Department of Physics

Comilla University

Cumilla, Bangladesh

Syllabus for M.Sc. in Physics
(Session: 2019-20, 2010-21 & 2021-22)

INTRODUCTION

The Department of Physics has started its functioning of 4-year B.Sc. (Hons.) programme on 16 January, 2011, along with 30 students, and three faculty members. The students of the first batch successfully completed their 4-year B.Sc. (Hons.) programme, and has started their Master of Science (M.Sc.) in Physics from the academic session of (2014-2015). The M.Sc. in Physics programme includes current topics, trends, and their applications. Once a student undergoes this programme successfully, s/he may be enabled enough to face the challenges of 21st century. With the background of current research trends, strengthening communication skills, and acquainting the student with the competitive job market both at home and abroad.It should not also be a problem to find a suitable job in various government and non-government sectors like universities, research organizations, IT sectors, or even in banking sectors.

DEGREE REQUIREMENT

To obtain Master of Science (M.Sc.) in Physics degree, students will have to complete 33 credit hours with a minimum CGPA of 2.25.

DURATION OF THE ACADEMIC PROGRAMME

The duration of the program will be of one (01) academic year and shall be completed by a student in not more than two (02) academic years from the date of first admission. A student who fails to complete the Master degree within one academic year, s/he will be treated as an irregular student. Each academic year is divided into two (02) semesters to be called as Semester-I and Semester-II.

An academic semester comprised of six months is distributed as follows:

i.	Class Teaching (actual class)	=	13 weeks
ii.	Preparation time for semester final examination	=	2 weeks
iii.	Semester final examination	=	3-4 weeks
		Total =	**18-19 weeks**

GROUPS

The Master of Science (M.Sc.) in Physics will be arranged under two groups, (i) General and (ii) Thesis groups. Considering the facilities and the number of teachers in the subject, a limited number of students will be enrolled and minimum CGPA requirement for thesis group will not less than 3.5 decided by the academic committee of the Department in every academic year. Students willing t to undertake thesis shall apply to the Chairman and the Chairman will place it to the Academic Committee for necessary action.

MEDIUM OF INSTRUCTION AND EXAMINATION

The medium of instruction and answer in the examination of M.Sc. in Physics shall be English.

EVALUATION SYSTEM

a. **Theoretical Course**: Each theoretical course offered should be composed of 100 marks (each 100 marks course consisting of 3 credit point). The proportion of the total marks of a particular course shall be distributed as follows:

Continuous Assessment/Before-Final Assessment	= 40%
Semester-Final Examination	= 60%
	Total = 100%

b. **Continuous Assessment**: Marks allocated for before-final assessment shall be distributed as follows:

i) Mid- Semester examination (At least two mid-semester exams.)	= 20%
ii) Class Test and/or Quiz and/or In-course and/or Sudden test and/or tutorial and/or Assignment and/or Term paper preparation & presentation/Case study and/or practical and/or Field work	= 10%-15%
iii) * Class Attendance	= 5%-10%
	Total = 40%

*The marks allocated for class attendance shall be given as following proportions:

Attendance	**Marks**
90% and above	100%
85% to less than 90%	90%
80% to less than 85%	80%
75% to less than 80%	70%
70% to less than 75%	60%
65% to less than 70%	50%
60% to less than 65%	40%
Less than 60%	00%

c. **Practical Courses:** For laboratory courses students will be evaluated in two phases. The marks distribution will be as follows:

Continuous Assessment:	**40%**
Lab Attendance:	10%
Lab Performance:	20%
Lab Report Writing:	10%
Final Assessment:	**60%**
Evaluation on Experiments:	50%
Viva-voce:	10%

Detail distribution of Marks for the evaluation on experiment will be decided by the Examination Committee and the course teachers.

IMPROVEMENT OF GRADE

Only the removal of 'F' (Fail) in any course shall be allowed. Removal of 'F' in any course is permitted sitting in the final examination only for one (01) time in subsequent semester excluding the regular examination. In such cases results shall be one grade down (unless the result is "D" grade) in tabulation and calculation of CGPA.

DROPOUT

a. If a student re-admitted once in any semester fails to earn minimum required credits for promotion shall be dropped out from the programme.

b. If a student fails to earn required total credit points within two academic years since admissions, s/he will be dropped-out from the programme and will no more be allowed to continue his/her studentship with other programmes.

