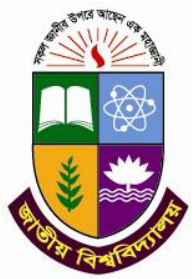
NATIONAL UNIVERSITY



Syllabus

Department of Physics

One Year Master's Course

Effective from the Session: 2013-2014

National University

Subject: Physics

Syllabus for One-Year Master's Course

Effective from the Session: 2013-2014

Paper Code	Paper Title	Credits
312701	Nuclear Physics	4
312703	Solid State Physics	4
312705	Electronics	4
Any four paper the followings		
312707	Health Physics	4
312709	Medical Physics	4
312711	Geophysics	4
312713	Reactor Physics	4
312715	Solar Energy	4
312717	Material Science	4
312719	Modern Field Theory	4
312720	Practical Three Experiments to be Performed (One from each group) 3x40=120 Laboratory Note Book =15 Viva-Voce on Experiment =15	6
312722	Viva-Voce (Practical)	2
312724	Thesis	6
312726	Viva Voce (Thesis)	2
	Total =	**36**

Detailed Syllabus

Paper Code: 312701	------	Credits: 4	Class Hours: 120 hrs.
Paper Title :	Nuclear Physics		

1. Fermi Gas Model: Assumptions, Fermi momentum and Fermi energy, Calculation of average and maximum kinetic energies of a nucleon in a nucleus.

2. Shell Model: Single particle potentials, Spin-orbit potential, Magic numbers, Shell model predictions, Ground state spins, Spin and Magic moments of nuclei, Schmidt curves.

3. **Collective Model:** Rotational energy spectrum and nuclear wave function for even-even nuclei and for odd- even nuclei, Vibrational model, Beta and Gamma vibrations in nuclei. .

4. **Nuclear Reactions**:

(**a) Compound Nucleus Model:** Cross section by the method of partial waves, Compound nuclear reactions, Continuous theory, Resonance Breit-wigner dispersion formula for L=O.

(b) Optional Model: Concept of optical potential, Energy averaged cross section and the optical model at low energies Phenomenological optical model.

(c) Direct Reactions: Direct reaction mechanism of nuclear reactions, Stripping pick up and knockout reactions. Plane wave theory of stripping and pick up reactions. Introduction to distorted wave method. Introduction to heavy ion reactions.5.

5. **Gamma Emission :** Gamma decay energetics, Multipole moments, Multipole fields, Theory of gamma emission, Selection rules,Angular correlations, Transition rates, Internal conversion,Measurement of Gamma ray energies and life time of excited states.

6. Elementary Particles : Definition, Classification; Bosons and Fennions; Leptons and Hadrons. Quantum number, Different types of interactions and conservation laws, Idea of quarks, Symmetry Transformation, Unitary symmetry, Gauge symmetry, SU(2) X U(1) model (Salam Weinberg model).

References:

1. H. Feshbach-Theoretical Nuclear Physics (Nuclear Reactions).
2. Nuclear Physics, Roy and Nigam. John Wiley and Sons.
3. Structure of the Nucleus, Preston and Bhaduri. Addision-Wesley.
4. Nuclear Physics, Blatt and Weiskoff. John Wiley ans Sons.
5. A. Bohr and B.R. Mottelson-Nuclear Structure.
6. G.R. Satchler: Direct Nuclear Reactions.
7. J.P. Davidson-Collectine models of the Nrclide.
8. Introduction to Nuclear physics, H.A. Enge. Addison-Wesley.

Paper Code: 312703	------	Credits: 4	Class Hours: 120 hrs.
Paper Title :	**Solid State Physics**		

1. Electron States and Energy Bands in Solids: The nearly free electron model, The tight binding method, Cellular method, Muffin-Tin potentials, Pseudo potentials.

2. The Fermi Surface: High magnetic fields, High-field magneto-magneto-coustic oscillation, Quantization ofresistance, resistance, Open orbits, orbits. The De-Haas-Van Alphen effect, Magnetic breakthrough.

3. Semiconductor Crystals:
i) Energy bands, Cyclotron resonance, Imp
ii) Optical absorption and excitation.

4. Advanced Magnetism : Ferromagnetism and exchange Interaction, Rare earth's magnetism, Magneto crystalline anisotropy, Ferromagnetic domains, Magneto elasticity, ferromagnetism, Ising model, Spin waves, Magnetic resonance

5. Elastic Properties of Solids: Elastic constant and modulee of elasticity, Elastic waves, Elastic and plastic deformation, Creep fatigue and hardness.

