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) – FOURTH SEMESTER

Fourth Semester			
S. No.	**Name of Subject**	**Credits**	**Total Marks**
1	Computational Method and Programming	5	100
2	**Any One** Elective Paper - Physics in Liquid Crystal Elective Paper - Environmental Physics Elective Paper - Atmospheric Physics	5	100
3	**Any One** Special Paper -III Condensed Matter Physics Special Paper -III Advanced Electronics	5	100
4	**Any One** Special Paper -III Condensed Matter Physics Special Paper -III Advanced Electronics	5	100
5	Project	4	100
Total		**24**	

Subject Name: COMPUTATIONAL METHODS AND PROGRAMMING

Computational Method

Methods for determination of zeroes of linear and nonlinear algebraic equations and transcendental equations, Convergence of solutions. Solution of simultaneous linear equations, Gaussian elimination, pivoting, iterative Method, matrix inversion. Eigen values and eigen vectors of matrices, Power and Jacobi Method. Finite differences, interpolation with equally spaced and unevenly spaced points. Curvefitting, Polynomial least squares and cubic Splinefitting. Numerical differentiation and integration, Newton-Cotes formulae, error estimates, Gauss method. Random variate, Monte Carlo evaluation of Integrals, Methods of importance sampling, Random walk and Metropolis method. Numerical solution of ordinary differential equations, Euler and Runge Kutta methods, Predictor and corrector method. Elementary ideas of solutions of partial differential equations.

Programming

Elementary information about Digital computer Principles, Compilers, Interpreters and Operating systems. Fortran programming, Flow Charts, Integer and Floating Point Arithmetic, Expressions, built in functions, executable and non-executable statements, assignment, control and input- output elements, Subroutines and functions, Operation with files.

Recommended Texts

Sastry: Introductory Methods of Numerical Analysis

Rajaraman: Numerical Analysis

Rajaraman: Fortran Programming

Vetterming, Teukolsky, Press and Flannery: Numerical Recipes

Subject Name: ELECTIVE PAPER (PHYSICS OF LIQUID CRYSTALS)

Classification of Liquid Crystals

Symmetry, structure and classification of liquid Crystals, Polymorphism in thermotropics, Reentrant phenomena in liquid crystals, Blue phases, Polymer liquid crystals, Distribution functions andorder parameters, macroscopic and microscopic order parameters. Measurement of order parameters, magnetic resonance, electron spin resonance, Raman Scattering and X- ray diffraction.

Theories of Liquid Crystalline Phase Transitions

Nature of phase transitions and critical phenomena in liquid crystals, hard particle, Maier-Saupe and Van der Waals theories for nematic -isotropic and nematic-smectic Atransitions; Landau theory: Essential ingradients, application tonematic-isotropic, nematic-smectic Atransitions and transitions involving smectic phases.

Continuum theory

Curvature elasticity in nematic and smectic A phases, distortions due to magnetic and electric Fields, magnetic Coherence length, Freedericksz transition, field-induced cholesteric-nematic transition.

Dynamical Properties of Nematics

The equations of nemato dynamics, Laminar flow, molecular motions.

Optical properties of Cholesterics

Optical properties of an ideal helix, agents influencing the pitch, liquid crystal displays.

Ferroelectric Liquid Crystals

The properties of smectic C, continuum description, smectic C –smectic a transition, applications.

Discotic Liquid Crystals

Symmetry and structure, mean-field description of discotic liquid crystals, continuum description Lyotropic liquid crystals and biological membrane. Applications of liquid crystals.

Recommended Texts

1. Chandrasekhar: Liquid Crystals
2. Vertogen & deJeu: Thermotropic Liquid Crystals: Fundamentals
3. deGennes &Prost: The Physics of Liquid Crystals
4. Introduction toliquid crystals: Physics and Chemistry (1997, Taylor and Francis)
5. Elston &Sambles: The Optics of Thermotropic Liquid Crystal
6. Collyer: Liquid Crystal Polymers: From Structures to Applications
7. Goodby etal.: Ferroelectric Liquid Crystals :Principles, Properties & Applications

Subject Name: ELECTIVE PAPER (ATMOSPHERIC PHYSICS)

1. **Physical Meteorology**

   Atmospheric composition, laws of thermodynamics of the atmosphere. Adiabatic process, potential temperature. The clausiscl apyeron equation, laws of black body radiation, solar and terrestrial radiation, Albedo, Green-house effect, Heat balance of earth-atmosphere system.

