR gate using AND and NOT gates. 10
4. (a) Define Madelung constant and show that the Madelung constant for a linear ionic solid having $2N$ ions of alternate charges $\pm e$ is $2 \ln 2$. 5
- (b) Derive Bragg's law of X-rays by diffraction of crystals. 5
- (c) What is Bloch theorem ? Describe the motion of electrons in a periodic lattice. Discuss the concept of effective mass of electron in the band. 15
- (d) Derive an expression for the intrinsic carrier density in a semiconductor as a function of temperature and energy. 15

OR

- (e) Discuss the classical theory of electronic polarization. 10
- (f) Give an account of Weiss theory of ferromagnetism. Explain Curie-Weiss Law for magnetic susceptibility. 10
- (g) What is Meissner effect ? Explain how London's equations lead to this effect. 10
- (h) How are Cooper pairs formed ? Outline the BCS theory of superconductivity. 10
5. (a) Show that $\vec{\sigma}_1 \cdot \vec{\sigma}_2 = 1$ and -3 respectively for the spin triplet and spin singlet states of the two nucleon system. 7
- (b) With a necessary argument explain how the force between a neutron and a proton is 'spin dependent' and 'charge independent'. 9
- (c) Briefly explain Fermi's theory of β -decay. 12
- (d) Describe Wu's experiment and discuss how the result of this experiment demonstrates the parity-violating effect in β -decay. 12

OR

- (e) What are the main assumptions of nuclear shell model ? Show that the spin-orbit splitting energy is proportional to $(2I + 1)$. 10
- (f) Explain nuclear fission process. What is the energy liberated during fission process ? What are the conditions for spontaneous fission process ? 10
- (g) Give an outline of Bohr's compound nucleus hypothesis to explain nuclear reactions. 10
- (h) (i) Explain Gell-Mann-Nishijima Scheme. 5
(ii) Discuss Quark Model. 5