6. Liquid Crystals: Structure and Classifications of different phases orientation order, Magnetic effects, Optical properties, introduction to theories of liquid crystaline phases, Practical applications.

References:

1. Solid State Physics : N.Y. Ashcroft and N.D. Mermin, Saunders Co., Philadelphia.
2. Statistical Mechanics : Kerson Hung. Wiley Eastern, New Delhi.
3. Elementary Solid state Physics : M. Ali Omar. Pearson Education, Inc.
4. An Introduction to Solid State Physics : C. Kittel, John Wiley and Sons, N.Y.
5. Introduction to Solid State Physics : A.J. Dekkar, Prentice-Hall N.J.
6. Introductory Solid State Physics : H.P. Myers.
7. Materials Science and Engineering: An Introduction- William D. Callister (Wiley, 2010).
8. The Physics of Liquid Crystals (International Series of Monographs on Physics) –P.G.de Gennes, J. Prost (1995).
8. R.G. Larson, The Structure and Rheology of Complex Fluids.
9. NanoPhysics and Nanotechnology, Edward L. Wolf (Wiley, 2006).
10. NanoScience, Nano Technologies and NanoPhysics (Springer, 2004).

Paper Code: 312705	------	Credits: 4	Class Hours: 120 hrs.
Paper Title :	**Electronics**		

1. Digital Building Blocks : Basic SR FF IC lozic families, tristate, Logic, Clocked FF, Edge triggered DFF, triggered JK FF. D-type latch, Synchronous and asynchronous FF inputs (preset and clear), Binary counters up/down counter. Memory element-FF register, Serial transfer of data. Decoder. Encoder, multiplexer, Typical Arithmetic Logic Unit.

2. Computers: computer system diagram and functions, Instruction words-op code and operand, Basic program execution, Flow diagram simplified 4046 microprocessor scheme, Buses and registers, program counter, Programming language types: Machine language, Assembly language and High level language, Source code, Executable files.

3. Input/Output : Handshaking, Examples of 1/0 : Process/instrument control, Keyboard entry/display, Asynchronous serial data communication, Parallel/serial interface-the UART, Parallel 1/0 chips, Peripheral interface, Adapter (PIA, basics only), General purpose analogue interface card for data acquisition.

4. A/D and D/A Conversion : Sampling theory, Aliasing, Dual slope integration and Successive approximation, A/D conversion, Weighted resistor, Ladder and Binary ladder D/A converters.

5. Modulation and Demodulation: Types of modulation, Importance of modulation, Amplitude and power spectrum in AM, Spectrum in FM, Amplitude modulation circuits, AM transmitter, AM vs FM, Fundamentals of demodulation, Diode detection, Superheterodyne, AM receiver.

6. Microwave Generator: Magnetron

References:

1. Tocci, R.J. and Laskowski : Microprocessors and Microcomputers. Prentice-Hall International, 3rd Edition, 1987.

2. Brophy, J.J. : Basic Electronics for Scientists, Mcgraw-Hill, 3rd Edition, 1977.

Paper Code: 312707	------	Credits: 4	Class Hours: 120 hrs.
Paper Title :	**Health Physics**		

1. Radiation Detectors: Scintillation detector, Semiconductor detectors, Tract etch detectors, TLD, Neutron detection.

2. Radiation Dosimetry: Radiation units, RBE, QF absorbed dose, Exposure dose relationship, Bragg- Gray principle, Internally deposited radioisotope, Calculation of dose rate from point and distributed sources.

3. **Problems in Radiation Detection and Measurements:** Detector efficiency, Energy selective counting, Absorption and scatter, Source and detection system calibration, Minimum detectable activity, Estimated required counting time, Application of different statistical distributions.

4. Biological Effects of Radiation: Chemical changes, Changes of biologically important molecules, Acute, Delayed and Genetic effects.

5. Radiation Protection Guide : Principle of radiation protection, Basic radiation safety criteria, Exposure of individuals in the general public, Allowable limit on intake, Typical rules for operation of a radiation laboratory.

6. External Radiation Protection: Techniques of external radiation protection, Shielding primary protective and secondary protection barriers, Charged particle and neutron shielding.

