

PT - 301 QUANTUM MECHANICS - II

Max. Marks: 35

2017-18

Pass Marks: 12

Unit- I Approximation methods for bound states-II

Formulation of first order time independent perturbation theory for degenerate levels, Application to first order Stark effect of a hydrogen like atom, Fine structure splitting of atomic energy levels, Zeeman Effect with and without electron spin.

Unit- II Approximation methods for time dependent problems

Time dependent perturbation theory, first order transition probability, constant perturbation, harmonic perturbation, Fermi Golden Rules, Atom in a radiation field, Einstein's  $A$  and  $B$  coefficients, Plane electromagnetic waves, Electric dipole transitions, selection rules.

Unit- III Identical Particles

Indistinguishability, Exchange degeneracy, Symmetric and antisymmetric wave functions for many particle systems, Spin and statistics, Computation of interaction energy for two-particle systems, Exchange interaction, Application to ground state of a helium-like atom, Structure of wave function for excited states of a helium-like atom, Pauli exclusion principle (qualitative), Collisions of identical particles Allowed states of 2-particle systems.

Unit- IV scattering theory

Scattering cross section, Laboratory and center-of-mass coordinate systems, Transformation of variables from one system to another, asymptotic behavior, scattering by spherically symmetric potentials, Partial waves and phase shifts, Partial wave expansion of differential cross section, Total cross section, Ramsauer-Townsend effect scattering by a perfectly rigid sphere, scattering by a square potential well, Green's functions in scattering theory, Born approximation, Application to scattering by (i) a square potential well (ii) Yukawa potential, Hyper geometric functions, scattering in a coulomb field (separation in parabolic coordinates), Rutherford formula.

Unit-V Elements of relativistic quantum mechanics

Klein-Gordon equation, Free particle solutions, Dirac equation for a free particle, Free particle solution, Negative energy, Hole theory, Reduction of Dirac equation into covariant form, Gamma matrices and their algebra, Existence of spin, Electromagnetic potentials in Dirac equation, Existence of magnetic moment.

Books Recommended:

1. Quantum Mechanics: L.I.Schiff
2. Quantum Mechanics: J.L. Powell and Crasman
3. Introduction to Quantum Mechanics: Pauling and Wilson
4. Quantum Mechanics and Field Theon: B.K Agrawal
5. Quantum Mechanics: A.K. Ghatak and S. Loknathan
6. The Principles of Quantum Mechanics: Dirac
7. Practical Quantum Mechanics: Flügge.

M. Colkh  
18.10.21

18.10.21  
Deepti Jain  
18/10/21

18/10/21

18/10/21

Premalata  
18.10.21

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Note: This paper has been divided into FIVE units. The paper will be set as per existing examination norms covering uniformly all the units and providing to the examinee sufficient choice in each unit.

**Unit- I Atomic Physics**

Quantum states of one electron atom, atomic orbitals, Hydrogen spectrum, spectra of alkali elements, spin orbit interaction and fine structure of alkali spectra, normal and anomalous Zeeman effect, Paschen back effect, Stark effect, two electron system, equivalent and non equivalent electrons, Pauli's exclusion principle, interaction energy, L-S and J-J coupling, Hyperfine structure, line broadening mechanisms.

**Unit- II Rotational Spectra**

Type of molecules: Linear, Non-linear, symmetric top, asymmetric top, spherical top; rotational spectra of diatomic molecules as a rigid rotator, energy level diagram and spectra, rotational spectra of non rigid rotator, energy level diagram and spectra, intensity of rotational lines, applications of rotational spectra and pure rotational spectra.

**Unit- III Vibrational and Vibrational-rotational Spectra**

Vibrational energy of diatomic molecules, diatomic molecule as a simple oscillator, its energy level diagram and spectrum, Morse potential energy curve, molecules as vibrating rotator, vibration spectrum of diatomic molecules, PQR branches, infrared spectrometry, vibrational Raman spectroscopy, structure determination from Raman and IR spectroscopy.

**Unit- IV Fluorescence Spectroscopy**

Vibronic interaction, Herzberg Teller theory, fluorescence spectroscopy, Kasha's rule, Quantum yield, non radiative transition, Jablonski diagram, time resolved fluorescence and determination of excited state life time.

**Unit- V Nuclear Instrumentation**

Ionization of matter by charge particles, interaction of electromagnetic radiation with matter, stopping power and range, photo electric effect, Compton effect and pair production, radiation detection, gas filled counters, solid state counters, scintillation counter, photomultiplier tube, Cerenkov detector, nuclear emulsions, Betatron, electron synchrotron and proton synchrotron.

