Universitatea Nationala de Ştiinţă şi Tehnologie
POLITEHNICA Bucureşti (UNST)
Departamentul de FIZICĂ

General physics competition program for engineering students
PHYSICS II

Atomic and molecular physics

Fundamental notions of atom and molecule physics
Electronic structure of atoms (characteristic quantum numbers); the periodic table of the elements
Atomic transitions - selection rules. The atomic spectrum
Elements of molecular structure; molecular spectrum
Raman effect
Optical spectroscopy - experimental approach
X-ray diffraction. X-ray spectrometry.
De Broglie hypothesis (particle wave duality)
Fundamental experiments indicating the particle-wave duality of the material world. (Davisson-Germer, GP Thomson). The Compton effect in the case of an (ultra)relativistic electron

2. Black body radiation

Spectral radiance of surfaces (black body model).
Stefan-Boltzmann law.
Volumetric spectral density of radiation.
Wien's displacement law

3. Quantum mechanics

The wave function – the Born interpretation
Quantum mechanics postulates
The Schrödinger equation; stationary states - the timeless Schroedinger equation: the problem of vectors and eigenvalues
Current density probability
Observables and operators in quantum mechanics
Orbital angular momentum, spin angular momentum, total angular momentum, Clebsch-Gordan coefficients, corresponding magnetic moments (spin-orbit interaction), Lande factor
Simultaneous observables, switching relations - interpretation. Heisenberg uncertainty relations
Elementary applications: free particle, (infinite and finite) potential well, potential step and barrier
Schrödinger equation for the hydrogen atom: spherical symmetry, wave function: radial component and angular component - orbitals
The Hilbert space of quantum states
The de Broglie wave packet
The quantum harmonic oscillator
Ehrenfest theorems – the classical limit
Approximation methods in quantum mechanics (stationary and time-dependent perturbations, variational method, WKB method)
Atom in external electric and magnetic fields, Stark effect, Zeeman effect.
Quantum systems of several identical particles – Pauli's principle
Fermi-Dirac and Bose-Einstein quantum statistics; applications
Lasers – the principle of operation; classification; Characteristics of laser radiation
Quantum theory of scattering – scattering amplitude
Elements of relativistic quantum mechanics (Dirac and Klein-Gordon equations)
Fundamentals of quantum computing.

4**. Nuclear physics.**

Noţiuni fundamentale.
Structura neutrono-protonică a nucleului
Specii nucleare; harta Segre a nuclizilor
Dimensiuni nucleare
Defectul de masă: energia de legătură, originea energiei nucleare
Forţe nucleare – proprietăţi;
Stări cuantice nucleare; spectre de excitaţie – exemple
Modele nucleare (modelul în pături, modele colective)
Dezintegrări nucleare – clasificare, legi de conservare
Acceleratorii de particule – principiu de funcţionare, clasificare

5. Nuclear reactions- conservation laws.

Nuclear fission and fusion reactions; Nuclear fission and fusion reactors. Fundamentals of plasma physics.

6. Astrophysics.

References:

1. Physics university courses

2. Physics problems given at the county, national and international school Olympiads and other Physics contests.