7. Internal Radiation Protection: Internal radiation hazard: Principle of control, Control of source, Environmental monitoring and control, Protective clothing, Respiratory protection, Surface. Contamination limits.

References:

1. Cember, H. Introduction to Health Physics
2. Martin and Halison Introduction to Radiation protection

Paper Code: 312709	**------**	**Credits: 4**	**Class Hours: 120 hrs.**
Paper Title :	**Medical Physics**		

1. Structure of Macromolecules:
Atomic and Molecular forces, Behaviour of marcromolecules, Physics techniques for structure determination (e.g. X-ray diffraction, Spectroscopy and NMR.)

2. Properties and structure of Nucleic Acid: DNA, RNA, Viruses, Methods of replication.

3. Protein Structures: Amino acids; Primary, secondary and tertiary structure.

4. Basics Enzyme Behavior: Michelis Menten Mechanism and MWC model, Haeomoglobin.

5. The Cell Memberane: Basic membrance properties, Diffusion and transport chemical pump and membrane potential, membrane model.

6. Physics of Nervous System: Electrical activity of the central nervous system, Huxley-Hodgkin Theory, neurotransmitters, Physics of vision and hearing.

7. Physics of Muscles: Smooth, striated and cardiac muscle, muscle action potential.

8. Cardio-Vascular System: Mechanics of fluids and its application to blood flow.

9. Ultrasound Imaging: Nature, production and detection of ultrasounds, A-scan, B-scan, M-scan, Clinical applications.

10. Other Imaging Techniques: Rectilinear Scanner, Gamma camera, CAT scanner, Clinical applications.

11. Audiology, Hearing aids.

12. Vasculer Measurements: Blood pressure, Blood flow, Blood velocity.

13. Cardiac Measurements: ECG, ECG planes, Einthoven's triangle, Elementary, idias on heart disorders, Defibrillators, pacemakers.

14. Neuromusclar Measurements: EEG EMG, Stimulation of neural tissue, Nerve conduction measurements.

15. Bio-electric amplifiers, patient safety.

16. Radiation and Health: Radiopharmaceuticals, Radiotherapy, Radiation Protection, Radiation Dosimetry.

References:

1. W.T. Hughes, Aspects of Biophysics, John Wiley and Sons.
2. B.H. Brown and R.H. Smallwood, Medical Physics and Physiological Measurements, Black-Well Scientific Publications.
3. J.R. Cameron and J.G. Skofronick, Medical Physics, John Wiley and Sons.
4. D. Hughes, Notes on Ionising Radiation, Quantities, Units, Bilogional Effects and Permissible Doses, Science Reviews Ltd., London and H. Scientific Constants Limited.
5. Antonini and Brunori, Haemoglobin and Myoglobin in their Reactions with Ligands, North-Holland.
6. N.C. Hilyard and H.C. Biggin, Physics for Applied Biologists, University Park Press, Maryland.
7. P. Davidovits, Physics in Biology and Biophysics, Saunders.
9. H. Cember, Introduction of Health Physics, McGraw-Hill, 1992.

Paper Code: 312711	------	Credits: 4	Class Hours: 120 hrs.
Paper Title :	Geophysics		

1. The Solar System: The planets, Meteorites, Cosmic ray exposures of meteorites. The Polynting- Robertson effect, Composition of the terrestrial planet.

2. Radioactivity and the Age of the Earth: The pre-radioactivity age problem, Radioactive elements and the principle of radiometric dating, Growth of the constituents and of atmospheric argon. Age of the earth and of meteorites. Dating the nuclear synthesis.

3. Rotation and the Figure of the Earth: Figure of the earth, Precession of the equinoxes, the Chandler Wobble, Tidal Friction and the history of the earth of the earth moon system. Fluctuation in rotation and excitation of the wobble.

4. Seismology and the Structure of Earth: Seismicity of the earth, Elastic waves and seismic rays. Travels time and velocity depth curves for body waves, Internal density and composition, free oscillation, Earthquake prediction problem.

5. Earth's Magnetic Field: The main field, secular variation, electrical conduction in the core and mantle. Generation of the main field.

6. Seismic Method: Theory of elasticity, Elastic constants, Strain energy, Wave equations, Plane and spherical wave solutions, Seismic reflection and refraction in two and multiple layer medium, transformation of reflection and refraction time into geological.

