

NB-136

December-2015

M.Sc., Sem. III

501 : Physics

(Nuclear Physics, Advanced Quantum Mechanics – 1 and Instrumentation)

Time : 3 Hours]

[Max. Marks : 70

- Instructions :** (1) Attempt **all** questions.
 (2) **All** questions carry equal marks.
 (3) Symbols have their usual meaning.
 (4) Scientific calculator is allowed.

1. (A) State types of excitations and derive the expression $\frac{N_{ortho}}{N_{para}} = \frac{I+1}{I}$ from molecular band spectra. 7

OR

State the nuclear properties and discuss electric quadrupole moment and show that existence of quadrupole moment in terms of $I \geq 1$.

- (B) Write brief description of hyperfine structure of atomic spectra and also explain effect of external magnetic field on the hyperfine structure. 7

OR

Describe the molecular beam experiments on hydrogen and deuteron and also discuss its results.

2. (A) Write different types of potentials. Explain the ground state of deuteron. 7

OR

Derive expression on scattering cross-section of neutron-proton scattering below 10 MeV energies.

- (B) Discuss proton-proton scattering at low energy and obtain scattering differential cross-section σ_{sc} . 7

OR

Write a short note on Yukawa's meson theory of nuclear forces.

3. (A) Discuss Green function method to obtain the solution of schrodinger equation. Show that scattering amplitude is the Fourier transformation of potential. 7

OR

Discuss Eikonal approximation and derive expression for scattering amplitude.

- (B) Obtain scattering amplitude (θ , ϕ) in terms of phase shift δ_1 . Also obtain total differential scattering cross-section σ . 7

OR

Derive condition for Born-approximation for scattering amplitude.

$\left| \int_0^{\infty} (e^{2ikr} - 1) V(r) dr \right| \ll \frac{\hbar^2 k}{m}$. Obtain condition for low energy scattering with square well potential.

4. (A) Define transducer and state its desired characteristics. Explain magnetic search coil. 7

OR

What do you mean by sensitivity and linearity of a transducer ? Explain optical transducer.

- (B) What do you mean by phase sensitive detection ? Explain concept of such detection and give block diagram of Lock in Amplifier. 7

OR

“In a multistage cascade amplifier, the noise due to the first stage must be made minimum” – Justify.

5. Answer in brief : 14

- (1) Draw the noise spectrum of a typical laboratory system.
- (2) Differentiate between Johnson noise and flicker noise.
- (3) Give a schematic of LVDT transducer.
- (4) What will be the value of spherical harmonics for $m = 0$?
- (5) What will be the contribution to the total scattering cross-section from S and P waves ?
- (6) What will be the unit of ' α ' in the expression of screened coulomb potential ?

- (7) Scattering amplitude for s-wave is independent of scattering angle (TRUE/FALSE).
 - (8) State the value of nuclear radius.
 - (9) What is the value of nuclear density of a nucleus ?
 - (10) Binding energy/Nucleon (B/A) remains constant between $A = \underline{\hspace{1cm}}$ and decreases for $A = \underline{\hspace{1cm}}$ and $A = \underline{\hspace{1cm}}$.
 - (11) Scattering length is positive is indicate $\underline{\hspace{1cm}}$ state whereas negative indicate $\underline{\hspace{1cm}}$.
 - (12) In case of Heisenberg potential, $L + S = \underline{\hspace{1cm}}$ for even ψ function.
 - (13) Write the equation for Gaussian potential $V(r) = \underline{\hspace{1cm}}$.
 - (14) Write definition of Hyperfine structure.
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