NATIONAL UNIVERSITY

Fourth Year Syllabus
Department of Physics

Four Year B.Sc Honours Course
Effective from the Session : 2013–2014

National University

Subject: Physics

Syllabus for Four Year B. Sc Honours Course

Effective from the Session: 2013-2014

Year Wise Papers and Marks Distribution

FOURTH YEAR

Paper Code	Paper Title	Marks	Credits
242701	Nuclear Physics-II	100	4
242703	Solid State Physics-II	100	4
242705	Quantum Mechanics-II	100	4
242707	Electronics-II	100	4
242709	Classical Electrodynamics	100	4
242711	Statistical Mechanics	100	4
242713	Computer Application and Programming	100	4
242715	Theory of Relativity and Cosmology	100	4
242716	Physics Practical-IV	100	4
242718	Viva-Voce	100	4
	Total=	1000	40

Detailed Syllabus

Paper Code	242701	Marks: 100	Credits: 4	Class Hours: 60 hrs.
Paper Title:	**Nuclear Physics-II**			Exam Duration: 4 Hours

1. **Two-Nucleon System: The Deuteron.** Central Potentials, Ground state of the Deuteron, Normalisation of the Deuteron Wave Function, Non-existence of Excited States, Tensor force, Magnetic and quardrupole Moments of the Deuteron.
2. **Two-Nucleon System: Scattering.** N-P and P-P Scattering at Low and High Energies, Scattering Length and Effective Range Theory, Coherent Scattering of Thermal Neutrons.
3. **Nuclear Forces**: Non-exchange and Exchange Forces, Meson Theory of Nuclear Force, One-Boson Exchange (OBE) potential, Paris Potential.
4. **Nuclear Shell Model**: Shell-Model, Single Particle Potentials, Wave Function and Energy Levels, Magic Numbers, Prediction of Spin and Magnetic Moments, Schmidt Values and Lines.
5. **Collective Model**: Rotational energy spectrum and nuclear wave function for even-even nuclei and for odd A nuclei, Beta and Gamma Vibrations in Nuclei.
6. **Nuclear Reactions**: Compound Nuclear Model, Nuclear Cross-section, Brit-Wigner Resonance Formula, Direct reaction, Butler's Theory.
7. **Optical Model:** Optical potential energy, Averaged Cross section, Optical Model at Low energy, Phenomenological Optical Model.
8. **Accelerators**: Van de Graff Generator, Linear accelerator, Cyclotron, Synchrotron.
9. **Elementary Particles**: General Properties and classification of elementary particles, Quantum numbers, different types of interaction and conservation laws; Cosmic rays (introduction).

Books Recommended:

1. Krane, K.S. : Introductory Nuclear Physics
2. Enge, H.A. : Introduction to Nuclear Physics
3. Cohen, B.L. : Concepts of Nuclear Physics
4. Meyerhof, W.E. : Elements of Nuclear Physics
5. Satchler G.R. : Nuclear Reactions
6. Roy and Nigam : Nuclear Physics
7. Blatt and Weiskoff : Nuclear Physics
8. Segre, E. : Nuclear and Particles (2^{nd} Ed)
9. Islam, A.K.M.A and Islam, M.A : নিউক্লীয় পদার্থবিজ্ঞান, ২য় সংস্করণ
10. Sen Gupta, H.M. : নিউক্লীয়ার পদার্থবিদ্যা
11. Islam, G.S. : পারমাণবিক পদার্থবিজ্ঞান ২য় খন্ড

Paper Code	242703	Marks: 100	Credits: 4	Class Hours: 60 hrs.
Paper Title:	**Solid State Physics-II**			Exam Duration: 4 Hours

1. **Band Theory of Solids**: Formation of energy levels in crystals. Electron in a periodic potential, Schrödinger equation, Bloch function, Korning-Penny model, Properties of free electrons in a Brillouin zone, Concept of hole, Reduced zone scheme, Classification of metal,

insulator and semi conductor, Band structure calculation, LCAO method and its application in simple cubic (sc), body centered cubic (bcc) and face centered cubic (fcc) lattice.

