SYLLABUS CONTAINING THE DESCRIPTION OF EACH EXAM TAKEN

PHY 112 – Basic Principles of Physics II- Electricity and Magnetism

Coulomb's law, electric charges and methods of charging. Electric field intensity and charge distribution in conductors and insulators of various configurations. Electric potential, potential gradient and the electrical potential energy. Capacitors and dielectric. Ohm's law and analysis of direct-current circuits containing only resistors, cells and simple circuit laws e.g. Kirchhoff's laws. The wheatsone bridge and potentiometer and their applications. Electrodynamics of charged particles, Magnetic fields and magnetic forces of/on current-carrying conductors. Applications to measuring instruments. Concept of Electromagnetic induction and applications: motors, dynamos, generators, etc. A.C. voltages applied to Inductors, Capacitors and resistance singly and combined. The transformer.

PHY 113 – Basic Principles of Physics IV – Waves, Optics and Modern Physics

The atomic structure, Isotopes. Radioactivity, vacuum and semi-conductor devices. The Cathode-ray and x-ray tubes. Types and properties of waves as applied to sound and light energies. Doppler effect. Superposition of waves; reflection and refraction of waves at plane and curved boundaries Huyggen's principle. Propagation of sound in gases, solids and liquids and their properties. Optical Refraction of light at plane and curved surfaces and lenses and applications in optical instruments-e.g. microscope, telescopes etc. Aberrations, Polarization, Interference, Dispersion of light. Photometry and light spectrum analysis. The unified spectra analysis of waves.

PHY 114 – Basic Principles of Physics I – Mechanics and Properties of Matter

Rectilinear motion: Newton's laws of motion Gravitation. Satellites and radial escape velocity. Work and energy, Friction and Viscosity. Orbital motion, Moments and energy of rotation. Simple harmonic motion of simple systems. Simple properties of solids-elasticity, etc. Surface tension and capillary effects.

PHY 115 – Basic Principles of Physics II – Heat and Thermodynamics

Temperature scales. 1st and 2^{nd} laws of thermodynamics as applied to the property of solids, liquids and gases e.g. calorimetry, expansion of liquids, gas properties, heat engines, heat pumps and refrigeration. Third law and absolute zero of temperature. Thermal Conductivity, types of radiation and energy spectrum of radiation.

PHY 118 –Experimental Physics I

Experiments arising from the theory courses of PHY 114, PHY 113, PHY 112 and PHY 115 are illustrative of basic physical techniques for observation, measurements, data collection and analysis and deduction.

PHY 298 – Experimental Physics II

Laboratory experiments fundamental to the development of classical physics illustrative of basic physical techniques for observation and measurement, and giving data challenging to analyse. About FIFTEEN experiments judiciously selected by staff.

PHY 201 – Classical Physics I

An introduction to classical mechanics, space and time; straight line kinematics; motion in a plane: forces and equilibrium; particle dynamics; universal gravitation; collisions and conservation laws; work and potential energy; vibration motion, conservative forces; inertial forces and non-inertial frames; central force motions; rigid bodies and rotational dynamics. Kinetic theory, equipartition of energy, diffusion rate, mean free path, viscosity, heat transfer, black body radiation, measurement of temperature.

PHY 203 – Elements of Modern Physics

Atomic nature of matter and electricity effect, Compton effect, thermionic emission, uncertainty principle. The atomic model. Nuclear structure and radioactivity; measurement and detection of charged particles (including the treatment of detectors) X-rays: nature and spectra.

PHY 204 – Classical Physics II: Electromagnetism:

Electrostatics and field concepts, electric currents and magnetic fields; properties of electro-magnetic waves, electro-magnetic wave spectrum and applications. Interference: Young's slit, Lylod's mirror and Newton's rings, Thick lens optics.

PHY 303 – Classical Physics II

Mechanical vibrations and waves; simple harmonic motion, superposition, forced vibrations and resonance, coupled oscillations and normal modes; vibrations of continuous systems; reflection and refraction: sound, string instruments, brass and woodwinds; Doppler's effect, phase and group velocity. Fraunhofer diffraction, gratings, Fresnel zone plates; plane wave solution of Maxwell's equations; polarization brief-ringent materials quarter wave plate, circular polarized light.

PHY 304 – Principles of Quantum Physics I

Experimental basis of quantum physics. Atomic spectra. Bohr theory. The particle aspect and the wave aspect of matter. Familiar wave phenomena and their associated wave equation. The Schrodinger equation. Physical interpretation of the wave function as a probability amplitude. Uncertainty principle. Energy levels and stationary states. Solution of the Schrodinger equation in simple one-dimensional cases; barrier penetration; resonances; energy bands in periodic lattice. Solution of the Schrodinger equation for a central potential in three dimensions; hydrogen atom; harmonic oscillator.