**BOOKS RECOMMENDED**

1. Introduction to Atomic Physics: H.E. white
2. Fundamentals of Molecular spectroscopy: C.N.Banwell and E.M. Mc Cash
3. Spectra of diatomic molecules: Herzberg
4. Spectroscopy Vol. I&II : Walker and Straughen
5. Nuclear Physics : Karlan

M. Cokle  
18.10.21

M  
18.10.21

Shikha  
18/10/21

B  
18/10/21

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Deepti Jain  
18/10/21

Premkumar  
18.10.21

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### Unit-I Point Defects and Alloys

Lattice vacancies, Interstitial and their thermodynamical calculations, Features of point defects, Color centers, Formation of alloys, Order-disorder transformation, Elementary theory of order

### Unit-II Dielectric and Ferroelectric

Static polarization: various types of polarization, Local fields, Clausius-Mossotti relation, Time dependent polarization and dielectric relation, Lyddane-Sachs-Teller relation, Ferroelectric crystals, Classification of ferroelectric crystals, polarization catastrophe, First and second order phase transitions, Idea of antiferroelectricity, Piezo-electricity and ferroelectricity

### Unit-III Magnetic Properties of Solids

Quantum theory of paramagnetism and ferromagnetism, exchange integral and Heisenberg interaction, Magnon and magnon dispersion relation, Antiferromagnetic and ferromagnetic orders, Anisotropy energy, Bloch Walls, Idea of ferrites

### Unit-IV Superconductivity - I

Concept of superconducting state, Thermodynamical properties of superconductors, London's equation and penetration depths, Magnetic properties and critical magnetic fields, Meissner effect, Flux quantization, Microwave and infrared properties, Coherence length

### Unit-V Superconductivity - II

Two fluid model for superconducting state, Ginzburg-Landau theory, Basic features of Pippard's non local theory, elements of BCS theory of superconductivity, Isotope effect, Single particle tunneling, DC and AC Josephson effects, Josephson tunneling, a Qualitative description of high T<sub>c</sub> superconductivity in ceramic oxides.

### BOOKS RECOMMENDED

1. Introduction to solid state physics: Kittel
2. Solid state Physics: Ashcroft and Marmin
3. Solid state Physics: Epifanov
4. Superconductivity: Parks
5. Intermediate quantum theory of crystalline solids: Animalu
6. Solid state Physics: Zimam

M. Gokhale  
18.10.21

M  
18/10/21

Shubra  
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S  
18/10/21

P  
18/10

Deepti Jain  
18/10/21

Premalata  
18.10.21

PT -304A MICROWAVE AND OPTICAL COMMUNICATION

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Unit-I Microwave Generators and Solid State Devices

Transit time effect at high frequency, failure of triodes/diodes at high frequency, concept of velocity modulation and current modulation, Klystron, Operation and characteristics, Reflex Klystron, Magnetron, Principle of operation and microwave characteristics of Gunn diode and Impatt diode

Unit- II Microwave Propagation and Components

Wave propagation in circular wave-guide, solution of wave guides, power transmission and losses in circular wave guide, Cavity resonators, Wave-guide Tee's (Magic Tee), S- parameters

Unit- III Microwave Integrated Circuits

Characteristics impedance of microstrip lines, effective dielectric constant, Losses in microstrip lines, Dielectric losses, Ohmic losses, Radiation Losses, The quality factor Q of the transmission line, microstrip line discontinuities, idea of capacitance and inductors, Idea of material used for integrated circuit, Brief idea about microwave integrated circuit

Unit-IV Optical Fibers

Basic optical laws and definitions, Optical fiber modes and configuration, Mode theory for circular waveguides, solution of wave equation for index fibers, Power flow in step index fibers, Graded index fibers, Modes in graded index fibers

Unit- V Integrated optics

Idea of modes in asymmetric planer wave guide, strip waveguide, Phase modulators, Mach-Zehnder interferometer modulator, optical directional couplers, PIN diode photodetectors, Avalanche photodiode detectors, Idea of optical fiber communication system

BOOKS RECOMMENDED

1. Radio and electrical engineering: Terman
2. Microwave devices and circuits: Lio
3. Microwave: Atwater
4. Microwave Engineering: Rizzi
5. Microstrip lines: K.C. Gupta
6. Optical fibre system: C.K. Kao
7. Optical fibre communication system: Kaiser
8. Optical fibre communication system: Gower
9. Optical electronics: Ghatak
10. An introduction to optical fibres: Cheriau.

M. Cokhar  
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Deepti Jain  
18/10/21

Premkumar  
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