RE-ADMISSION

a. A student failing to earn the requisite credit points for promotion from one semester to the next may seek re-admission with the following batch.
b. For re-admission a student shall have to apply within one month after the announcement of the result of the 1st Semester.

NATURE OF COURSES AND DISTRIBUTION OF MARKS

Master of Science (M.Sc.) in Physics is divided into two groups, namely:

1. General Group
2. Thesis Group

The program shall be of one-year duration and shall consist of 33.0 credits (1100 marks) in total.

1. General Group

Students of this group shall take seven (07) theoretical courses from the offered courses with the approval of the academic committee of the Department. Students of this group shall also take two (02) Practical courses and one (01) Project. Each course contains 100 marks (3.0 Credits). Project carries 100 marks (3.0 credits). Total marks for this group will be distributed as follows:

		Marks	**Credits**
1.	Seven (07) theoretical courses:	700	21
2.	Two (02) Laboratory courses:	200	6
3.	Project:	100	3
4.	General Viva:	100	3
	Grand Total =	**1100**	**33**

2. Thesis Group

The student of this group shall be selected by the Departmental Academic Committee on the basis of the results of fouryears B.Sc. (Honours) examination. Students of this group shall also take seven (07) theoretical

courses of which at least one course must be related to the research work of the thesis. The remaining courses may be taken from the offered courses with the approval of the academic committee of the Department. The thesis dissertation carries 300 marks, oral presentation 50 marks and Pre-thesis work 50 marks. The total marks distribution for the Thesis group is as follows:

		Marks	**Credits**
1.	Seven (07) theoretical courses:	700	21
2.	Thesis (Pre-thesis:50+Dissertation:200 +Oral presentation: 50)	300	9
3.	General Viva:	100	3
	Grand Total =	**1100**	**33**

Semester Wise Credit Distribution:

Semester-I

General Group			**Thesis Group**		
Types & no. of Courses	**Credit per course**	**Total credit**	**Types & no. of Courses**	**Credit per course**	**Total credit**
Theoretical Course: 04	**3.0**	**12.0**	Theoretical Course: 04	**3.0**	**12.0**
Practical Course: 01	**3.0**	**3.0**	Pre-thesis		**2.0**
Grand Total		**15.0**	**Grand Total**		**14.0**

Semester-II

General Group			**Thesis Group**		
Types & no. of Courses	**Credit per course**	**Total credit**	**Types & no. of Courses**	**Credit per course**	**Total credit**
Theoretical Course: 03	**3.0**	**9.0**	Theoretical Course: 03	**3.0**	**9.0**
Practical Course: 01	**3.0**	**3.0**	Thesis	**7.0**	**7.0**
Project	**3.0**	**3.0**			
General Viva	**3.0**	**3.0**	General Viva	**3.0**	**3.0**
Grand Total		**18.0**	**Grand Total**		**19.0**

Semester wise course distribution is listed in the table

Semester-I		Semester-II	
1.	PHY-5101: Advanced Quantum Mechanics	1.	PHY-5201 Advanced Electronics and Telecommunication
2.	PHY-5102: Advanced Nuclear Physics	2.	PHY- 5202: Condensed Matter Physics
3.	PHY-5103: Radiation and Health Physics	3.	PHY-5203: Atmospheric Physics
4.	PHY-5104: Semiconductor Devices and Technology	4.	PHY-5204: Advanced Reactor Physics
5.	PHY-5105: Advanced Geophysics	5.	PHY-5205: Advanced Renewable Energy Physics
6.	PHY-5106: Materials Science and Engineering	6.	PHY-5206: Magnetism and Magnetic Materials
7.	PHY-5107: Superconductivity	7.	PHY-5207: Thin Film Technology
8.	PHY-5108: Biophysics	8.	PHY-5208: Quantum Field Theory
9.	PHY-5109: Nano-Physics and Nano-Electronics	9.	PHY-5209: Advanced Medical Physics
10.	PHY-5110: Advanced Plasma Physics	10.	PHY-5210: Climatology
11.	PHY-5111: Particle Physics	11.	PHY-5211: Physics Practical
12.	PHY-5112: Fiber Optics and Optical Fiber Communication	12.	PHY-5212: Project (For General Group)
13.	PHY-5113: Advanced Astrophysics	13.	PHY-5213: General Viva
14.	PHY-5114: Physics Practical		
PHY-5001: Pre-thesis			
PHY-5002 : Thesis			

DETAILED SYLLABUS

M.Sc. 1st SEMESTER

Course Title: Advanced Quantum Mechanics

Course Code: PHY-5101 **Credit Hour: 03**

1. **Introduction to Advanced Quantum Mechanics:** Schrödinger wave equation and stationary states; The Heisenberg equations of motion; Poisson brackets; Integral of motions and symmetry conditions; Group theory in quantum mechanics; The form of the Schrödinger equation in different coordinate systems.