2. **Fermi Surfaces and Metals**: Reduced zone scheme, Periodic zone scheme, Construction of Fermi surfaces, Nearly free electrons, Electron orbits, Hole orbits and open orbits, Calculation of energy bands, Tight binding method for energy bands, Winger-Seitz method. Experimental methods in Fermi surface studies, Quantization of orbits in a magnetic field. De Haas-Van Alphen effect, Fermi surface of copper.
3. **Dielectric Properties**: Macroscopic electric field, Local electric field at an atom, Static dielectric constant, Electronic, Ionic and Orientational polarizibilities, Clausius-Mossotti relations, Complex dielectric constant, Dielectric loss, Relaxation time, Polarization mechanism, Pyro, Piezo and Ferro-electricity, dielectric properties in an alternating field, Properties of ferroelectric materials, Pole theory of ferro-electricity, Spontaneous polarization, Ferroelectric domain piezo-electricity, Electromechanical transducers.
4. **Semiconductors**: Direct and Indirect band gap semiconductors, Extrinsic semiconductor, Shallow levels, Density of states, Charge carrier concentration, Carrier life time, Recombination process, P-N Junction, Depletion region, Junction capacitance, Diode current, Tunnel diode, Metal-semiconductor junction, Surface states.
5. **Superconductivity**: Basic properties of superconductors, Meissner effect, Type-I and Type-II superconductors; Thermodynamics of superconductivity, London equation, BCS theory of superconductivity, Tunneling, D.C and A.C Josephson effect, High-Temperature superconductors.
6. **Magnetism**: Origin of Magnetism, Diamagnetism, Paramagnetic equations Ferromagnetism, Weiss theory of ferromagnetism, Nature and origin of Weiss molecular field, Concept of domains and Hysteresis, Anti-ferromagnetism, Ferrimagnetism, Magnons.

Books Recommended:

1. Dekker, A.J. : Solid State Physics
2. Kittel, C. : Introduction to Solid State Physics
3. McKelvey : Solid State and Semiconductor Physics
4. Brailsford, F. : Physical Principles of Magnetism
5. Chikazumi, S. : Physics of Magnetism
6. Singhal, R.L. : Introduction to Solid State Physics
7. Islam M.S. : কঠিন অবস্থার পদার্থ বিজ্ঞান
8. সাইদুজ্জামান : সলিড স্টেট ফিজিক্স
৯. . এস. এম. মোকছেদ আলী : কঠিন অবস্থার পদার্থ বিজ্ঞান

Paper Code	242705	**Marks: 100**	**Credits: 4**	**Class Hours: 60 hrs.**
Paper Title:	**Quantum Mechanics-II**			Exam Duration: 4 Hours

1. **Operators and Matrices**: Linear operators, Kets and Bras, Eigenvalues and eigenkets, Expansion in eigenkets, Completeness and orthogonality of eigenkets, Representation of an operator, Commuting operators, Projection, Hermitian operator, Unitary operators, Diagonalization of a matrix.
2. **Matrix Formulation of Quantum Mechanics**: Linear vector space, Hilbert space, Matrix representation of state vectors and Operators, Transformation theory, Schordinger, Heisenberg and Dirac pictures, Parity operator, Density matrix, Harmonic oscillator.

3. **Theory of Angular Momentum**: Definition of angular momentum, Angular momentum operators and their commutation relations, Eigenvalues of angular momentum, Addition of angular momenta, Clebsch-Gordon coefficients, Explicit forms of the angular momentum matrices, Pauli's exclusion principle and spin matrics.
4. **Approximation Methods**: WKB-Approximation method, Stationary perturbation theory, Time-dependent perturbation theory, Variational method.
5. **Theory of Scattering**: Two body systems, Scattering cross-section, Scattering of particles by spherically symmetric potentials, Partial waves, Phase shifts, General formulation of scattering theory, Born approximation method and its application.
6. **Identical Particles**: Symmetric and antisymmetric wave functions, Exclusion Principle, Spin and statistics, Projection and density operators, Liouville's equation of motion, Polarization vector for a spin S-particle, Scattering of identical particles.
7. **Relativistic Wave Equations**: Klein-Gordon equation, Dirac's relativistic equation, Covariant form of Dirac's equation, Dirac's equation for a central field, Spin angular momentum of the particle, Magnetic moment of the Dirac's particle, Negative energy states and hole theory.

