NATIONAL UNIVERSITY

Third 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

THIRD YEAR

Paper Code	Paper Title	Marks	Credits
232701	Atomic & Molecular Physics	100	4
232703	Quantum Mechanics-I	100	4
232705	Computer Fundamentals and Numerical Analysis	100	4
232707	Electronics-I	100	4
232709	Nuclear Physics-I	100	4
232711	Solid State Physics-I	100	4
232713	Mathematical Physics	100	4
232714	Physics Practical-III	100	4
	Total=	800	32

Detailed Syllabus

Paper Code	232701	Marks: 100	Credits: 4	Class Hours: 60 hrs.
Paper Title:	Atomic & Molecular Physics			Exam Duration: 4 Hours

1. **Quantum Theory**: Quantum character of radiation, Black Body Radiation, Photoelectric effect, Einstein's photon theory, Photoelectric equation, Compton effect, Wave-particle duality, De Broglie wave, Electron diffraction: Thompson and Davisson-Germer experiment.
2. **Rutherford Nucleus**: Rutherford alpha scattering experiment, Nucleus, Bohr quantization rules, Hydrogen atom spectra, Franck-Hertz experiment, Sommerfeld-Wilson quantization rules.
3. **Electron Spin**: Stern-Gerlach experiment, Pauli's exclusion principle, Electronic configuration of atom, Vector model, Coupling schemes, Hund's rule.
4. **Multiple Structures**: Fine structure, Hyperfine structure, Zeeman effect, Paschen-Back effect.
5. **X-rays**: Production and properties of X-rays, Continuous and characteristic X-rays, X-ray spectra: X-ray absorption: Moseley's law.
6. **Molecular Spectra**: Rotational and vibrational levels, Raman effect, Applications of Raman effect.

7. **Laser**: Stimulated emission, Einstein's A and B co-efficients, Population inversion, Laser idea, three and four level lasers, Properties of a laser beam, Ruby, He-Ne and CO_2 lasers.

Books Recommended:

1. Beiser, A. : Perspectives of Modern Physics
2. Beiser, A. : Concepts of Modern Physics
3. Svelto, O. : Principles of Laser
4. Weidner, R.T. and Sells R.L. : Elements of Modern Physics
5. Verdeyen, J.T. : Laser Electronics
6. Islam, G.S. : পারমানবিক পদার্থবিজ্ঞান ১ম খন্ড

Paper Code	232703	Marks: 100	Credits: 4	Class Hours: 60 hrs.
Paper Title:	Quantum Mechanics-I			Exam Duration: 4 Hours

1. **Physical Basis**: Failures of Classical Mechanics and emergence of Quantum Mechanics, Bohr atom model and old quantum theory, Quantization of the phase integral, Particle in a box, Shortcomings of old quantum theory, Wave particle duality, De-Broglie wavelength.
2. **Basic Concept of Quantum Mechanics**: Uncertainty principle, Postulates of quantum mechanics: (a) Interpretive postulates and (b) Physical postulates, Correspondence principle and complementary principle, Operators and its properties, Eigenfunctions and eigenvalues,

Scalar product of two functions, Orthogonality relations of any function f(x), Heisenberg uncertainty relations for arbitrary observables, Momentum eigenfunctions, completeness.

3. **Schördinger Wave Equation**: Development of the wave equation, Interpretation of wave function, Probability current density, Expectation value of dynamical variables and Ehrenfest's theorem.
4. **Principle of Superposition of States and Fourier Transforms of Wave Functions**: Co-ordinates and momentum representations, Wave packets and uncertainty principle, Monochromatic waves, Spread of Gaussian wave packets with time.
5. **Problems in One-Dimension**: Particle in a box, Potential step, Potential barrier, Barrier Tunneling, Alpha particle decay, Square-well potentials, Linear harmonic oscillators.
6. **Spherically Symmetric Systems**: Schrödinger Equation for spherically symmetric potentials, Spherical harmonics, Three-Dimensional square well potential, Hydrogen atom.