2. **Scattering Theory:** General formulation of scattering theory; Classical and quantum scattering; Asymptotic condition; Möller's operators; Problem of asymptotic completeness; Definition of one particle scattering operator and its unitarity; Energy conservation; S-matrix; T-matrix; Representation of S and T-matrix in the configuration space and in the momentum space; Relation between Green's function and T-matrix; Lippman-Schwinger equations for two and three particle systems.

3. **Quantum Theory of Systems Consisting of Identical Particles**: Schrödinger equation for a system consisting of identical particles; Elementary theory of the ground state of two electron atoms; Excited state of helium atom; Self-consistent Hartree-Fock field; The statistical Thomas-Fermi method; The Periodic system.

4. **Second Quantization for Bosons and Fermions**: Second quantization of a field corresponding to Bosons; Second quantization of the meson field; Application of second quantization method of systems of interacting Bosons; Occupation number representation for systems of non-interacting Fermions for small energies; Systems of Fermions interacting through pair forces; Bogolyubov's canonical transformation; Quantization of the electron-positron field.

5. **Interaction of Radiation with Matter:** Maxwell's equations, plane electromagnetic waves; Classical formulation of Lagrangian and Hamiltonian equations of motions; Classical radiation field equations; Quantization of fields; creation, annihilation and number operators in both Bose and Fermi statistics; Planck's distribution formula.

BOOKS RECOMMENDED:

1. Davydov, A.S.; Quantum Mechanics.
2. Taylor, John.R., John Wiley & Sons; Scattering Theory.
3. Newton, R.G.; Scattering Theory and Waves.
4. Dirac, P.M.A.; Quantum Mechanics.
5. Sakurai,J.J.; Modern Quantum Mechanics.
6. Cohen; Quantum mechanics (Part 1 & II).

Course Title: Advanced Nuclear Physics

Course Code: PHY-5102 Credit Hour: 03

1. **Compound Nucleus:** Bohr hypothesis of compound nucleus: resonance scattering of nuclei, formation of compound nucleus cross sections; The continuum theory of nuclear reaction; Statistical theory of nuclear reaction; Evaporation probabilities and pre-equilibrium reactions.
2. **Direct Reactions:** Kinematics of stripping and pick-up reactions; Semi-classical approach; Born Approximation; Distorted Wave Born Approximation (DWBA).
3. **Nuclear Models and Potentials:** Optical Model; Kapur- Peierls dispersion formula; Giant resonance; Nilsson's distorted potential model.
4. **Electromagnetic Interactions with Nuclei:** Multi-pole expansion; Sources of multi-pole radiation; Selection rules; Quantum mechanical treatment of transition probabilities; Internal conversion; Angular distributions of γ-γ transition and angular correlations.
5. **Nuclear Analytical Techniques:** Neutron activation analysis; Neutron radiography; PIXE; PIGE; Accelerator mass spectrometry.
6. **Particle Physics:** Elementary particles and their symmetries; Types of interactions and conservation laws; Production and decay of pions, muons and hyperons; Resonance particles; Baryons; Quarks; Spontaneous symmetry breaking; The Higgs mechanism; The Weinberg-Salam theory.

BOOKS RECOMMENDED:

1. Roy, R.R. and Nigam, B.P.; Nuclear Physics.
2. Preston, M.A. and Bhaduri, R.; Structure of the Nucleus.
3. Bohr, A. and Mottelson, B.R; Nucleus Structure.
4. Tobocman, W.; Theory of Direct Nuclear Reactions.
5. Satchler, G.R.; Introduction to Direct Nuclear Reactions.
6. Greiner, W. and Maruhn, J.Al; Nuclear Models.
7. Krane, K.S.; Introductory Nuclear Physics.
8. Blatt, J.M. and Weisskopf, V.F.; Theoretical Nuclear Physics.
9. Hans, H. S.: Nuclear Physics.

