Established by Govt. of Arunachal Pradesh vide Act 9 of 2012, the Arunachal University of Studies Act, 2012 Recognized as per u/s 2(f) of University Grants Commission Act, 1956
NH-52, Namsai, Arunachal Pradesh -792103

MASTER OF SCIENCE (PHYSICS) – THIRD SEMESTER

Third Semester			
S. No.	**Name of Subject**	**Credits**	**Total Marks**
1	Condensed Matter Physics	5	100
2	Nuclear and Practical Physics	5	100
3	**Any One** Special Paper-I Condensed Matter Physics Special Paper-I Advanced Electronics	5	100
4	**Any One** Special Paper-II Condensed Matter Physics Special Paper-II Advanced Electronics	5	100
5	**Any One** Optics Laboratory Computational Method and Programme Laboratory	4	100
	Total	**24**	

Subject Name: CONDENCED MATTER PHYSICS

Crystal Physics and Defects in Crystals:

Unit 1: Crystalline solids, unit cells and direct lattice, two and three dimensional Bravais lattices, closed packed structures.

Unit 2: Interaction of X-rays with matter, absorption of X-rays. Elastic scattering from a perfect lattice. The reciprocal lattice and its applications to diffraction techniques. The Laue, powder and rotating crystal methods, crystal structure factor and intensity of diffraction maxima. Extinctions due to lattice centering.

Unit 3: Point defects, line defects and planer (stacking) faults. The role of dislocations in plastic deformation and crystal growth. The observation of imperfect ions in crystals, X-ray and electron microscopic techniques.

Electronic Properties of Solids:

Unit 4: Electronsin a periodic lattice: Bloch theorem, band theory, classification of solids, effective mass. Tight-bonding, cellular and pseudo-potential methods. Fermi surface, de Hass von Alfen effect, cyclotron resonance, magneto-resistance, quantum Hall effect. Superconductivity: critical temperature, persistent current, Meissner effect.

Unit 5: Weiss theory of ferromagnetism. Heisenberg model and molecular field theory. Spin waves and magnons. Curie-Weiss law for susceptibility, Ferri- andanti-ferromagnetic order. Domains and Bloch-wallenergy.

Recommended Texts

1. Crystallography for Solid State Physics, Verma and Srivastava
2. Introduction to Solids, Azaroff
3. Elementary Solid State Physics, Omar
4. SolidState Physics, Aschroft & Mermin, Solid State Physics, Kittel
5. Principles of Condensed Matter Physics, Chaikin and Lubensky

Subject Name: NUCLEAR AND PARTICLE PHYSICS

Unit 1: Nuclear Interactions and Nuclear Reactions

Nucleon –nucleon interaction -Exchange forces and tensor forces -Meson theory of nuclear forces - Nucleon -nucleon scattering - Effective range theory -Spin dependence of nuclear forces -Charge independence and charge symmetry of nuclear forces –Iso spin formalism - Yukawa interaction. Direct and compound nuclear reaction mechanisms -Cross sections in terms of partial wave amplitudes - Compound nucleus -Scattering matrix -Reciprocity theorem -Breit-Wigner one- level formula Resonance scattering.

Unit 2: Nuclear Models

Liquid drop model -Bohr -Wheeler theory of fission -Experimental evidence for shell effects – Shell model -Spin-Orbit coupling -Magic numbers -Angular momenta and parities of nuclear ground states - Qualitative discussion and estimates of transition rates-Magnetic moments and Schmidt lines-Collective model of Bohrand Mottelson.

Unit 3: Nuclear Decay

Beta decay - Fermi theory of beta decay - Shape of the beta spectrum -Total decay rate- Angular momentum and parity selection rules-Comparative half-lives-Allowed and forbidden transitions - Selection rules - Parity violation - Two-component theory of neutrino decay - Detection and properties of neutrino -Gamma decay -Multipole transitions in nuclei -Angular momentum and parity selection rules-Internal conversion -Nuclear isomerism.

Unit 4: Elementary Particle Physics

Types of interaction between elementary particles - Hadrons and leptons - Symmetry and conservation laws -Elementary' ideas of CP and CPT invariance -Classification of hadrons – Lie algebra, SU(2) -SU(3) multiplets -Quark model -Gell -Mann -Okubo mass formula for octetand decuplet hadrons -Charm, bottom and top quarks.

Recommended Texts

1. Bohr and B.R. Mottelson, Nuclear Structure, Vol. 1(1969) and Vo1.2, Benjamin, Reading, A, 1975.
2. Kenneth, S. Kiane, Introductory Nuclear Physics, Wiley, New York, 1988.
3. Ghoshal, Atomic and Nuclear Physics Vol.2.P.H.Perkins,
4. Introduction to High Energy Physics, Addison-Wesley, London, 1982.
5. S.de Benedetti, Nuclear Interaction, John Wiley & Sons, New York, 1964.

