### Department of Physics
**Andhra University**

**Common for M.Sc. Physics and M.Sc. Space Physics**

**II Semester (w.e.f 2009-10 batch)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>P 201</td>
<td>Electrodynamics</td>
<td>85+15=100</td>
</tr>
<tr>
<td>P 202</td>
<td>Statistical Mechanics</td>
<td>85+15=100</td>
</tr>
<tr>
<td>P 203</td>
<td>Atomic and Molecular Physics</td>
<td>85+15=100</td>
</tr>
<tr>
<td>P 204</td>
<td>Nuclear and Particle Physics</td>
<td>85+15=100</td>
</tr>
<tr>
<td>P 205</td>
<td>Modern Physics lab - II Practical</td>
<td>100</td>
</tr>
<tr>
<td>P 206</td>
<td>Electronics Lab –II Practical</td>
<td>100</td>
</tr>
</tbody>
</table>

**TOTAL MARKS**

600

**Introductory Atmospheric and Space Physics**

*For Each Theory Paper  85 marks for semester end exam and 15 marks for internal assessment*

**Scheme of Examination**

- Theory pass minimum: 40%
- Practical pass minimum: 50%
- Aggregate: 50%

**Scheme of Instruction:**

- Teaching Hours: 4 Periods per week
- Tutorial: 1 Period per week
- Practical: 6 Periods per week
DEPARTMENT OF PHYSICS
ANDHRA UNIVERSITY
Common for M.Sc. Physics and M.Sc. (Space Physics)
II Semester
(w.e.f 2009-10 batch)
P201, SP201: ELECTRO DYNAMICS.

UNIT-I: Gauss Theorem, Poission’s equation, Laplaces equation, solution to Lapalaces equation in cartesian coordiantes, spherical coordinates, cylindrical coordinates, use of Laplaces equation in the solutions of electrostatic problems.

6Hrs

Ampere’s circuital law, magnetic vector potential, displacement current, Faraday’s law of electromagnetic induction,

4Hrs

UNIT-II: Maxwell’s equations, differential and integral forms, physical significance of Maxwell’s equations.

4Hrs

Wave equation, plane electromagnetic waves in free space, in nonconducting isotropic medium, in conducting medium, electromagnetic vector and scalar potentials, uniqueness of electromagnetic potentials and concept of gauge, Lorentz gauge, Coulomb gauge,

6Hrs

charged particles in electric and magnetic fields: charged particles in uniform electric field, charged particles in homogerous magnetic fields, charged particles in simultaneous electric and magnetic fields, charged particles in nonhomogeneous magnetic fields.

6Hrs

UNIT-III: Lienard-Wiechert potentials, electromagnetic fields from Lienard-wiechert potentials of a moving charge, electromagnetic fields of a uniformly moving charge, radiation due to non-relativistic charges, radiation damping, Abraham-Lorentz formula, cherenkov radiation, radiation due to an oscillatory electric dipole, radiation due to a small current element. Condition for plasma existence, occurrence of plasma, magneto hydrodynamics, plasma waves

10 Hrs

UNIT-IV: Transformation of electromagnetic potentials, Lorentz condition in covariant form, invariance or covariance of Maxwell field equations in terms of 4 vectors, electromagnetic field tensor, Lorentz transformation of electric and magnetic fields.

12 Hrs

Text books:
1. Classical Electrodynamics                      - J.D. Jackson
2. Introduction to Electrodynamics               - D.R. Griffiths
3. Electromagnetic Theory and Electrodynamics    - Satyaprakash
4. Electrodynamics                              - KL Kakani
UNIT-I : Basic Methods and Results of Statistical Mechanics: 13 Hrs
Specification of the state of a system, phase space and quantum states, Liouville's theorem, Basic postulates, Probability calculations, concept of ensembles, thermal interaction, Mechanical interaction, quasi static process, distribution of energy between systems in equilibrium, statistical calculations of thermo dynamic quantities, Isolated systems (Microcanonical ensemble). Entropy of a perfect gas in microcanonical ensemble. Canonical ensemble - system in contact with heat reservoir, system with specified mean energy, connection with thermodynamics, Energy fluctuations in the canonical ensemble. Grand canonical ensemble, Thermodynamic function for the grand canonical ensemble. Density and energy fluctuations in the grand canonical ensemble. Thermodynamic equivalence of ensembles. Reif Ch:2, 3.3,3.12 Ch:6