Course Title: Radiation and Health Physics

Course Code: PHY-5103 Credit Hour: 03

1. **Interaction:** Interaction of Ionizing and Electromagnetic Radiations with Matter.
2. **Personal Dosimetry:** Film Badge; TLD, merit and demerits; Purpose ofpersonnel dosimetry; Area monitoring; Portable radiation dose rate meter.
3. **Biological effects of Radiation:** Somatic and genetic effects; Stochastic and deterministic effects; Effective half-life of radioisotopes within biological being.
4. **Radiation shielding:** Purpose and necessity of radiation shielding; Shielding of an X-ray (Diagnostic/Therapeutic) room, shielding of a research room, shielding of a radiotherapy room, shielding of a radioactive waste chamber area; Industrial applications of Ionizing radiation in leak detection, in Agriculture; Radioisotopes as Radio Tracers.
5. **Radio gauging:** Principles and Techniques; Radio gauging standardization and calibration; Radio gauging accuracy and semitivity static and continuous radio gauge.
6. **Radioactive Analysis:** Principle and Theory; Neutron Activation Analysis.
7. **Safety Measures:** Transportation of Radioactive materials; Nuclear accident.

BOOKS RECOMMENDED:

1. Morgan, T.; Principle of Radiation and Protection.
2. Cember, H.and Johnson, T.E.; Introduction to Health Physics.
3. Gardner, R.P.; Radioisotope Measurement Applications in Engineering.
4. Evans, R. D.; The atomic Nucleus.
5. Knolls, G.F.; Principle of Radioactive Protection.
6. Martin, A. and Harbison, S.A.; An Introduction to Radiation Protection.

Course Title: Semiconductor Devices and Technology

Course Code: PHY-5104 Credit Hour: 03

1. **Semiconductor Physics:** Semiconductor materials; Basic crystal structure; Basic crystal growth technique; Energy bands; Intrinsic carrier concentration, donors and acceptors; Carrier drift, carrier Diffusion; Generation and recombination Process; Continuity equation; Thermionic emission process; Tunneling Process; High-field effects.
2. **Semiconductor Devices:** P-N junction: basic fabrication steps, thermal equilibrium condition, depletion region, depletion capacitance, Current-Voltage characteristics, charge storage and transient behavior; Heterojunction; Bipolar transistor and related devices: The transistor action, static characteristics of bipolar transistor, frequency response and switching of bipolar transistor, the heterojunction bipolar transistor; The thyristor and related power devices; MOSFET and related devices; The MOS diode; MOSFET fundamentals, CMOS and biCMOS; MOS memory structures; The Power MOSFET: quantum-effect devices, hot-electron devices, photonic devices, Light-Emitting Diodes; Semiconductor laser; Photodetector.

3. **Semiconductor Technology:** Crystal growthand epitaxy: silicon crystal growth from the melt, GaAs crystal-growth techniques, material characterization, eptiaxial-growth techniques, structures and defects in epitaxial layers; Film formation: thermal oxidation, dielectric deposition, polysilicon deposition, metallization; Impurity Doping: basic diffusion process, extrinsic diffusion, diffusion-related processes; Annealing; Integrated devices; Passive components; Bipolar technology; MOSFET technology; MESFET technology.

BOOKS RECOMMENDED:

1. Sze, S.M.; Physics of Semiconductor Devices (2nd Edition).
2. Sze, S.M.; Semiconductor Devices; Physics and Technology.
3. Bhattacharya, P.; Optoelectronics.
4. Boylested, R.L. and Nashelsky, L.; Electronics Devices and Circuit Theory (10th edition).

Course Title: Advanced Geophysics

Course Code: PHY-5105 Credit Hour: 03

1. **Seismic Theory:** Theory of elasticity; Wave equation and its solution; Body waves (P&S waves); Surface waves; Energy of waves; Partition of energy at an interface.
2. **Seismic Wave Path:** Seismic velocity; Reflection paths in a constant-velocity layer; Velocity gradient and ray path curvature; Geometry of refraction path; Characteristics of seismic events: diffractions, multiples, surface waves, types of seismic noise, attenuation of noise.
3. **Field Methods and Equipment:** (i) Reflection field methods and field layouts; Measurement of velocity; Data reduction (ii) Refraction field methods and profiles; Comparison of reflection and refraction methods; Data reduction.
4. **Digital Signal Processing:** Fourier transformation; Convolution; Co-relation; Phase consideration; Frequency filtering; Velocity analysis; Common-midpoint stacking; Apparent velocity filtering; P-transformation; Migration of imaging; Measures of coherence.
5. **Interpretation:** (i) Refraction interpretation methods; Delay time methods; Wave front methods; Engineering applications; (ii) Reflection interpretation; Modeling evidence of faulting; Fold and flow structure; Hydrocarbon indicators.