7. Gravitational Method: Gravitational force, Acceleration and its relation to gravity exploration, Gravitational effects over sub surface bodies. Instruments for measuring gravity. Interpretation of gravity data separation of anomalies, graphical and analytical methods.

8. Magnetic Method: Basic concepts and definition in magnetic prospecting. Magnetism of the earth variation of the earth's magnetic field, magnetic effect form burried magnetic bodies. Instruments used for magnetic measurements. Quantitative interpretation of vertical magnetic field data.

9. Electrical Method: Electrical properties of rocks, self potential method, resistivity method, use of master curves in interpretation of resistivity data. Tulluric and magneto-telluric methods.

10. Nuclear Method: Radioactivity of rocks and minerals. Detection of radiation. Radiocarbon dating. Field operation and interpretation.

References:

1. F.D. Stacey, Physics of the Earth.
2. M.B. Dobrin, Introduction to Geophysical Prospecting.

3. R. E. Sheriff and L. P. Geldart, exploration Seismology Vol. 1.
4. B. P. Howell, Introduction to Geophysical.

Paper Code: 312713	------	Credits: 4	Class Hours: 120 hrs.
Paper Title :	**Reactor Physics**		

1. Neutrons: Production of neutrons, interactions of neutrons with nuclei, mechanism of nuclear reactions, resonance absorption, Breit-Wigner formula, neutron cross section, determination of cross section by transmission and activation methods, neutron activation analysis, average cross section 1/v and non-1/v, absorbers, variation of cross section with neutron energy, spectrum for reactor neutrons.

2. **Nuclear Fission:** Mechanics of fission, fission fuels, fission cross section, fission products and asymmetric fission, decay heat calculation, prompt neutrons and gamma rays, energy release in fission, reactor power, fuel consumption

3. **Diffusion of Neutrons:** Neutron interaction rates and neutron flux, neutron current density, equation of continuity, Fick's law, diffusion equation, solution of diffuision equation for various source conditions in infinite and finite media, multiregion problems in infinite and finite media, multiregion problems, diffusion length and its measurement albedo concept.

4. **Slowing Down of Neutrons:** Mechanics of elastic scattering , collision density, slowing down density, moderation of neutron in hydrogen, lethargy, average logarithmic energy decrement, sloring down in infinite media with capture, resonance escape probability, continuous slowing down model, Fermi age equation and physical significance of Fermi age.

5. **The Critical Equation**: Four factor formula, One group and two group critical equations for bare reactor, age diffusion method, reactors of various shapes, nonleakage probabilities, critical equations for large reactors, refected reactors, homogeneous and heterogeneous reactor system.

6. Reactor Kinetics: Neutrons lifetime, reactor kinetic equation, reactor period, one group of delayed neutrons, inhour formula, prompt critical condition, rod drop experiment and basic principles of reactor control.

7. **Nuclear Heat Removal:** Heat transfer by conduction, convection and radiation; heat transmission in clad plate type fuel element, heat transmission in clad cylindrical fuel element, and heat transmission in shields and pressure vessel in the form of slab with exponential heat source.

8. **Radiological Physics:** Units and Measurements, Biological effects of ionizing and non-ionizing radiations, external effects, internal effects, low level radiation effect and radiation protection guide.

9. **Radiation Detection and Reactor Instrumentation:** Ionization chambers, proportional counters, Geiger-Muller counters, scintillation counters, Neutron Detectors: fission chambers, fast neutron detection, self-powered detectors; PWR protection system and BWR protection system.

10. **Reactor Materials and Radiant in Damage problems:** Radiation damage to crystalline solids, amorphous materials, atom displacements per neutron scattering collision, temperature for

BCC metals, stainless steel in fast reactors, comparison between thermal and fast neutron damage, nuclear fuels, fuel densification, major causes of fuel defects, dispersion type alloys, and metallic fuels for fast breeders.

11. **Select Topics in Reactor and Fuel Cycle Technology:** Thermal discharges, BAEC research reactor (TRIGA type), gas-cooled reactor accident risks, loss of coolant accident (LOCA), the accident at TMI-2 and Chernobyl, diversion-resistant fuel cycle, radioactive waste disposal management, decommissioning of a reactor.

