Semester-III
Course No. MPE-362
(Credit-4)
Physics of Dense Matter
Lectures: 50
Full marks: 50

1. Relatively Low Density Region: (10)
a) Hartree and Hartree-Fock Equations- use of Variational method; Application to Bulk nuclear matter and finite nuclei.
b) Thomas-Fermi and Thomas-Fermi-Dirac equations.
c) Thermal Thomas-Fermi and Thermal Hartree-Fock equations.

2. Matter of Moderate Density-I: (15)
a) Nuclear Skyrme interaction; Direct and Exchange interactions; Nuclear symmetry energy; Nuclear compressibility.
b) Harrison-Wheeler (HW), Baym-Pethick-Sutherland (BPS) and Baym-Bethe-Pethick (BBP) equation of states.
c) Nuclear Coulomb and Lattice energies.

3. Matter of Moderate Density-II: (10)
a) Nucleon-Nucleon scattering and nuclear realistic potential.
b) Lipmann-Schwinger equation.
c) Reid soft and hard core potentials.
d) Brueckner-Bethe-Goldstone equation.

4. Matter at High and Ultra-High Density: (15)
a) Dirac equation and relativistic Hartree and Hartree-Fock equations with some application to bulk nuclear matter and finite nuclei.
b) Mean field theory for nuclear matter with sigma-omega-rho meson exchange.
c) Hyperons in dense nuclear matter.
d) Pion-nucleon interaction and the possibility of pion condensation.
e) Quark matter: Quark-hadron phase transition at high density; Study of dense quark matter with relativistic Hartree-Fock equation and relativistic version of Landau theory of Fermi liquid at zero temperature.

Books Recommended:

1. Theory of finite Fermi system and applications to atomic nuclei, A.B. Migdal, Wiley Inter-Science.
2. Collision theory, M.L. Goldberger and K.M. Watson, Wiley.
3. K.A. Brueckner, in “The many-body problem”, Ed. C. Dewitt, Dunod Cie, Paris.
4. Physics of dense matter, Y.S. Leung, World Scientific.
5. S.L. Shapiro and S.A. Teukolsky, Black Holes, White Dwarfs and Neutron Stars, John Wiley and Sons, New York, (1983)

6. Recent progress in many body theory, J.G. Zabolitsky, M. De Lano, M. Fortes and J.W. Clark, Springer-Verlag.
7. Quantum theory of many-particle systems, A.L. Fetter and J.D. Walecka, Mc. Graw-Hill.
8. Theoretical nuclear and sub-nuclear physics, J.D. Walecka, Oxford Univ. Press.
9. Meson in nuclei, Vol.-I, M. Rho and D. Wilkinson (eds.), North-Holland.
10. G. Baym and D.K. Campbell, Mesons in nuclei-III, (M.Rho and D. Wilkinson eds.), North-Holland.
11. Models of the nuclei, R.K. Bhaduri, Addision-Wesley Publishing Co.
12. K.A. Brueckner, "Theory of nuclear structure", in The Many-Body Problem, (ed. C. Dewitt), John Wiley.
13. L.S. Celenza and C.M. Shakin, Relativistic nuclear physics, World Scientific.
14. Quantum many-particle system, J.W. Negele and H. Orland, Addision-Wiesly.
15. N.K. Glendenning, Compact Stars: Nuclear physics, particle physics and gravitation, Springer.
16. P. Ring and P. Schuck, The nuclear many-body problem, Springer-Verlag.
17. Matter at high densities in astrophysics- compact stars and the equation of states- In Honor of Friedrich Hund's 100^{th} Birthday, Springer.