INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE**:** **DEPARTMENT OF PHYSICS**

1. Subject Code: **PH 624** Course Title: **Computational Nuclear Structure Physics**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): Theory | 0 | 3 | Practical | 0 | 0 |

4. Relative Weightage: **CWS** | | | **PRS** | | | **MTE** | | | **ETE** | | | **PRE** | 0 | 0 |

5. Credits: | 0 | 3 | 6. Semester: | Spring | 7. Subject Area: | DEC |

7. Pre-requisite: Introductory course in nuclear physics and in computer programming

9. **Objective of Course:** To understand the concepts of nuclear physics through numerical solutions obtained by writing computer programs

10. Details of the Course:

S. No.	Particulars	Contact Hours
1.	Harmonic oscillator, wave functions, evaluation of special functions using recurrence relations and optimization, spherical harmonics, shapes of atomic orbitals, Coupling of angular momenta.	**5**
2.	Simulation of Rutherford scattering, Semi empirical mass formula, estimation of the constants in mass formulae using atomic mass evaluations, mapping of drip lines. Quantum tunneling: application of WKB approach to alpha and proton decays.	**5**
3.	Numerical evaluation of Eigen states for different potentials by solving coupled differential equations with boundary conditions, harmonic oscillator, square-well and Woods-Saxon potentials. Complex Eigen values and resonances	**5**
4.	Independent particle models, Eigen states, Solutions for Nilsson model. Single-*j* shell approximation and Cranking model. Effective interaction: Simple estimates, Evaluation of matrix elements in sd shell. Superconductivity: Solution for BCS equations at $T = 0$. Hot nuclei: Application of Fermi-Dirac distribution. Quantum Hadrodynamics: Walecka model, Equation of State for symmetric, asymmetric and neutron star matter	**10**
5.	Setting up large codes, parallel and distributed computing, open access codes, libraries	**3**
	Total	**28**

11. Suggested Books:

S. No.	Name of Books/Authors	Year of Publication
1.	Greiner W and Maruhn J A, **"Nuclear models",** Springer-Verlag	1997
2.	Arfken G B, Weber H J and Harris F E, **"Mathematical Methods for Physicists 7ed"**, Academic Press	2013
3.	Abramowitz M and Stegun I A, "**Handbook of mathematical functions with formulas, graphs and mathematical tables**", Dover Publications	1972
4.	Giordano N and Nakanishi H **"Computational Physics, 2ed"**, Pearson/Prentice Hall	2006
5.	Pang T, **"An Introduction to Computational Physics"**, Cambridge Univ. Press	2006