2. **Dynamic Meteorology**

   Fundamental forces, non-inertial reference frames and apparent forces, structure of static atmosphere. Momentum, continuity and energy equations, Thermodynamics of the dry atmosphere, elementary applications of the basic equations.The circulation theorem, voracity, potential vorticity, vorticity and potential vorticity equations.

3. **Monsoon Dynamics**

   Wind, temperature and pressure distribution over India in the lower, middle and upper atmosphere during pre, post and mid-monsoon season. Monsoon circulation in the meridonal (Y-Z) and zonal (X-Y) planes, energy cycle of monsoon. Dynamics of monsoon depressions and easterly waves. Intra seasonal and inter annual variability of monsoon. Quasi-be weekly and30-60dayoscillations. ENSO and dynamical mechanism for their existence.

4. **Numerical Methods for atmospheric Models**

   Filtering of sound and gravity waves, filtered forecast equations, basic concepts of quasi- geostrophic and primitive equation models, one level and multi-level models. Basic concepts of initialization and objective analysis for wave equation, advection equation and diffusion equation.

5. Atmospheric Pollution

   Role of meteorology on atmospheric pollution, Atmospheric boundary layer, air stability, local wind structure, Ekman spiral, turbulence boundary layers caling.

   Residence time and reaction rates of pollutants, sulphur compounds, nitrogen compounds, carbon compounds, organic compounds, aerosols, toxic gases and radio active particles trace gases.

6. Atmospheric Instrumentation Systems

   Ground based instruments for the measurement of Temperature, Pressure, Humidity, Wind and Rain fall Rate. Airborne instruments-Radisonde, Rawinsonde, Rockestsonde-satellite instrumentation (space borne instruments)

7. Radar Meteorology

   Basic meteorology-radar principles and technology-radar signal processing and display-weather radar-observation of precipitating systems-estimation of precipitation-radar observation of tropical cyclones, use of weather radar in aviation, clear air radars-observation of clear air phenomena-other radar systems and applications.

Recommended Texts

1. The Atmosphere by Frederick K.Lutgens and Edward J.Tarbuk (for chapter IandVI)
2. Dynamic Meteorology by Holton, J.R.,3'" edition, Academic Press N.Yf. (1992).

3. The Physics of Monsoons, By R.N.Keshvamurthy and M.Shankar Rao,Allied Publishers, 1992(for chapter 3)
4. Numerical Weather Prediction, by G.J. Haltiner and R.T.Villians, John Wiley andsons, 1980(for chapter 4)
5. Principles of Air pollution meteorology by Tom Lyons and Prillscott, CBS publishers &Distributors (P)Ltd.
6. Radar Meterology by Henry Saugageot

Subject Name: ELECTIVE PAPER (ENVIRONMENTAL PHYSICS)

1. **Essentials of Environmental Physics**

   Structure and thermodynamics of the atmosphere. Composition of air. Greenhouse effect. Transport of matter,energy and momentum in nature.Stratification and stability of atmosphere. Laws of motion,hydrostatic equilibrium.General circulation of the tropics. Elements of weather and climate of India.

2. **Solar and Terrestrial Radiation**

   Physics of radiation. Interaction of light with matter.Rayleigh and Mie scattering. Laws of radiation (Kirchoffslaw,Planck'slaw,Beer'slaw ,Wien's displacement law, etc.).Solar and terrestrial spectra.UV radiation.Ozone depletion problem.IR absorption energy balance of the earth atmosphere system.