Books Recommended:

1. Schiff, L.I. : Quantum Mechanics
2. Powell, J.L. and Crasemann, B. : Quantum Mechanics
3. Rashid, A.M.H. : Quantum Mechanics
4. Merzbacher, E. : Quantum Mechanics
5. Landau, L.D. and Lifshitz, E.M : Quantum Mechanics
6. Dirac, P.A.M : The Principles of Quantum Mechanics
7. Rose, M.E : Elementary Theory of Angular Momentum
8. Edmonds, A.R. : Angular Momentum in Quantum Mechanics
9. Newton, R.G. : Scattering Theory of Waves and Particles
10. Golder, S.K. : কোয়ান্টাম বলবিদ্যা

Paper Code	242707	**Marks: 100**	**Credits: 4**	**Class Hours: 60 hrs.**
Paper Title:	**Electronics -II**			Exam Duration: 4 Hours

1. **Power Amplifiers**: Class-B push-pull power amplifiers, Output power, Efficiency, Transistor power dissipation, Transformer coupled and complementary push-pull circuits, Crossover distortion and eliminate-ion, Basic concepts of harmonic distortion.
2. **Oscillator Circuits**: Positive feedback and Barkhausen criterion for oscillation, Wien-bridge, Hartley and Colpitts oscillator, BJT stable multivibrator.
3. **Field Effect Transistors**: JFET action, Depletion and enhancement MOSFET, Advantages over bipolar transistors.
4. **SCR and TRIAC**: SCR action and characteristics, Switching and half wave phase control of power, TRIAC action and characteristics, Full wave phase control.

5. **Electronic Devices for Measurement**: Basic concepts of thermistors, Photoconductive cells, Liquid crystal displays, Seven-segment displays, Cathode ray table.
6. **Digital Electronics, An Overview**: Analogue and digital world, Advantages in error free communication and processing, Binary representation of digital values by electronic circuit elements, Number systems and codes: Decimal, Binary and hexadecimal numbers, conversion, Binary addition, Codes: BCD, ASCII.
7. **Digital Logic Circuits**: Logic gates, definitions, symbols and truth tables, Boolean expression, simple logic circuit example, Diode gate, DTL gate, TTL gate, Truth table and Boolean algebra, half adder circuit, SR flip flop, Binary counter.
8. **Radio Principles**: Basic concepts of modulation and demodulation, AM transmitter and TRF receive circuits, super heterodyne receivers.
9. **IC Fabrication Technique**: Monolithic planar process, Fabrication schemes for resistance, diode and transistor on a silicon chip.
10. **Television**: Basic principle, Image scanning and display, Block diagram of a B/W receiver, LCD and LED television.
11. **Radar**: Basic principles, Block diagram, Radar range equation.

Books Recommended:

1. Boylestad, R. and Nashelsky, L. : Elctronic Devices and Circuit Theory.
2. Brophy, J.J. : Basic Electronics for Scientists
3. Millman, J. and Halkias, C.C : Electronic Devices and Circuits
4. Malvino, A.P : Electronic Principles.