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. Merziacher, E. : Quantum Mechanics
5. Mathews, P.T. : Quantum Mechanics
6. Golder, S.K. : কোয়ান্টাম বলবিদ্যা
7. Bhuiya, G.M. : Quantum Mechanics
8. Sherwin, C.W. : Introduction to Quantum Mechanics
9. Golam Md. Bhuiyan : কোয়ান্টাম বলবিদ্যা

Paper Code	232705	**Marks: 100**	**Credits: 4**	**Class Hours: 60 hrs.**
Paper Title:	**Computer Fundamentals and Numerical Analysis**			Exam Duration: 4 Hours

1. **Fundamental Concepts:** Block Structure of a Computer, Characteristics of Computers, Problem Solving with Computers, Generation of Computers, Classification of Computers.
2. **Logic Design:** Boolean Algebra; De-Morgan's Law, Minimum Boolean Expression; Karnaugh Map Method of Simplification of Logic Expression; Combinational and Sequential Circuits; Arithmetic Circuits. Fixed Point Representation – Integer Storage, Largest Integer Storage, Negative Integer Storage representation, Floating Point representation, Overflow and Underflow.
3. **Digital Devices:** Logic Gates and their Truth Tables, Canonical Forms, Combinational Logic Circuits, Minimization Technique, Arithmetic and Data Handling Logic Circuits. Decoders, Encoders, Multiplexers, Demultiplexers. Combinational Circuit Design, Flip Flops, Half-Adder, Full-Adder, Race around problems, Counters, Asynchronous Counters, Synchronous Counters and their Applications, Odd Sequence Counter Design, Register of different types and their Applications; Minimization of Sequential Circuits, and Memory Units.

4. **Computer CPU:** CPU Organization, Function of ALU, CPU Instruction, Types of Buses, Size of CPU Registers –Program Counter, Memory Address Register, Memory Data Register, Accumulator. Input-Output Devices – Architecture of Keyboard, Mouse, Webcam, Scanner, Types of Monitor, Types of Printer
5. **Input and Output Units :** Their Functional Characteristics, Types of Primary (Main) Memory, Types of Secondary Memory, Chache Memory, Physical and Virtual Memory, Types of Optical Memory, RAM Disks. Addressing Modes – Direct Addressing, Indirect Addressing, Indexed Addressing, Immediate Addressing Modes.
6. **Computer Storage Devices:** Overview of Storage Devices- Floppy Disk, Hard Disk, Compact Disk, Tape. Secondary Storage Devices, Sequential and Direct Access Devices, Magnetic Disk, Floppy Disk, Winchester Disk, Mass Storage, Optical Disk, Magnetic Bubble Memory.
7. **Software:** What is Software, Low level and High Level languages for programming, Relationship between Software and Hardware, Types of Software: System Software (Meaning and its type), Application Software, Acquiring Software, Software Development Steps, Firmware, Middleware.
8. **Network:** Computer Communication, basic concepts of LAN, WAN, Workstation, and Server, Optical Fiber in Communication, World Wide Web (www) and E-mail, E-commerce.
9. **Roots of Equations**: Bisection methods, False-Position method, Newton-Raphson method, Secant method, Systems of Linear Algebraic Equations, Naïve Gauss Elimination, Gauss-Jordan method and matrix inversion, Gauss-Seidel method, Nurnerical Integration: Trapezoidal rule, Simpson's rules, Ordinary Differential Equations. Runge-Kutta methods with different orders, Interpolation, Linear interpolation, Quadratic interpolation, Lagrange interpolating Polynomials.

Books Recommended:

1. Sarah E. Hutchinson and Stacey. Swyer : Computers and Information Systemsl.
2. Byron Gottfried. : Programming with C.
3. Stephen G. Kochan. : Programming in C.
4. Herbert Schildt : Turbo C/C ++ (The Complete Reference)
5. Hidebrand F.M. and Scarborough. : Numerical Analysis.
6. Floyd & Jain : Digital fundamentals, Pearson Education.
7. Norton, P. : Inside the PC.
8. Ram, B. : Computer Fundamentals, Wiley, 1997.
9. French, C. S. : Computer Science
10. Trainer, T. N. : Computers (4th Edition) McGraw Hill, 1994.