References:

1. Basic Nuclear Engineering (4^{th} Ed.) by Foster and Wright, Allyn and Bacon, Inc.
2. Nuclear Reactor Engineering by Glasstone and Sessonske, Van Nostrand and Reinhold Company
3. Introduction to Nuclear Reactor Theory by J.R.Lamarsh, Addison-Wesly Publishing Company.
4. Nuclear Reactor Analysis by Duderstadt and Hamilton, John Wiley and Sons.
5. Nuclear Reactor Analysis by A.F. Henry, MIT Press.
6. Nuclear Radiation Shielding by N.M. Schaffer, U.S. Atomic Energy Commission.
7. Radiation Shielding and Dosimetry by A.E. Profio, John Wiley and Sons.
8. Nuclear Radiation Detection and Measurements by G.F. Knoll, John Wiley and Sons.
9. Nuclear Power Reactor Instrumentation Systems Handbook by J.M. Harrer and J.G.
10. Beckerely. Technical Information Center, U.S. Atomic Energy Commission.

Paper Code: 312715	**------**	**Credits: 4**	**Class Hours: 120 hrs.**
Paper Title :	**Solar Energy**		

1. Introduction: Energy and human activities, growth rate of G.D.P. and energy consumption, world production reserve of commercial resources, Bangladesh situation, pollution from fossil fuels, green house effect, ozone depletion, energy options for the future, possible role of direct and indirect solar energy, a short review of devices for energy conversion.

2. Solar Radiation: The Structure of the sun, thermal radiation from the sun, the solar constant, extraterrestrial radiation, solar time, solar geometry.

3. Solar Energy Availability: Pyrheliometers and pyranometers, sunshine recorders, attenuation of solar radiation by the atmosphere, turbidity parameters, estimating G.D. and I, tilt factor.

4. Heat Transfer: Fourier equation, thermal resistance and diffusivity, free and forced convection, Nusselt, Prandtl and related numbers, convection heat transfer coefficients, Radiation heat transfer, Radiation exchange between two gray surfaces, sky radiation, radiation heat transfer coefficient, selective surfaces.

5. Radiation Transmission and Absorption: Transmittance of non-absorbing glass, absorption, transmittance for diffuse radiation, transmittance absorption product.

6. Thermal Energy Storage: Sensible heat storage with liquids, packed bed storage, phase change storage, thermo chemical storage.

7. The Physics of the Solar Cell: Review: Crystal Structure, Energy Band Structure, Densities of State, Light Absorption, Carrier Transport, Semiconductor Equations, Minority-carrier Diffusion Equation, *PN* -Junction Diode Electrostatics, Solar Cell Fundamentals, Solar Cell Boundary Conditions, Generation Rate, Terminal Characteristics, Solar Cell I –V Characteristics, equivalent circuit, efficiency, fill factor Properties of Efficient Solar Cells, Lifetime and Surface Recombination Effects, Efficiency and Band gap, Spectral Response, Parasitic Resistance Effects, Temperature Effects, Concentrator Solar Cells

8. Photovoltaic Materials: Crystalline Silicon, Amorphous Silicon, Gallium Arsenide and Other III-V Materials, Cadmium Telluride and Other II-VI Materials, Copper Indium Diselenide and Other I-III-VI Materials, Other Materials of Interest for Solar.

9. Organic and Dye sensitized solar cell: Background, Structure and Materials, Mechanism, Charge-transfer Kinetics, Characteristics, Fabrication, Assembling the Cell and Cell Performance, New Developments.

10. PV Systems: Lighting, water pumping, community use and connection to grids, solar batteries, electronic regulator, DC/AC converters.

References:

1. Duffy and Beckman – Solar Engineering of Thermal Processes.
2. Garg-A Treatise on Solar Energy.
3. Richard H, Bube - Photovoltaic Materials
4. Peter Wolfel - Physics of Solar Cell
5. Stephen J. Fonash - Solar Cell Device Physics
6. Sukhatme - Solar Energy.
7. Reviews of Renewable Energy Res., Vol. 4, Wiley Eastern.
8. The Physics of Solar Cells, Imperial College Press, Jenny Nelson

Paper Code: 312717	------	**Credits: 4**	**Class Hours: 120 hrs.**
Paper Title :	**Meterial Science**		

1. Solidification: Homogeneous and Heterogeneous nucleation, Crystal growth techniques, Sintering of materials, Theory. of liquid-solid phase transformation, Metal glass transition, Definition and experimental characteristics, Kinetic view of glass transition, Thermodynamics of glass transition, Free volume, Volume-temperature diagram, Vibrational model and structural models of glass transition.