UNIT-II : Simple Applications of Statistical Mechanics: 12 Hrs

UNIT-III: Quantum Statistics: 15 Hrs

UNIT-IV: Non Ideal Classical Gas: 10 Hrs
Calculation of the partition function for low densities. Equation of state and virial coefficients (Van Der Walls equation) Reif Ch:10.3,10.4

Phase Transitions and Critical Phenomena:
Phase transitions, conditions for Phase equilibrium, First order Phase transition – the Clausius–Clayperon equation, Second order phase transition, The critical indices, Van der Waals theory of liquid gas transition. Order parameter, Landau theory. Sinha Ch:10

Text Books
1. Fundamentals of Statistical and Thermal Physics F. Reif
2. Statistical Mechanics, Theory and Applications S.K. Sinha
UNIT-I  
12 Hrs  

**ONE VALENCE ELECTRON ATOMS:** Modified term values (quantum defect) due to lifting of orbital degeneracy by core penetration (penetrating orbits) and core polarization (non-penetrating orbits) by nl electrons. Term values and fine structure of chief spectral series of sodium. Intensity rules and application to doublets of sodium. Hyperfine structure of 2P-2S of sodium (I= 3/2).

UNIT-II  
10 Hrs  

**Lasers** - spontaneous emission, stimulated emission, population inversion, Einstein coefficients, metastable levels, resonance transfer and population inversion in He-Ne laser.

UNIT-III  
8 Hrs  
**ATOMS IN EXTERNAL MAGNETIC FIELD:** Quantum theory of Zeeman and Paschen-Back effects and application to 2P-2S, 3P-3S transitions.

**ATOMS IN EXTERNAL ELECTRIC FIELD:** Linear stark pattern of Hα line of hydrogen and Quadratic stark pattern of D1 and D2 lines of Sodium.

UNIT-IV  
20 Hrs  

**MOLECULAR VIBRATIONS:** Symmetry operations and identification of point Groups of HCN, CO₂, BH₃, NH₃, H₂O molecules. Properties of irreducible representations and C₂v character table. Reducible representation and symmetry of fundamental vibrations of H₂O.

**BOOKS:**
1. Atomic and Molecular Spectra - Rajkumar
2. Fundamentals of Molecular Spectroscopy - C.N.Banwell.
UNIT - I
INTRODUCTION :
Objective of Studying Nuclear Physics, Nomenclature, nuclear radius, mass &
Binding energy, angular momentum, magnetic dipole moment, Electric quadrupole
moment, parity and symmetry, domains of instability, Energy levels, mirror nuclei.
NUCLEAR FORCES : Simple theory of the deuteron, scattering cross-sections, qualitative
discussion of neutron- proton and proton- proton scattering, charge independence and charge
symmetry of nuclear forces, exchange forces, Yukawa’s Potential, Characteristics of Nuclear
Forces.
UNIT - II
NUCLEAR MODELS : Liquid drop model, Weissacker’s semi-emperical mass formula,
Mass – parabolas. Nuclear shell model : Spin orbit interaction, magic numbers, prediction of
angular momenta and parities for ground states, Collective model, More-realistic models
NUCLEAR DECAY : Alpha decay process, Energy release in Beta-decay, Fermi’s
Theory of β - decay, selection rules, parity violation in β - decay, Detection and properties of
neutrino. Energetics of gamma decay, selection rules, angular correlation, Mossbauer effect.
NUCLEAR REACTIONS : Types of reactions and conservation laws, the Q – equation,
Optical model, heavy ion Reactions
UNIT - III
NUCLEAR ENERGY Stability limit against spontaneous fission, Characteristics of
fission, delayed neutrons, Four factor formula for controlled fission, Nuclear fusion, prospects of
continued fusion energy.
ELEMENTARY PARTICLE PHYSICS: Particle interactions and families, symmetries and
conservation laws ( energy and momentum, angular momentum, parity, Baryon number, Lepton
number, isospin, strangeness number (Gellmann and Nishijima formula) and charm),
Elementary ideas of CP and CPT invariance, SU(2), SU(3) multiplets, Quark model.
UNIT - IV
DETECTING NUCLEAR RADIATION: Interaction of radiation with matter. Gas filled
counters, scintillation detectors, semiconductor detectors, energy measurements, coincidence
measurements and time resolution, magnetic spectrometers.
ACCELERATORS: Electrostatic accelerators, cyclotron accelerators, synchrotrons, linear
accelerators, colliding beam accelerators.
APPLICATIONS OF NUCLEAR PHYSICS: Trace Element Analysis, Rutherford Back-
scattering, Mass spectrometry with accelerators, Diagnostic Nuclear Medicine, Therapeutic
Nuclear Medicine.
TEXT BOOKS : “Introductory Nuclear Physics” Kenneth S. Krane