PHY 305 – Numerical Computation in Physics

Introduction to numerical methods and computer programming in FORTRAN: Fundamentals of FORTRAN programming; fundamentals of numerical methods: solution of non-linear algebraic equations; polynomials and zero's of polynomials matrix methods and systems of linear algebraic equations, interpolation, least squares and cubic spline curve-fitting; numerical integration; solution of ordinary differential equations. Treatment of data.

PHY 306 – Introduction to Electronics

An elementary but practical introduction to electronic circuits and circuitry. Amplification and the transistor, the field-effect transistor. Thermionic emission and the cathode ray tube; Negative feedback, impedance matching; semi-conductor device characteristics, Amplification at high frequencies; Low-frequency signals; d.c. and the differential amplifier, Power supplies and power control; Pulse handling and time constraints; integrated circuit building bricks; positive feedback circuit building and signal generators, logic, counters and timers (ALTERNATIVE WEEK LABORATORY)

PHY 307 – Solid State Physics I

Basic concepts of the quantum theory of solids: periodic structures and symmetry of crystals; diffraction; lattice dynamics, phonons, thermal properties of solids; electron state in metals, the free electron model, weak and tight binding approximations, energy band structures in metals semiconductors and insulators.

PHY 308 – Electromagnetism

Theory of isotopic dielectrics, Gauss theorem in dielectrics, Poisson's and Laplace's equations, uniqueness theorem, magnetic shells, steady circuits, magnetic properties, motors, generators, energy in electromagnetic field, Maxwell's equations, Poynting vectors, dispersion in dielectrics, induction to spherical waves.

PHY 310 – Introduction

X-rays – spectra, scattering and diffraction. Natural radioactivity and radio active series. Nuclear composition, size and binding energy. Nuclear forces. Properties of particles and their interactions with matter.

PHY 311 – Mathematical Methods for Physics I

Complex variable theory and their relation to selected physical problems. Complex differentiation and integration, Cauchy's theorem, Taylor and Laurent series, Residues and physical applications of conformal mapping. Matrices and eigenvalue problems: Determinants, adjoint, inverse of matrix. Solution of linear equations using matrices. Singular and non-singular transformations.

PHY – 312 Mathematical Methods for Physics II

Ordinary differential equations of first and second order and their physical applications. Introduction to numerical analysis: finite differences, interpolation, etc. Laplace and Fourier transformation methods. Linear and non-linear partial differential equations of order one. Homogeneous partial differential equations of higher order with constant co-efficient.

PHY – 313 Introduction to Special Relativity

Galilean relativity and Newtonian mechanics, Lorentz-Einstein transformations. Space-time diagrams, events and world lines. Proper distance and length contraction. Relativistic Kinematics and dynamics. Space time and energy momentum invariants. Relativity and electric and magnetic fields.

PHY – 314 Semiconductor Devices

The physics, modelling and application of selected semiconductor devices. Brief review of junction and bipolar transistor physics. Major emphasis on MOS devices including field effect transistors and charge coupled devices. Also consideration of advanced bipolar structures, Schottky barrier devices device noise, light emitting diodes and photodetectors.

PHY 398 – Experimental Physics IV

Continuation of PHY 299; with experiments chosen to span the range of topics covered by the 300-series courses.

PHY 399 – Experimental Physics V

Continuation of PHY 398; with experiments chosen to cover the basic principles of physics.

PHY 403 – Statistical and Thermal Physics

Kinetic Theory: Phase space, Liouville theorem, Boltzmann equation, H-theorem. Ideal gas: work, heat entropy, Transport phenomena. Thermo-dynamics: State variables; equations of state. First law, Second law, entropy maximum principle, reversible and irreversible processes. Thermodynamic temperature, Ideal gas and photon gas. Thermodynamic potentials, Maxwell's relations. Simple and composite system, phase transitions and chemical equilibrium.

Statistical Mechanics: Ensembles and theory, Canonical ensemble. Partition function in classical and quantum mechanics Bose and Fermi gas. Boltzmann Limit, specific heats, electric and magnetic susceptibilities. Fluctuations, noise and Nernst theorem.

PHY 405 – Principles of Quantum Physics II

General formalism of quantum mechanics and its physical interpretation. Definition and uses of operators, Predictions concerning future measurement. Uncertainty principles. Angualar momentum operators. Spin. Time-dependent problems: magnetic resonance. Emission and absorption of radiation. Variational approximation; time-independent perturbation theory. Properties and spectra of hydrogen-like atoms; fine structure; Zeeman and Stark effects. Selection rules. Many electron atoms; Pauli exclusion principles, periodic table of the elements. Simple molecules and their spectra. Scattering theory.