2. Equilibrium Phase Diagrams: Solid solution of two component system, Simple eutectic diagram, Hume-Rothery electron compounds, Order-disorder phase transformation, Long-range and short-range order theories.
3. Diffusion: Ficks laws for isothermal diffusion, Atomic mechanisms of diffusion, Hydrogen diffusion, thermodynamics of diffusion of Pd-H system, Effect of lattice defects.
4. Engineering Alloys: Ferrous and non-ferrous alloys, Production of steel, The iron-carbon phase diagram, Structure and classification of plain carbon steel, Heat treatment of steel, Alloy steel stainless steel, Cast-iron and malleable iron, Tool steels.
5. Materials for Optical-Communication and Semiconductor Devices: Materials system and preparation, Characterization, Physical processes in these materials, Optical-communication devices, Signal sources, LED for Fiber optics, Laser and detectors for optical-communication system.
6. Composite Materials: Fibers for reinforcedplastic composite materials, Formation of composites, Open-mold and closed-mold process of preparation, metal matrix and ceramic-matrix composites, Elastic properties of composites, Strength and toughness of fiber reinforced composites.

7. Corrosion :
i)Wet Corrosion- Electrode potential, Galvanic corrosion, corrosion rate.
ii) Dry Corrosion- Mechanisms of oxidation of metal surfaces, Pilling-Bedworth ratio, Formation of scale and growth laws, Scaler esistance alloys.
iii) Corrosion Control and Prevention- Theory of cathodic and anodic protection, Passivation processes, Ion implantation.

8. Microstructure Examination: Experimental methods for the physical examination of materials, Metallurgical microscope, Microscopy of surfaces, TEM (Transmission electron microscopy) SEM (Scanning electron microscope), STM (Scanning Tunneling Microscopy) and AFM (Atomic forced microscopy), Thermal analysis - DTA, TGA, DSC (Differential thermal analysis, Thermogravimetric analysis, Differential scanning calorimeter), Crystal grains and grain boundaries, Energy of grain boundaries.

References:

1. Owen, F. D. – Topics in Metallurgical Thermodynamics.
2. Heyer, R. H. – Engineering Physical Metallurgy..
3. Compbell, J. S. – Principles of Manufacturing Mat and Processes.
4. Verron, J. – Introduction of Engineering Materials.
5. Haasen, P. - Physical Metallurgy.

Paper Code: 312719	------	Credits: 4	Class Hours: 120 hrs.
Paper Title :	**Modern Field Theory**		

1. Introduction. Overview, need for quantum field theory. Introduction to groups, rotation group and SU(2). Internal symmetries. Lorentz Transformation. Generators of the Poincare group.

2. Relativistic Quantum Mechanics: Klein-Gordon equation, Feynman-Stuckleberg interpretation of negative energy states, concept of anti particles. Dirac equation, covariant form, adjoint equation; plane wave solution and momentum space spinors. Spin and magnetic moment of electron. Properties of γ-matrices, charge conjugation, normalization and completeness of spinors. Relativistic convariance of Dirac equation, bilinear covariants.

3. Classical Field Theory: Action Principle of Hamilton and Euler Lagrange equations. Noether's theorem. Invariance of action under space-time translation and Lorentz transformation, energy momentum tensor. Symmetry under internal transformations.

4. Canonical Quantization Scalar Field: Equation of motion, equal time commutation relations, Fourier decomposition of the field, Ground state of the Hamiltonian and normal ordering, concept of Fock space, causality and invariant delta function. Feynman propagator. Complex scalar field, charge operator, particles and antiparticles. Propagator.

5. Canonical quantization of spin-1/2 field: The Dirac equation and the Lagrangian. Energy momentum and angular momentum tensor. Fourier decomposition of the Dirac field. Creation and destruction operators of particles and antiparticles. Propagator for the Dirac field.

6. Cononical Quantization of the Electromagnetic Field: Lagrangian formulation of Maxwell equations. Proca equation. Fourier decomposition of the electromagnetic field. Quantization in the radiation gauge and Lorentz gauge. The photon propagator.

7. Feynman Path Integral: Path integral in Quantum Mechanics: path integral for a free particle and harmonic oscillator. The path integral for free and interacting fields.