Paper Code	232707	**Marks: 100**	**Credits: 4**	**Class Hours: 60 hrs.**
Paper Title:	**Electronics-I**			Exam Duration: 4 Hours

1. **History of Electronics**: Electronics and electricity, Vacuum diode, Triode.

2. **Semiconductor Diode**: p-n junction, Forward and reverse bias, I-V curve, Diode equation, Ge and Si diodes, Breakdown PIV rating, DC and AC resistance, Load line and Q-point, Maximum current.
3. **Diode Applications**: Application in reverse voltage protection or auto polarity (using bridge) of dc equipment and as an OR gate in instant emergency power supplies, Half wave and full wave rectification of sinusoidal AC, Average voltage, Capacitor smoothing, Ripple factor and voltage, Zener voltage regulator.
4. **Bipolar Junction Transistor (BJT)**: npn and pnp configurations, transistor action, CB, CE and CC configuration, alpha and beta parameters, CE characteristics, Load line and operating points, Cut-off and saturation, Transistor as a switch, Active region for liner amplification, Q-point, Graphical analysis, Class A, B and C amplifiers, Transistor biasing: Fixed bias, collector feedback and voltage divider bias, Emitter feedback for bias stabilization (including bypass capacitor), Ohm meter testing of transistor, Photo transistor characteristics.
5. **Equivalent Models and Circuits**: Constant voltage and constant current sources, Thevenin's and Norton's theorems and determination of equivalent circuits for known and unknown network, Superposition theorem, Two-port network equations Z and h-equivalent circuits and parameters, Ebers Mol model and h-equivalent model for a transistor.
6. **CE Amplifier**: Small signal analysis of a CE amplifier with voltage divider bias (voltage gain, input and output impedences) using Ebers Moll and approximate h-equivalent circuits, Typical CB and CC (Emitter Follower) amplifier circuits, Comparison of important features of CB, CE and CC amplifier, RC couple cascaded CE amplifier, Equivalent circuit and analysis.
7. **Frequency Response of Amplifiers**: General voltage gain and phase response considerations, Bandwidth, Decibel (dB), Voltage gain, Identification of low pass and high pass elements in CE amplifier including stray capacitance and Miller effect capacitance and their responses.
8. **Operational Amplifier**: Basic concepts on difference amplifier (double ended input, single ended output) as the input stage of an op-amp, Differential and Common mode operation, Common mode rejection ratio, Necessity of negative feedback, analysis for gain, input and output impedance for voltage series feedback, Frequency response, Gain-bandwidth product, Ideal op-amp approximations, Inverting amplifier, Non-inverting amplifier, Adder, Subtractor, Comparator, Applications in millivolt meter and current meter.
9. **DC Stabilized Power Supply**: Series voltage regulation with feedback using transistor and op-amplifier, IC regulators (positive and negative, fixed and variable).

Books Recommended:

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

Paper Code	232709	Marks: 100	Credits: 4	Class Hours: 60 hrs.
Paper Title:	**Nuclear Physics-I**			Exam Duration: 4 Hours

1. **Basis Properties of Nuclei**: Constituents of nuclei, Nuclear mass, charge, size; Nuclear density, Mass defect, Binding energy, Nucleon separation energy, Liquid drop mode, Semi empirical mass formula.
2. **Nuclear Spin**: Nuclear spin and angular moment, Nuclear moments, magnetic dipole moment, Effective magnetic moment expression, Electric moments (Multipole expression).
3. **Radioactivity**: Radioactive decay laws, Half life, Mean life, Transformation law of successive changes, Secular and transient equilibrium, Measurement of decay constant, Artificial radioactivity, Radioisotopes; production and uses, Units of radioactivity, Energy loss of charged particles, Collision energy loss, Radiation energy loss, straggling of alpha particles range in the absorber.
   Radiation hazards, Biological effects of radiation, interaction of radiation with human cells.
4. **Alpha Decay**: Alpha instability, Fine structure, Large range alpha particles, Alpha particle spectra and nuclear energy levels, Theory of alpha decay.
5. **Beta Decay**: Energy measurement, Conservation of energy and momentum, Neutrino hypothesis, Evidence for antineutrino, orbital electron capture, Positron emission.
6. **Gamma Decay**: Energy measurement, Pair spectrometer, Theory of gamma emission, Mean lives for gamma emission, Internal conversion, Mossbauer effect.
7. **Nuclear Fission and Fusion**: Fission process, Energy release in fission, Chain reaction, Nuclear reactor, Nuclear fusion, Thermonuclear reaction is stars.
8. **Detectors**: Ionization chambers, Proportional counter Geiger-Muller counters, Solid State Detector, Scintillation counter.
9. **Nuclear Reactions**: Reaction dynamics, The Q-Value equation and threshold energy Conserved Properties.