PHY406 –Classical Mechanics

Basic Concepts of Mechanics: Inertial frames of reference, space, time mass, force. Equations of motion; noninertial frames of reference. Conservation laws for closed systems. Planetary motion. Harmonic oscillator. Macroscopic objects: Constraints Hamilton's principle and Lagrange's equations. Rigid body dynamics. Coupled oscillators Green's functions. Normal modes, continuum, limit; Elastic strings, solids, field, canonical variables, Hamilton's equations.

PHY407 – Solid State Physics II

Dynamics of electrons in solids, transport phenomena, such as electrical and thermal conductivity, with applications to metals and semiconductors. Optical properties of solids with applications to metals, Semiconductors and insulators: magnetic phenomena in solids such as paramagnetism diamagnetism, resonance studies in a magnetic field; super conductivity.

PHY 408 – Electromagnetic Theory

Survey of electrodynamics: Basic phenomena and systems of units, Maxwell's equations. Simple applications: wave guides and transmission lines. Moving frames of reference, the Lorentz grouonp. Energy-momentum four vectors, field tensors and relativistic equations of motion. Electro-magnetic waves, plane waves, polarization. Energy, momentum, angular momentum of wave packets. Spherical waves in homogeneous wave equation. Green's function, solution causality.

PHY 409 – Modern Optics

Coherence and interference. Michelson and Fabry-Parot interference filters. Fourier interference spectrosocopy. Franhoffer and Fresnel diffraction, gratings, Laser, holograph. Optics of solids propagation of light in anisotropic solids, the index elipsod, double refraction, optical activity, electro-optic effects. Introduction to non-linear optics.

PHY410 – Nuclear Physics

Liquid drop model, the shell and collective models. Alpha-decay, Nuclear reactions, Neutron Physics, Fission, Fussion and thermonuclear reactions. Nuclear energy source, the neutron, accelerators, introduction to elementary particles physics and classification of fundamental particles.

PHY 486 – Geomagnetism

Earth's magnetic field. Transient geomagnetic variations. The interaction of the solar plasma with emphasis with the earth's magnetic field. Magnetic observatories.

PHY 488 – Solid Earth Physics

Seismology, introduction to seismic structure of the earth's interior Seismicity, Earth tremors and earthquake mechanisms. Theory of Seismometers used for the detection of Earth movements. Introduction to theoretical Seismology.

Electromagnetic Induction: Electromagnetic Induction studies, Earth currents and the electrical conductivity of the earth's interior. *Palaeomagnetism:* Measurement of natural remnant magnetization. Rock magnetism and magnetic properties of rocks. Continental drift sea-floor spreading and tectonophysics.

PHY 498 – Experimental Physics VI

Continuation of PHY 399. Further experiments chosen to illustrate the basic principles of Physics.

PHY 499 – Undergraduate Project

MAT 111 – ALGEBRA

Polynomials: The Remainder and Factor Theorems, Polynomial Equations and Inequalities especially linear, quadratic and cubic. Domain and Zeroes of Rational Functions, Partial Fractions, Curve Sketching of Polynomial and Rational Function. The principle of mathematical induction and its application to Natural Numbers. Permutations and Combinations. The Binomial Theorem for any index and applications. Sequences, Series, A.P., G.P., Limits and sums to infinity. First and Second Differences of a sequence. Addition, Subtraction, Multiplication and Division of Complex Numbers. Fundamental Theorem of Algebra (statement only). The Argand Diagram, De-Moivre's Theorem, N-th roots of Comlex Numbers. Introduction to m x n matrix where m, n<5. Elementary Operations on Matrices and Applicants to Solutions of Linear Equations. Elementary Properties of Determinants of at most 3 x 3 matrices. Transformation of the plane: Translation; Reflection; Rotation; Enlargement; Composition of Transformations-Invariant Points and Lines.

MAT 121 – CALCULUS AND TRIGONOMETRY

Functions; Concept and Notation; Polynomial and Rational Functions; Trigonometric Functions; Exponential/Logarithmic Functions; Functional Linear Equations; Idea of Limits; Techniques of Finding Limits; Derivatives: Definition and Calculation from Principles; Derivatives of Constants; Powers, Sums, Products, Quotients, Composite Functions; Implicit Functions; Polynomial and Rational Functions; Inverse Functions; Circular Functions; Logarithmic/Exponential Function; Higher Order Derivatives; Applications: Small Increments; Approximations and Errors, Extreme Integration: as the inverse of differentiation, as area, as limit of finite sums, Integration of sum/scalar multiple of functions with applications; Integration

of circular functions. Definite Integrals: General properties of definite integral. Some applications to Geometry, Mechanic, Biology and Social Sciences. Derivatives of Hyperbolic Functions. Inverse circular/hyperbolic functions. Method of taking the logarithm before differentiation of implicit functions and of functions like a-at sin(bt+c); approximations. Hard integration: Further techniques Evaluation of (t2+a2) etc; integration of irrational functions; integration via harder substitute e.g. trigonometric substitution; integration by parts.