Reference Books:
1. “Introduction to Nuclear Physics “ Harald A. Enge
4. “Introduction to Elementary Particles” D. Griffiths
Department of Physics, Andhra University

Introductory Atmospheric and Space Physics
(Choice based course to be offered in the Department of Physics during II Semester with a minimum intake of 15 and maximum 25)
With effect from 2009-2010 admitted batch)

Target aspirants: PG students from departments of Meteorology and Oceanography, Geophysics, Environmental sciences, Geography, Geo-engineering and Electronics and Communication engineering)

Unit I: The Neutral atmosphere, atmospheric nomenclature, the Hydrostatic equation, geopotential height, expansion and contraction, fundamental forces in the atmosphere, apparent forces, atmospheric composition, solar radiation interaction with the neutral atmosphere, climate change.

Unit II: Electromagnetic radiation and propagation of waves: EM Radiation, fundamentals of EM waves, effects of environment, Antennas- basic considerations, types of antennas. Propagation of waves: ground wave, sky wave, and space wave propagation, troposcatter communication and extra terrestrial communication.

Unit III: The Ionosphere, morphology of ionosphere, the D, E and F-regions, chemistry of the ionosphere, ionospheric parameters, E and F region anomalies and irregularities in the ionosphere.

Unit IV: Global Positioning systems (GPS)- basic concepts, overview of GPS system, augmentation services, GPS system segment, GPS signal characteristics, GPS errors, multi path effects, GPS performance, satellite navigation system and applications.

Reference Books:

2. Climatology, An atmospheric Science by John E. Oliver and John J. Hindore, Pearson Education
4. Introduction to Ionospheric Physics by Henry Rishbeth and Owen K. Garriot, Academic press
5. Understanding GPS principles and applications by Elliot D. Kaplan and Christopher J. Hegarty, Artech House, Boston.
1. Atomic Spectrum of Sodium.
   a) identification of sharp and diffuse doublets
   b) doublet separation
   c) assignment of principal quantum numbers
2. Raman Spectrum of Carbon Tetrachloride
   a) Raman shifts
   b) Fermi resonance
3. Vibrational analysis of AlO Green system.
   a) identification of sequences, assignment of vibrational quantum numbers,
   b) Deslandre’s table and Vibrational constants.
4. Determination of Specific Charge of an electron by Thomson’s Method.
5. Experiments with He- Ne laser.
   a) Polarization of laser light
   b) Divergence of laser beam and monochromaticity.
7. Dielectric constant as a function of temperature and determination of Curie Temperature
8. Susceptibility of a substance Gouy’s method
9. Dissociation energy of Iodine molecule from the given data.
List of Experiments (Any SIX of the following)

1. Active Low pass and High Pass filters (IC 741)
2. Twin -T filter (IC 741)
3. Logarithmic Amplifier (IC 741)
4. Wein Bridge Oscillator (IC 741)
5. Monostable multivibrator (IC 555)
6. Voltage Regulator (IC 723)
7. Phase Shift Oscillator (IC 741)
8. Astable multivibrator (IC 555)
9. Active band pass filter (IC 741)
10. Voltage controlled oscillator (IC 741, IC 555)