6. M.K. Pal, Theory of Nuclear Structure, Affiliated East-West, Madras, 1982.
7. Y.R. Waghmare, Introductory Nuclear Physics, Oxford-IBH, Bombay, 1981.
8. J.M. Longo, Elementary Particles, MeGraw -Hill, New York, 1971.
9. R.D. Evans, Atomic Nucleus, MeGraw Hill, New York, 1955.
10. Kaplan, Nuclear Physics, 2nd Ed., Narosa, Madras, 1989.
11. B.L. Cohen, Concepts of Nuclear Physics, TMGH, Bombay, 1971.
12. R.R. Royand B. P. Nigam, Nuclear Physics, Wiley-Eastern Ltd., 1983.

Subject Name: SPECIAL PAPER I (CONDENSED MATTER PHYSICS)

Unit 1: Lattice Dynamics and Optical Properties of Solids

Inter atomic forces and lattice dynamics of simple metals, ionic and covalent crystals. Optical phonons and dielectric constants. Inelastic neutron scattering. Mossbauer Effect. Debye Waller factor. An - harmonicity, thermal expansion and thermal conductivity. Interaction of electrons andphonons with photons. Direct and indirect transitions. Absorption in insulators, Polaritons, one- phonon absorption, optical properties of metals, skin effect and anomalous skin effect.

Unit 2: Electron-Phonon Interaction

Interaction of electrons with acoustic and optical phonons, polarons. Superconductivity: manifestations of energy gap. Cooper pairing due to phonons, BCS theory of superconductivity, Ginzsburg. Landau theory and application to Josephson effect: d-e Josephson effect, a-c Josephson effect, macroscopic quantum interference. Vortices and type II superconductors, high temperature superconductivity (elementary).

Recommended Texts

1. Madelung: Introduction to Solid State Theory
2. Callaway: Quantum Theory of Solid State
3. Huang: Theoretical Solid State Physics
4. Kittel: Quantum Theory of Solids

Subject Name: SPECIAL PAPER I (ADVANCED ELECTRONICS)

UNIT 1: Operational Amplifiers

Differential amplifier -circuit configurations –dual input, balanced output differential amplifier –DC analysis – AC analysis, inverting and non- inverting inputs CMRR – constant current bias level translator .Block diagram of a typical Op – Amp- analysis. Open loop configuration inverting and non – inverting amplifiers. Op – amp with negative feedback –voltage series feedback –effect of feedback on closed loop gain input persistence output resistance bandwidth and output offset voltage –voltage follower. Practical op – amp input offset voltage –input bias current –input offset current, total output offset voltage, CMRR frequency response. DC and AC amplifier summing scaling and averaging amplifiers instrumentation amplifier, integrator and differentiator. Oscillator's principles – oscillators types – frequency stability –

response – the phase shift oscillator. Wein bridge oscillator – LC tunable oscillators – Multivibrators – monostable and astable – comparators – square wave and triangle wave generators. Oscillators principles – types – frequency stability – the phase oscillator. Wein bridge – LC tunable oscillators – Monostable Astable – comparators – square wave and triangle wave enerators. Voltage regulators – fixed regulators – adjustable voltage regulators switching regulators.

UNIT 2: Communication Electronics

Amplitude modulation – Generation of AM waves – Demodulation of AM waves – DSBSC modulation. Generation of DSBSC waves, Coherent detection of DSBSC waves, SSB modulation, Generation and detection of SSB waves. Vestigial side band modulation. Frequency Division multiplexing (FDM).

Digital Electronics

1. Combinational Logic

   The transistor as a switch, OR, AND and NOT gates -NOR and NAND gates Boolean algebra - Demorgan's theorems - Exclusive OR gate, Decoder/ Demultiplexer Data selector / multiplexer - Encoder.

2. Sequential Logic

   Flip-Flops: AI-bitmemory -The RSFlip-Flop, JKFlip-Flop-JK master slave Flip-Flops- TFlip-Flop -DFlip-Flop -Shift registers -synchronous and asynchronous counters - cascade counters.

UNIT 3: Microprocessors

Introduction tomicro computers -memory -input/output -Interfacing devices 8085 CPU-Architecture - BUS timings - Demultiplexing the address bus generating control signals - Instruction set - addressing modes - Illustrative programmes - writing assembly language programmes looping, counting and indexing - counters and timing delays -stack and subroutine.

Recommended Texts:

1. "Electronic Devices and circuit theory" by Robert Boylested and Louis Nashdsky PHI,New Delhi - 110001,1991
2. "OP-Amps & Linear integrated circuits,"by Ramakanth A.Gayakwad PHI, Second Edition, 1991
3. "Digital principles and Applications "by A.P. Malvino and Donald P.Laach, Tata Megraw –Hill company. New Delhi, 1993
4. "Microprocessor Architecture, programming and Applications with 8085/8086 by Ramesh S.Gaonkar, Wiley -Eastern Ltd., 1987 (forunitv)

Subject Name: SPECIAL PAPER II (CONDENSED MATTER PHYSICS)

UNIT1: Crystal Physics and X-ray Crystallography

External symmetry elements of crystals. Concept of point groups. Influence of symmetry on physical properties: Electrical conductivity. Space groups, derivation of equivalent point positions (with examples from triclinic and monoclinic systems), and experimental determination of space group. Principle of powder diffraction method, interpretation of powder photographs, analytical indexing: Ito's method .Accurate determination of lattice parameters-least-square method. Applications of powder method. Oscillation and Buerger's precession methods. Determination of relative structure amplitudes from

measured intensities (Lorentz and polarization factors), Fourier representation of electron density. The phase problem, Patterson function.