Paper Code	242709	**Marks: 100**	**Credits: 4**	**Class Hours: 60 hrs.**
Paper Title:	**Classical Electrodynamics**			Exam Duration: 4 Hours

1. **Electrostatics**
   a) **Electric Field**: Gauss laws in integral and differential form.
   b) **Scalar Potential**: Lap lace's equation and Poisson's equation, Boundary conditions and uniqueness theorem, General solution of the Poisson's equation, The method of images to solve electrostatic problems, Boundary value problems in rectangular, spherical and polar coordinates, Multipole expansion.
   c) **Electrostatics in Dielectric**: Field inside a dielectric, Boundary condition on **E** and **D**
2. **Elements of Magnetostatives**:
   a) Concept of a vector potential and the differential equation for it, Magnetostatic boundary condition problems, Multipole expansion for the vector potential: Magnetic field due to a localized current distribution, Magnetic dipole moment.
   b) Magnetization-boundary conditions on **B** and **H**.
3. **Maxwell's Equations**:
   a) Equation of continuity. Maxwell's displacement current, Maxwell's equations, Absence of isolated magnetic charges, Maxwell's equation in material media.
   b) Scalar and vector potentials in Maxwell's equation, Gauge transformation: Coulomb gauge and Lorentz gauge.
   c) Poynting vector and energy momentum conservation in electrodynamics: Energy density and Maxwell's stress tensor.
4. **Electromagnetic Wave Equation**:

a) Wave equation for the electric and magnetic field from Maxwell's equation, Electromagnetic plane waves in vacuum and non-conducting media, Polarization of electromagnetic waves.
b) Reflection and refraction of electromagnetic plane waves on a dielectric interface, Fresnel equations, Total internal reflection and polarization by reflection.
c) EM waves in conductors: Attenuation, Skin depth, Reflection and transmission at a interface between a conductor and a dielectric.

5. **Wave Guides**: Solution of the wave equation in a rectangular wave guide, Transverse electric (TE) and transverse magnetic (TM) modes, Transverse electromagnetic (TEM) modes, Simple cavity resonator.
6. **Electromagnetic**:
   a) Solution of the wave equation in spherical coordinates, Multipole expansions, Retarded potentials, Electric dipole radiation, Short, Center-fed antenna.
   b) Radiation from a moving charge, Lienard-Wiechert potentials, Power radiated by a point charge, Radiation reaction-Abraham-Lorenz force.

Books Recommended:

1. Griffiths, D.J. : Introduction to Electrodynamics
2. Panofsky, W. and Philips, M. : Classical Electricity and Magnetism
3. Jackson, J.D. : Classical Electrodynamics
4. Islam, A.K.M.A. and Islam, S. : তড়িৎ গতিবিজ্ঞান
5. Reitz, Millford. : Classical Electrodynamics
৬. এস. এম. মোকছেদ আলী : তড়িত গতিবিদ্যা

Paper Code	242711	Marks: 100	Credits: 4	Class Hours: 60 hrs.
Paper Title:	Statistical Mechanics			Exam Duration: 4 Hours

1. **The scope of statistical physics**: Assembles, Phase space, Liouville theorem. Distribution over energies, weights of configuration, the most probable configuration, The Maxwell-Botlzmann Distribution, Application.
2. **Temperature and Entropy:** The statistical concept of temperature. Ensembles: Microcanonical, canonical and grand-canonical ensembles. Boltzmann formula. Entropy, Free energy and other thermodynamic functions.
3. **The Thermodynamics of Gases:** The weight A_{max} for a classical perfect gas. The Boltzmann partition function, The evaluation of the classical partition function, The semi-classical perfect gas components of the partition function.
4. **Particle Statistics:** Principle of indistinguishability for quantum particles. Spin-statistics connection. Degenerate and non-degenerate system.
5. **Bose-Einstein Distribution:** Bose-Einstein gas, Black-body Radiation, The Photon gas, The Specific heats of solids, The Phonon gas, Bose-Einstein condensation, Fremi-Dirac Gas, The Electron Gas, Fermi degeneracy pressure.
6. **Applications of statistical thermodynamics:** The paramagnetic gas, the harmonic oscillator, the diatomic molecule, The disordered lattice

7. **Transport phenomena:** Boltzmann transport equation, H-theorem, validity of the equation, Mean free path, Viscosity and Diffusion, Electrical conductivity, Brownian motion.
8. **Phase Transition:** Thermodynamic classification of phase transitions, Difference between first and second order phase transition, Mean-field theory.