MAT 141 – ANALYTICAL GEOMETRY AND MECHANICS

Equations of lines and planes; conic sections circles parabola; hyperbola, ellipse. Vectors in R2, R3, scalar product, vector product, triple products. Applications to Geometry. (The vector approach should be used where possible in what follows). The notions of displacement, speed, velocity and acceleration of a particle. Newton's law of motion and applications to simple problems. Work, power and energy. Application to the principle of conservation of energy to motion of particles and those involving elastic strings and springs. Conical pendulum. Simple Harmonic Motion. Resultant of any number of forces acting on a particle, reduction of coplanar forces acting on a rigid body to a force and a couple, Equilibrium of coplanar forces, parallel forces, couples Laws of friction. Applications of the principle of moments. Moment of inertia of simple bodies.

MAT 213 – ALGEBRA I

Sets, relations, mappings, orders, Groups, rings Integral domains, fields. Fundamental theorem of arithmetic, polynomials in single variable. Theory of equations, inequalities. Vector spaces, Linear dependence, basis and dimension. Linear mappings, rank nullity. Algebra of matrices, elementary operations on matrices. Determinants, Linear equations. Eigenvalues and eigenvectors. Similarity to diagonal matrices. Boolean algebra with applications.

MAT 223 – ANALYSIS (for Non-Major)

Real and complex numbers, convergence and divergence of sequences and series of compex numbers. Functions of a real variable. Continuity and differentiability. Taylor's theorem, extensions and applications. Riemann integration. Functions of complex variable. Bilinear transformation.

MAT 241 – ORDINARY DIFFERNTIAL EQUATIONS

Derivation of equations from Physics, Geometry, etc. Techniques for solving first and second order linear and non-linear equations; and for solving nth order linear equations. Finite differences and difference equations; Interpolation; errors; Solution of Equations; Elementary numerical integration.

MAT 242 – VECTORIAL MECHANICS

Vectors in Euclidean spaces; Vector products; Equations of linears and planes; Elements of vector calculus. General kinematics; Momentum; Angular momentum; Energy and Conservation laws; Dynamics of particle of a rigid body.

MAT 341 – MATHEMATICAL METHODS I

Linear dependence; Wronskian; Reduction of order; Variation of parameters: Series Solutions about ordinary and regular points; Special functions; Bessel; Legendre, hypergeometric, etc. Laplace transforms and applications to initial value problems.

MAT 342 – MATHEMATICAL METHODS II

Sturn-Liouville problem. Orthogonal polynomials and functions. Fourier series and integrals. Partial differential equations: First and second order linear equations; Solutions of the heat, wave and Laplace equations by the method of separation of variables, eigen functions expansion, and Fourier transforms.

CSC 101 – INTRODUCTION TO COMPUTER SCIENCE

Overview of the discipline of Computer Science; General structure of a computer system; Historical development of computer systems; Generations of computer systems; Computer operations; Internal structure of a computer hardware; Microcomputer technology; Computer numbering systems; computer arithmetic; computer data representation schemes; Problem solving with computers. Elements of programming languages, Computers in the Society; internet and its facilities, Basic file processing concepts, Introduction to computer programming using VISUAL BASIC programming language; Algorithms. Data structures and Logic; Laboratory exercises in VISUAL BASIC programming and the internet.

CSC 231 –SCIENTIFIC PROGRAMMING

FORTRAN programming language; Comparison of various versions of the language. Programming exercises using FORTRAN with emphasis on scientific application problems.

STA 111 – DESCRIPTIVE STATISTICS

Statistics of data: types, sources and methods of collection. Presentation of data: tables, graphs and charts. Errors and approximations. Frequency and cumulative distributions. Measures of location, partition, dispersion, skewness and Kurtosis. Method of data collection, Design of forms of questionnaires, Regression and correlation, Elementary time series.

STA 112 – PROBABILITY I

Permutation and Combination Concepts and principles of probability. Random variables. Probability and distribution functions. Basic distribution: Bernoulli, Binomial, Hypergeometric, Possion and Normal.

STA 211 – PROBABILITY II

Further permutation and combination. Total probability, Probability laws. Conditional probability. Independence. Bayes' theorem. Probability distribution of discrete and continuous random variable: binomial, passion, geometric, hyper-geometric, rectangular (uniform), negative exponential, normal. Expectation and moments of random variables. Chebyshev's inequality, Joint, marginal and conditional distributions and moments. Limiting distributions and moments.

STA 231 – STATISTICAL COMPUTING II

Use of computers in statistical computing. Introduction to package. Word Star, WordPerfect, Spread Sheets, SYSTAT, EXCEL; C-stat, MINETAB, SPSS. Use of BASIC and FORTRAN programs in solving problems in STA211 and STA 231