UNIT 2: Exotic Solids

Structure and symmetries of liquids, liquid crystals and amorphous solids. A periodic solids and quasi crystals; Fibonaccy sequence, Penrose lattices and their extension to 3-dimensions. Special carbon solids; fullerenes and tubules; formation and characterization off ullerenes and tubules. Single wall and multi-wall carbon tubules. Electronic properties of tubules. Carbon- nanotubule based electronic based electronic devices. Definition and properties of nanostructured materials. Methods of synthesis of nanostructured materials. Special experimental techniques for characterization of nanostructured materials. Quantum size effect and its applications.

Recommended Texts:

1. Azaroff: X-ray Crystallography
2. Weertman & Weertman: Elementary Dislocation Theory
3. Verma & Srivastava: Crystallography for Solid State Physics
4. Kittel: Solid State Physics
5. Azaroll & Buerger: The Powder Method
6. Buerger: Crystal Structure Analysis
7. M.Ali Omar: Elementary Solid State Physics
8. The Physics of Quasi - crystals, Eds. Steinhardt and Ostulond
9. Handbook of Nanostructured Materials and Nanotechnology (Vol. 1to4).Ed.HariSingh Nafwa.

Subject Name: SPECIAL PAPER II (ADVANCED ELECTRONICS)

UNIT 1: Analog and Digital Systems

Analog computation, active filters, comparators, logarithmic and anti-logarithmic amplifiers, sample and hold amplifiers, waveform generators. Square and triangular wave generators, pulse generator. Read-only Memory (ROM) and applications. Random Access Memory (RAM) and applications. Digital to –analog converters, ladder and weighted resistor types Analog to digital converters – counter type, successive approximation and dual slope converters, Applications of DACs and ADCs.

Optoelectronics

Photodetectors: Photo detectors with external photo effect, photo detectors with internal photo effect, photoconductors andphotoresistors, junction photodetectors. Circuits with Light Emitting Diodes, Diode tester. Polarity and voltage tester, measuring instruments with LED indication. LED, Numeric and alphanumeric display units. Semiconductor switches and potential isolation, The phototransistor as a switch in the opto - couplers, steady state performance, dynamic performance, use of opto - couplers.

UNIT 2: Microwave Devices

Klystrons, Magnetrons and Travelling Wave Tubes, Velocity modulation, Basic principles of two cavity Klystrons and Reflex Klystrons, principles of operation of magnetrons. Helix Travelling Wave Tubes, Wave Modes. Transferred electron devices, Gunn Effect, Principles of operation. Modes of operation, Read diode, IMPATT diode, TRAPATT

Microwave Communications

Advantages and disadvantages of microwave transmission, loss in free space, propagation of microwaves, atmospheric effects on propagation, Fresnel zone problem, ground reflection, fading sources, detectors, components, antennas used in MW communication systems.

Radar Systems

Radar block diagram an operation, radar frequencies, pulse considerations. Radar range equation, derivation of radar range equation, minimum detectable signal, receiver noise, signal to noise ratio, Integration of radar pulses. Radar cross section. Pulse repetition frequency. Antenna parameters, system Losses and Propagation losses. Radar transmitters, receivers. Antennas, Displays.

Satellite Communications

Satellite communications: orbital satellites, geostationary satellites, orbital patterns, look angles, orbital spacing, satellite systems. Link modules.

Text and Reference Books

1. "Microelectronics" by Jacob Millman, Megraw-hillinternational Book Co.. New Delhi, 1990
2. "Optoelectronics: Theory and Practice", Edited by Alien chappal. Me GrawHili Book Co., New York.
3. "Microwaves" by K.L. Gupta, Wiley Eastern Ltd., New Delhi, 1983
4. "Advanced Electronics Communications Systems" by Wayne Tomasi., Phi.Edn.

Subject Name: OPTICS LABORATORY

1. To calibrate a spectrometer with spectral lines of known wave length and hence determine the wavelength of the spectral line emitted by the source.
2. Determination of wavelength of sodium light by Michelson interferometer.
3. Adjust and focus the given spectrometer using Schuster's method and then determine the refractive index of material of the prism.
4. To study the V-I characteristics of a p-n diode.
5. Digital: Basic Logic Gates, TTL, NAND and NOR.
6. Operational Amplifier (741)
7. Differential Amplifier.
8. To verify Stefan's law by electrical method.
9. To draw the characteristics of a zener diode and find the breakdown voltage and to study the zener diode as a voltage regulator under-

   a) Input variation

   b) Load variation
10. To study various logic gates and verify the truth tables and fabricate a half adder
11. To study design and study of a full adder circuit using logic gates.
12. To determine the lines per centimetre of the given diffraction grating using given known wavelength and hence to determine the wavelength of the given unknown radiation.