Books Recommended:

1. Reif, F : Fundamentals of Statistical Mechanics and Thermal Physics
2. Huang, K : Statistical Mechanics
3. Kittel, C : Elementary Statistical Mechanics
4. Beiser, A : Perspective of Modern Physics

Paper Code	242713	**Marks: 100**	**Credits: 4**	**Class Hours: 60 hrs.**
Paper Title:	**Computer Application and Programming**		Exam Duration: 4 Hours	

1. **Introduction:** Object oriented development themes, Modeling Concepts, Modeling as a design technique, Object modeling, Dynamic modeling, Functional modeling.
2. **Design Methodology:** Analysis, System design, Object design, Comparison of methodologies.
3. **Network:** Computer Communication, basic concepts of LAN, WAN, Workstation, and Server, Optical Fiber in Communication, World Wide Web (www) and E-mail, E-commerce.
4. **Object Oriented Language:** C++ as an object oriented programming, Comparison of C and C++, Declaration and constants, Expression and statements, Data types, Operator, Functions, Inheritance – Extending classes, Encapsulation, Operator overloading and type conversion, Managing console I/O operation, Working with files, Object oriented system development.
5. **Object oriented Programming and Java:** Objects and classes, Attributes and behavior, Inheritance, Interfaces, and Packages, Creating a Class hierarchy, Statements and expressions, Variables and data types, Literals, Expressions and operators, Arrays and loops.
6. **Creating Classes and Methods:** Defining classes, Class variables, Creating methods, Class methods, Constructor methods, Overriding methods, Finalizer methods.
7. **Developing Applets:** Applet and application, Creating applet, Including applet on web page, Java archives, Parameter to applet.

Books Recommended:

1. Schildt, Herbert : Turbo C/C++, The Complete Reference
2. Gotfried, Byron : Programming with C++
3. Balagurusamy, E : Object Oriented Programming with C++
4. Brown, D : An Introduction to Object Oriented Analysis
5. Norton, Peter : Introduction to Computers
6. Deitel, H.M. and Deitel P.J. : JAVA How to Program.
7. Davis, Stephen R. : Teach Yourself JAVA in 21 days.

Paper Code	242715	Marks: 100	Credits: 4	Class Hours: 60 hrs.
Paper Title:	Theory of Relativity and Cosmology			Exam Duration: 4 Hours

1. Introduction

Galilean transformation and invariance of Newton's laws of motion, non-invariance of Maxwell's equations. Michelson-Morley experiment and explanation of the null result.

2. Special Theory of Relativity

Concept of inertial frame. Postulates of special theory; simultaneity; Lorentz transformation along one of the axes – length contraction, time dilatation and velocity addition theorem, Fizeau's experiment. Four vectors. Relativistic dynamics : variation of mass with velocity; energy momentum relationship.

3. Relativistic Electrodynamics:

Magnetism as a relativistic phenomenon, Fields transformation, Field tensor, Electrodynamics in tensor rotation, Relativistic potential

4. Vectors and Tensors

Covariant and contravariant vectors. Contraction. Covariant, contravariant, and mixed tensors of rank-2, transformation properties. The metric tensor (flat space-time only). Raising and lowering of indices with metric tensors.

5. Invariant intervals

Concept of space-time: Euclidean and Minkowski. Invariant intervals in 1+1 and 3+1 dimensions (use Minkowski space-time). Space like, time-like and light like four vectors. Light cone. Causality and simultaneity in different frames.

6. Tensor calculus:

Idea of Euclidean and non-Euclidean space, meaning of parallel transport and covariant derivatives, Geodesics and autoparallel curves, Curvature tensor and its properties, Bianchi Identities, vanishing of Riemann-Christoffel tensor as the necessary and sufficient condition of flatness, Ricci tensor, Einstein tensor.