3. **Environmental Pollution and Degradation**

   Elementary fluid dynamics.Diffusion.Turbulence and turbulent diffusion.Factors governing air, water and noise pollution.Air and water quality standards.Waste disposal.Heat island effect. Land and see breeze. Puffs and plumes. Gaseous and particulate matters.Wet and dry deposition

4. **Environmental Changes and Remote Sensing**

   Energy sources and combustion processes. Renewable sources of energy. Solar energy. wind energy, bio energy, hydropower, fuel cells, nuclear energy. Forestry and bio energy.

5. **Global and Regional Climate**

   Elements of weather and climate. Stability and vertical motion of air.Horizontal motion of air and water. Pressure gradient forces. Viscous forces. Inertia forces.Reynolds number.Enhanced Greenhouse Effect.Energy balance-azero-dimensional Greenhouse model.Global climate models.

Recommended Texts

1. Egbert Boeker &Rienk VanGroundelle: Environmental Physics (John Wiley).
2. J.T.Hougtion: The Physics of Atmosphere (Cambridge University Press, 1977).
3. J.Twidell and J.weir: Renewable Energy Resources (Elbs, 1988).
4. SolWieder: An Introduction to Solar Energy for Scientists and Engineers (John Wiley, 1982).
5. R.N.Keshavamurthy and M.Shanker Rao:The Physics of Monsoons (Allied Publishers, 1992).
6. G.J.Haltiner andR.T.wiliiams: Numerical Weather Prediction (John Wiley, 1980).

Subject Name: Special Paper III (CONDENSED MATTER PHYSICS)

Unit 1: Electrons in Solids and Surface States

Interacting electron gas: Hartree and Hartree-Fock approximations, correlation energy. Screening, plasma oscillations. Dielectric function of an electron gas in random phase approximation. Limiting cases and Friedel oscillation, strongly-interacting Fermi system. Elementary introduction to Landau's quasi-particle theory ota Fermi liquid. Strongly correlated electron gas. Elementary ideas regarding surface states, metallic surfaces and surface reconstruction.

Unit 2: Disordered Systems

Point-defects: Shallow impurity states in semiconductors. Localized lattice vibrational states in solids. Vacancies, interstitials and colour centers in ionic crystals.

Disorder in condensed matter, substitutional, positional and topographical disorder, Short and long range order. Atomic correlation function and structural descriptions of glasses and liquids.Anderson model for random systems and electron localization, mobility edge, qualitative application of the idea to amorphous semiconductors and hopping conduction.

RECOMMENDED TEXTS:

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

Subject Name: Special Paper III (ADVANCED ELECTRONICS)

Unit 1: Digital Communications

Pulse-Modulation Systems : Sampling theorem-Low-Pass and Band-pass signals, PAM, Channel BW for a PAM signal. Natural sampling. Flat-top sampling. Signal recovery through Holding, Quantization of signals, Quantization, Differential PCM, Delta Modulation, Adaptive Delta modulation, CVSD.

Digital Modulation Techniques :BPSK, DPSK, QPSK, PSK, QASK, BFSK, FSK, MSK. Mathematical Representation of Noise: Sources of noise. Frequency domain representation of noise, Effect of filtering on the probability Density of Gaussian noise, spectral component of noise, Effect of a filter on the power spectral density of noise. Superposition of noises. Mixing involving noise. Linear filtering, Noise Bandwidth, Quadrature Components of noise. Power spectral density of nc(t), ns(t) and their time derivatives

Data Transmission : Baseband signal receiver, probability of error. Optimum filter. White noise. Matched filter and probability of error. Coherent reception, Correlation, PSK, FSK, Non-coherent detection of FSK, Differential PSK, QPSK, Calculation of error probability for BPSK, BFSK and QPSK.

Unit 2:

Noise in pulse-code and Delta-modulation systems: PCM transmission, Calculation of Quantization noise, output-signal power. Effect of thermal noise, output signal-to-noise ratio in PCM, DM, Quantization noise in DM, output signal power, OM output - signal - to quantization - noise ratio. Effect of thermal noise in Delta modulation, output signal-to-noise ratio in DM.

Computer Communication Systems: Types of networks, Design features of a communication network, examples, TYMNET, ARPANET, ISDN, LAN. Mobile Radio and Satellites: Time Division multiple Access(TDMA),Frequency Division Multiple Access (FDMA), ALOHA, Slotted ALOHA, Carrier Sense Multiple Access (CSMA). Poisson, distribution, protocols.