8. Interacting Fields: The S-matrix. LSZ reduction technique for different fields. Scattering amplitudes and Feynman rules for the self interacting φ^3 theory. Gauge invariance and scalar and spinor electrodynamics, Feynman rules.

Scattering cross section for some electromagnetic processes: (a) Compton scattering $e^- + \gamma \rightarrow e^- + \gamma$, (b) muon pair production $e^- + e^+ \rightarrow \mu^- + \mu^+$, (c) pair annihilation $e^- + e^+ \rightarrow \gamma + \gamma$, (d) Möller scattering $e^- + e^- \rightarrow e^- + e^-$, (e) Bhabha scattering $e^- + e^+ \rightarrow e^- + e^+$.

References:

1. Mark Srednicki, *Quantum Field Theory* (Cambridge University Press, 2007).
2. A. M. Harun ar Rashid, *Introduction to Quantum Field Theory* (University Grants Commission, Bangladesh, 2009).
3. Michael E. Peshkin and Daniel V. Schroeder, *An Introduction to Quantum Field Theory* (Westview Press, 1995).

4. P. Ramond, *Field Theory: a Modern Primer* (Addison Wesley, 1990).
5. P. B. Pal and A. Lahiri, *A First Book of Quantum Field Theory* (Narosa Publishing House, (2005)
6. A. Zee, *Quantum Field Theory in a Nutshell* (Princeton University Press, 2003).
7. F. Mandl and G. Shaw, *Quantum Field Theory* (John Wiley, 1984).
8. Claude Itzykson and Jean-Bernard Zuber, *Quantum Field Theory* (McGraw-Hill, 1980).

Paper Code: 312720		**Credits: 6**	
Paper Title :	**Practical**		

LABORATORY CLASSES: <u>All Experiments are to be performed during 1 year</u>.

(Three Experiments, one from each group are to be performed in nine (9) hours during final examination)

Distribution of Marks

Distribution of Marks			**Distribution of Marks on each Experiment**		
i)	**Three Experiments (One from each group)**	**3×40 =120**	i)	Theory	**5**
ii)	**Laboratory Note Book**	**15**	ii)	Procedure & Data Collection	**20**
iii)	**Viva-Voce on Experiment**	**15**	iii)	Calculations & Results	**10**
			iv)	Discussions	**5**
	Total =	**150**		**Total =**	**40**

<u>GROUP</u>- A (Nuclear Physics)

(One experiment of 3 hrs. duration to be performed)

1. Determination of the efficiency of a G-M tube for beta counting (Y-Sr source).
2. Relative efficiency of a G-M tube for beta/gamma counting (Co or Cs source).
3. Determination of the resolving time of a G-M counter by the double-source method (two Cs sources with slightly different strength).

4. To study the random of radioactive decay and show that the 68.3% to the measurements would fall within the limits bounded by ± σ from the mean value of the measurements.
5. Determination of the binding energy of deuteron.

GROUP- B (Solid State Physics)

1. Investigate the current voltage characteristics of a base-emitter and base-collector junction of a transistor and hence find the Ohmic resistance of the element of the transistor.
2. Study the effect of temperature on the reverse saturation current of a given p-n junction and hence find the intrinsic forbidden energy gap of the semiconductor specimen.
3. Measurement of junction capacitance of a p-n junction and determination of the depletion width.
4. To study the conductivity as a function of temperature in an intrinsic semiconductor.
5. Determination of Hall effect in a p- or –n type Si or Ge and to find out the mobility of carriers.
6. Analysis the given X-ray powder photograph of a material and hence find out the lattice spacing of the crystal.

GROUP- C (Electronics)

1 Construct a transistorized stabilized power supply and study its output characteristics.
2 Construct a summing amplifier using a 741 OPAMP and show the summing in tabular form for three different values of gain.
3 To construct a single stage transistor amplifier and to find its frequency response curve.
4 To construct a JK or SR flip-flop.
5 To construct a half adder circuit using IC logic gates.
6 To construct a full adder.

References:

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. Millman, J. and halkias, C. C. : Electronic Devices and Circuit.
7. Din, K. and Matin, M. A. : A Text Book of Practical Physics.

Paper Code: 312722	**-----**	**Credits:2**	
Paper Title :	**Viva-Voce**		