Books Recommended:

1. Enge, H.A. : Introduction to Nuclear Physics
2. Cohen, B.L. : Concepts of Nuclear Physics
3. Meyerhoff, W.E. : Elements of Nuclear Physics
4. Burcham, W.E : Nuclear Physics
5. Irving Kaplan : Nuclear Physics
6. Gelly, A.H. : Fundamentals of Nuclear Physics
7. Krane, K.S. : Introductory Nuclear Physics
8. Islam, A.K.M.A. and Islam, M.A., : নিউক্লীয় পদার্থবিজ্ঞান ২য় সংস্করণ
9. Islam, G.S. : পারমাণবিক পদার্থবিজ্ঞান ২য় খন্ড
10. Sen Gupta : নিউক্লীয়ার পদার্থবিদ্যা
11. Knolls : Principle of Radioactive protection.

Paper Code	232711	Marks: 100	Credits: 4	Class Hours: 60 hrs.
Paper Title:	Solid State Physics-I			Exam Duration: 4 Hours

1. **Crystal Structure**: Crystalline state of solids, Unit cells and Bravais lattices, Symmetry operations, Miller indices, Crystal planes and directions, Simple crystal structures, Diffraction of X-rays by crystals, Laue equations and Bragg law of x-ray diffraction, Experimental diffraction methods – Laue method, Rotating crystal method and Powder method, Reciprocal lattice.
2. **Crystal Bonding**: Interatomic forces and crystal bonding, lonic crystals – Calculation of electrostatic energy, Madelung constant, Repulsive interactions and bulk modulus, Covalent crystals, Crystals of inert gases – Van der waals, Metal crystals and Hydrogen bonded crystals.
3. **Lattice Vibrations and Thermal Properties**: Vibrations of monatomic linear lattice, Vibrations of diatomic linear lattice, Phonon, Phonon momentum, Enumeration of normal modes, Lattice specific heat, Einstein and Debye models, Lattice thermal resistivity.
4. **Defects in solids**: Point defects, Thermodynamic consideration of defect concentration – Schottky and Frankel types of defects, Colour centers in ionic crystals, Line defects, Various types of dislocations.
5. **Free Electron Theory of Metals**: Free electron gas, Energy levels, Degenerate and Non-degenerate states, Fermi-energy absolute zero temperature, Density of state, Fermi-function, Effect of temperature on Fermi energy, Average kinetic energy. Electronic specific heat, Electrical conductivity, Thermal conductivity, Hall effect of free electron, Wiedmann-Franz law.
6. **Fundamentals of Semiconductors:** The electrical properties of solids, Energy levels in crystalline solid, Insulators, Conductors, Semiconductors, Doped semiconductors, n-type semiconductors, p-type semiconductors, pn-junction, Majority and minority carriers, Junction rectifier, Diode, Light-Emitting Diode (LED), Transistor, Integrated Circuit (IC).