Recommended Texts:

1. Taub and Schilling, Principles of Communication Systems, Second Edition, TMH, 1994
2. Simon Haykin, Communication Systems, Third Edition, John Wiley & Sons, Inc. 1994

Subject Name: Special Paper IV (CONDENSED MATTER PHYSICS)

Unit 1: Imperfection in Crystals

Mechanism of plastic deformation in solids, Stress and strain fields of screw and edge dislocations. Elastic energy of dislocations. Forces between dislocations, stress needed to operate Frank-Read source, dislocations in fcc, hcp and bcc lattices. Partial dislocations and stacking faults in close-packed structures.

Experimental methods of observing dislocations and stacking faults. Electron microscopy: kinematical theory of diffraction contrast and lattice imaging.

Unit 2: Films and Surfaces

Study of surface topography by multiple-beam interferometry, Conditions for accurate determination of step height and film thicknesses (Fizeau fringes). Electrical conductivity of thin films, difference of behavior of thin films from bulk, Boltzmann transport equation for a thin film (for diffused scattering), expression for electrical conductivity for thin film.

Elementary concepts of surface crystallography. Scanning, tunneling andatomic force microscopy.

RECOMMENDED TEXTS:

1. Azaroff: X-ray Crystallography
2. Weertman & Weertman: Elementary Dislocation Theory
3. Verma & Srivastave: Crystallography for Solid State Physics
4. Kittel: Solid State Physics
5. Azaroff & Buerger: The Powder Method
6. Buerger: Crystal Structure Analysis
7. Thomas: Transmission Electron Microscopy
8. Tolansky: Multiple Beam Interferometry

9. Heavens: Thin Films
10. Chopra: Physics of Thin Films

Subject Name: Special Paper IV (ADVANCED ELECTRONICS)

Unit 1: Microprocessors & Micro Computers

Microprocessors and Architecture : Internal Microprocessor Architecture, Real mode and protected modes of memory addressing, memory paging.

Addressing modes : Data addressing modes. Program memory addressing modes, Stack-memory addressing modes.

Instruction Set: Data movement instructions, Arithmetic and Logic instructions, Program control instructions. Assembler details.

Programming the Microprocessor : Modular programming, using the keyboard and video display, Data conversions. Disk files. Example programs.

Hardware Specifications : Pin-outs and the Pin functions, clock-generator (8284A), Bus buffering and Latching, Bus timing. Ready and wait state. Minimum mode versus maximum mode.

Unit 2:

Memory Interface : Memory devices, Address decoding, 8088 and 80188 (8-bit) memory interface, 8086, 80186, 80286 and 80386 (16-bit) memory interface, 80386DX and 80486 (32- bit) memory Interface, Dynamic RAM.

Basic I/O Interface: Introduction to I/O interface, I/O port address decoding, 8255, 8279, 8254,16550, ADC and DAC (excluding multiplexed display & keyboard display using 8255)

Interrupts: Basic interrupt processing, Hardware interrupts. Expanding the interrupt structure,8259A PIC.

Direct Memory Access :Basic DMA operation, 8237 DMA controller, Shared Bus operation, Diskmemory systems, Video displays.

RECOMMENDED TEXTS:

1. Barry B.Brey, "The Intel Microprocessors 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium and Pentium pro processor architecture, programming, andinterfacing" Fourth Edition, PHI, 1999.
2. Douglas V. Hall, "Microprocessors and Interfacing, Programming and Hardware", second edition, McGraw HillInternational Edition, 1992.
3. Muhammad AliMaxidi and Janice Gillispie Mazidi, "The BOx86IBMPCand Compatible Computers (Volumes I&II), second edition, Prentice-Hall International, 1998.

Subject Name: PROJECT

Note: The Normal Rule and Regulation pertaining to the Examination and other issues will be applicable in Faculty of Science as per Arunachal University of Studies Act 2012, Subsequent Statute and Rules & Regulations.