7. Einstein's field equations

Inconsistencies of Newtonian gravitation with STR, Principles of equivalence, Principle of general covariance, Metric tensors and Newtonian Gravitational potential, Logical steps leading to Einstein's field equations of gravitation.

8. Cosmology:

Qualitative discussions on: White Dwarfs, Neutron stars and Black Holes, Static Black Holes (Schwarzschild and Reissner-Nordstrom). Rotating Black Holes, Cosmological Principles, Weyl postulates, Robertson-Walker metric (derivation is not required), Cosmological parameters, Static Universe, Expanding universe, Open and Closed universe, Cosmological red shift, Hubble's law. Olber's Paradox.

Books Recommended:

1. Goldstein, H. — Classical Mechanics
2. Harun-ar-Rashid, A.M — Classical Mechanics
3. French, A.P. — Special Relativity
4. Harun-ar-Rashid, A.M. — Einstein and Relativity Theory (in Bangla)
5. S. Weinberg — Gravitation and Cosmology: Principles and Applications of the General Theory of Relativity (Wiley, 1972).
6. P. G. Bergmann — Introduction to Theory of Relativity (Pren tice-Hall, 1969
7. R. Resnick — Introduction to Special Theory of Relativity.
8. W.G.V.Rosser — Introduction to the Theory of Relativity.

Paper Code	242716	**Marks: 100**	**Credits: 4**	**Class Hours: 60 hrs.**
Paper Title:	**Physics Practical -IV**			Exam Duration: 12 Hours

Examination duration: 6 hours.

To perform two experiments from group A, and one experiment each from group B and C.

All experiments should be of three hours duration.

i) Experiments (3 hours each)	4 x 20 =	80
ii) Laboratory note book		10
iii) Viva-voce		10
Total marks	=	100

Marks for each experiment shall be distributed as follows:

a) Theory	3
b) Data collection and tabulation	8
c) Calculation, graphs and result	6
d) Discussions	3
Total marks =	20

Group – A: Electronics

1. To calibrate the frequency dial of a signal generator with the help of line frequency by forming Lissajous figures on an oscilloscope screen.
2. To determine the characteristics of a given transistor for common base and common emitter configurations and find the parameters α and β
3. To construct a free running multivibrator and measure its frequency from the display of its output wave forms on an oscilloscope screen.

4. To study a non-investing amplifier employing an operation amplifier (frequency response and gain).
5. To construct a saw tooth wave generator employing an unijunction transistor (2N2646) and determine its repetitive frequency.
6. To construct the AND OR and NOT (inverter) gates using semiconductor diodes and transistor.
7. To construct NOR and NAND gates.

Group – B: Nuclear Physics

1. (a) To determine the plateau and operating voltage of a Geiger-Muller counter.
   (b) To determine the dead-time of the G-M tube.
2. To find out the linear absorption coefficient, mass absorption coefficient and atomic absorption coefficient of lead. (Ra-Source or Cs-Source).
3. To determine the absorption co-efficient for beta radiation of a given material and find the range of beta radiation in that material (Y-Sr source).
4. To verify the inverse square law for γ–rays (Cs or Co-Source).

Group – C: Solid State Physics

1. To find out the speed of sound with the help of acoustic transducers.
2. To study the variation of impedance of a given acoustic transducer as a function of frequency.
3. To find out the forbidden energy gap of a given semiconductor specimen
4. To measure the dielectric loss of certain lossy materials.

Books Recommended:

1. Ahmad G. and Nasreen F : Advanced Practical Physics
2. Din K. and Matin M.A. : A text book of practical Physics
3. Squires G.L. : Practical Physics
4. Topping J. : Errors of observation and their treatment
5. Millman, J. and Halkias, C.C : Electronic Devices and Circuit
6. Mannan, K.M. and Pramanik, N : ব্যবহারিক পদার্থবিজ্ঞান ১ম ও ২য় খন্ড
7. Worsnop & Flint : Practical Physics

Paper Code	242718	**Marks: 100**	**Credits: 4**	
Paper Title:	**Viva-voce**			