Books Recommended:

1. Kittel, C. : Introduction to Solid State Physics
2. Dekker, A.J. : Solid State Physics
3. Omar, A.M. : Elementary Solid State Physics
4. Singhal, R.L. : Introduction to Solid State Physics
5. Saxena, Gupta and Sexena : Fundamentals of Solid State Physics
6. Islam, M.S. : কঠিন অবস্থার পদার্থবিজ্ঞান
7. সাইদুজ্জামান : সলিড স্টেট ফিজিক্স

Paper Code	232713	Marks: 100	Credits: 4	Class Hours: 60 hrs.
Paper Title:	**Mathematical Physics**			Exam Duration: 4 Hours

1. **Functions of complex Variable**:
   i) Complex algebra, Cauchy-Riemann equations as conditions of analyticity, Cauchy's integra theorem for analytic function.
   ii) Taylor series expansion, Types of singularities, Laurent expansion, Cauchy's Residue Theorem, Contour integration using the residue technique.
   iii) Gamma function and Beta functions, their recursion properties and singularities.
2. **Fourier Series and Integral Transformations**:
   a) Fourier's theorem about periodic functions. Determination of Fourier coefficients. Gibbs phenomenon. Parseval relation. Summation of series using Fourier method.
   b) Fourier transformation via Fourier series. Inverse Fourier transformation. Idea of a function Space and the fourier transforms as its dual space. Properties of Fourier transformations. Parseval relation. Dirac delta function. Fourier sine and cosine transformation. Use of Fourier transformations for solving differential equations. Convolution theorem.
3. **Transformations:** Laplace transform. Inverse Laplace transformation: Bromwich integral. Elements of operational calculus.
4. **Special Functions in Physics**: Gamma and Beta functions. Series solution of differential equations by Forbenius method.
   Bessel Functions. Legendre. Hermite and Laguerre Polynomials-generating functions, recursion relation and orthogonality properties.
5. **Theory of Matrices**: Type of matrices (unitary, hermitian. Symmetric etc.); Determinant of a square matrix; Equivalence; Adjoint and inverse of a square matrix; Liner equations; Linear transformations: Similarity transformations.

Books Recommended:

1. Arfken, G.B. : Mathematical methods in Physics, (4^{th} ed.)
2. Mary, L. Boas : Mathematical Methods in Physical Science
3. Pipe, L.A. : Applied Mathematics for Physicists and Engineers.

Paper Code	232714	Marks: 100	Credits: 4	Practical Class Hours: 60 hrs.
Paper Title:	**Physics Practical-III**			Exam Duration: 6 Hours

To perform two experiments each of three hours duration.

i) Experiments (3 hours each)	2 x 40= 80
ii) Laboratory note book	10
iii) Viva-voce	10
Total marks	= 100

Marks for each experiment shall be distributed as follows:

a) Theory		5
b) Data collection and tabulation		15
c) Calculation, graphs and result		15
d) Discussions		5
Total marks	=	40

1. Formalization of an oscilloscope
   i) Stabilization of a signal display using triggering mechanism.
   ii) Measurement of tune period and amplifier.
2. Determination of Rydbegr constant using spectrometer.
3. Determination of dispersive power and resolving power of a prism.
4. Determination of dispersive power and resolving power of grating.
5. To determine the separation between D1 and D2 lines of sodium by Michelson interferometer.
6. To determine the refractive index (or thickness) of a film by Michelson interferometer.
7. To determine wavelength of monochromatic light by Michelson interferometer.
8. Determination of resonance frequency in LCR circuit with (a) L and C in series and (b) L and C in parallel.
9. Plotting the characteristic curve for a semi-conductor diode.
10. Plotting the characteristic curves of a transistor.
11. To construct a power supply and to find the ripple factor of full wave rectifier for two different loads.
12. Construction of an audio frequency amplifier employing transistors and study its frequency response.
13. To study the frequency response of a low pass RC filter.
14. Determination of Planck's constant.
15. Study of voltage divider bias for a CE amplifier.

Books Recommended:

1. Worsnop B.L. and Flint, H.T. : Advanced Practical Physics
2. Ahmed, G.U. and Uddin, M.S. : Practical Physics
3. Ahmad, G. and Nasreen, F. : Advanced Practical Physics
4. Din, K. and Matin, M.A. : Advanced Practical Physics
5. Ahmed, R. : Experiments in Basic Electronics
6. চৌধুরী, এস.এ : ব্যবহারিক পদার্থবিদ্যা