Low energy scattering from a potential well and bound states, scattering length. Resonance scattering and quasi-bound states. 14 Hours

Unit -III

Relativistic Quantum Mechanics: The Klein-Gordon(KG) equation. Plane-wave solutions. KG equation in an electromagnetic field. Continuity equation. Limitations of KG equation and its correct interpretation. Non-relativistic reduction of KG equation. Application to two-body problem of two spinless particles in a Coulomb potential.

Dirac Equation: The free particle Dirac equation. Pauli-Dirac representation. Continuity equation. Plane wave solutions of the Dirac equation in the Pauli-Dirac representation, Normalisation. Dirac equation in an electromagnetic field. Non-relativistic approximation. Spin in Dirac theory, Conservation of angular momentum. Helicity. Negative energy solutions and Hole theory. Covariant formulation of Dirac equation, Gordon decomposition of vector current. Brief discussion on application of Dirac theory to the hydrogen atom. 14 Hours

References

1. E Merzbacher, Quantum Mechanics, 3rd edition, John Wiley (2012).
2. V K Thankappan, Quantum Mechanics, New Age International, New Delhi (2012).
3. P M Mathews and K Venkatesan, A Textbook of Quantum Mechanics, Tata McGraw-Hill, New Delhi (2012).
4. R L Liboff, Introduction to Quantum Mechanics, Pearson Education (2003).
5. R Shankar, Principles of Quantum Mechanics, 2nd edition,Plenum US (1994).
6. A Ghatak and S Lokanathan, QuantumMechanics: Theory and Applications, Macmillan (2004)
7. L I Schiff, Quantum Mechanics, 4th ed. McGraw-Hill Education Pvt Ltd. Chennai (2014)
8. B Bransden, C Joachain, Quantum Mechanics, 2nd edition, Pearson, New Delhi (2011).
9. J J Sakurai, Modern Quantum Mechanics, Pearson, New Delhi (2014).
10. J J Sakurai, Advanced Quantum Mechanics, Pearson, New Delhi (2006).
11. R P Feynman, R B Leighton and M Sands, The Feynman Lectures on Physics, Vol.3, Pearson, New York (2013).
12. J S Townsend,A Modern Approach to Quantum Mechanics, Viva Books, New Delhi (2014)
13. C Cohen-Tannoudji, B Diu, F Laloe, Quantum Mechanics (2 vol. set), Wiley-Interscience (1996).

MSE 510: MATERIALS IN ENERGY PRODUCTION -OPEN ELECTIVE-2
(3 Credits)

Objectives: Objective of the course is to impart a basic knowledge about global energy scenario, energy consumption in various sectors, renewable energy sources and energy production. The course gives brief idea on energy production with solar cells, fuel cells, etc. The course also provides basic knowledge on superconductivity and superconducting materials.

Expected course outcomes: The students should gain knowledge on global energy scenario such as production and consumption by various sectors. Students would have a basic knowledge about the solar cells and fuel cells for the energy production along with energy saving application like superconductors. Students are expected to learn to use energy resources effectively and efficiently.

Unit I

Global Energy Scene Energy consumption in various sectors, projected energy consumption for the next century, Definition and units of energy, power, forms of energy, conservation of energy, second law of thermodynamics. Solar Cells – Photovoltaic effect- light absorption- carrier generation and recombination, p-n junction: homo and heterojunctions, Metal-semiconductor interface; Equivalent Circuit of the Solar Cell, Analysis of PV Cells: Dark and illumination characteristics; solar cell- efficiency limits; variation of efficiency with band-gap and temperature- Efficiency measurements-high efficiency cells. Types of Solar cells. Solar cell fabrication technology. Recent developments. 14 hours

Unit II

Hydrogen energy – merits as a fuel – production of hydrogen – fossil fuels, electrolysis, thermal decomposition, photochemical and photocatalytic methods. Hydrogen storage – metal hydrides, metal alloy hydrides, carbon nanotubes, sea as source of deuterium. Fuel cells – introduction – difference between batteries and fuel cells, components of fuel cells, principle of working of fuel cell, performance characteristics of fuel cells, efficiency of fuel cell, fuel cell stack, fuel cell power plant: fuel processor, fuel cell power section, power conditioner, Advantages and disadvantages of fuel cell power plant. Types of fuel cells - Solid oxide fuel cells (SOFC), Molten carbonate fuel cells (MCFC), Phosphoric acid fuel cells (PAFC) Polymer electrolyte fuel cells. Application of fuel cells – Recent developments- commercially available fuel cells. 14 hours

Unit III

Superconductors - development in the field of superconductivity – properties of superconductors - perfect diamagnetism, Meissner effect – critical field and current – BCS theory. Types of superconductors - high T_c superconductors – properties - synthesis of high Tc superconductors. Applications of Superconductors in Energy, Superconducting wires and their characteristics, High field magnets for production of energy by magnetic fusion, Energy generation- Magnetohydrodynamics (MHD), energy storage, electric generators and role of superconductors. Large scale applications of superconductors. Electric power transmission, Applications of superconductor in medicine - Magnetic Resonance Imaging (MRI), Areas of applications, Superconducting Quantum Interference Devices (SQUID).

14 hours

References:

1. Fuel Cell Systems Explained, 2nd Edition- J Larminie and A Dicks (Wiley, 2003)
2. Principles of Fuel Cells- Xianguo Li (Taylor and Francis, 2005)
3. Fuel Cells: From Fundamentals to Applications- S Srinivasan (Springer, 2006)
4. Fuel Cell Fundamentals- O'Hayre, S W Cha, W Colella and F B Prinz, (Wiley, 2005)
5. Solid State Devices – Ben G Streetman and Sanjay Banerjee (Prentice-Hall, 2000)
6. High efficiency silicon solar cells – M A Green (Tran. Tech., 1987)