BOOKS RECOMMENDED:

1. Parasmis, D.S.; Principles of Applied Geophysics.
2. Telford, E.M. Geldart, L.P., Sheriff, R.E., Keyes, A.D.; Applied Geophysics.
3. Grant, F.S. West, P.F.; Interpretation Theory in Applied Geophysics.
4. Kanasewich, E.R.; Time Sequence Analysis in Geophysics.

Course Title: Materials Science and Engineering

Course Code: PHY-5106 Credit Hour: 03

1. **Introduction of Materials:** Selected characteristics; Types of materials; Structure and properties; Mechanical and electrical behaviors; Thermal characteristics.
2. **Phase and Equilibrium Diagrams:** Phase rule; Solid solution; Grain boundaries; Diffusion; Alloys; Binary alloys; Chemical composition of phases; Phases of iron carbon system; The Fe-Fe3C phase diagram; Microstructures.
3. **Organic Materials:** Wood, coal, organic polymers; three dimensional polymers; Deformation of polymers; Electrical properties of polymers; Stability of polymers.
4. **Ceramic Materials:** Ceramic phases; Ceramic crystal; Multiphase compounds; Silicate structure; Glasses; Mechanical and electrical behaviors of ceramics.
5. **Magnetic Materials:** Magnetic materials and theoretical models for their magnetic properties; Application of magnetic materials; Ferrites and garnets.
6. **Methods for Characterization of Materials:** Diffraction methods: X-ray; electron and neutron diffraction methods; Electron microscopy.
7. **Composite Materials:** Classification; Fibrous composites; Matrix materials; Reinforcement materials; Matrix dependent classification.

BOOKS RECOMMENDED:

1. Van-Vlack, L.H.; Elements of Materials Science and Engineering.
2. Kumar, D., Jain, S.K. and Bhargava, A.K.; Material Science and Manufacturing Processes.
3. Kumar, S.; Engineering Materials.
4. Starfield, M.J. and Shavger A.M.; Introductory Materials Science.
5. Longman; Introduction to Magnetic Materials.

Course Title: Superconductivity

Course Code: PHY-5107 Credit Hour: 03

1. **Basic Phenomena of Superconductivity:** Review of superconductivity; Critical magnetic field; Meissner-Ochsenfeld effect; London equation; London penetration depth; Josephson effect; Energy gaps in superconductor.
2. **Thermodynamic & Magnetic Properties of Superconductor:** Entropy; Heat capacity; Magnetic flux quantization; magnetic relaxation in HTSCs; Flux pinning and critical current density; Flux Flow and Flux Creep model: Thermally activated flux flow (TAFF) model; Critical state model.

3. **Microscopic BCS Theory of Superconductivity:** Isotope effect; Concept of electron-phonon interaction; Theory of bound electron pair-Cooper pair; The BCS groundstate; Self consistent equation; Energy gap equation.

4. **Quantum Effect:** Quantum mechanical tunnel effect: Josephson junction; Shapiro effect, Pendulum analog; Flux quantization: Fluxoid, the Little-Park experiment; Consequence of flux quantization- SQUID; Quantum resistance and Diffraction phenomena in superconductor.

5. **Fluctuation Effect in Superconductor**: Time dependent G-L equation for fluctuation phenomena: Order parameter Fluctuation; Heat capacity and Diamagnetism; Paraconductivity: Theoretical model; Evaluation of related parameters; Measurement techniques for HTSCs.

6. **Superconductor Device and Application:** superconducting devices: superconducting Taps; Thin films, Transmission Cables Motors and Generators; Technological Applications: SQUIDs; MAGLEV; SMES; TES.

BOOKS RECOMMENDED:

1. Tinkham, M.; Introduction to Superconductivity (1st and 2nd edition).
2. Poole, C.P., Horacia, Jr., Farach, A. and Creswick, R. J.; Superconductivity.
3. Schmidt, V.V.; The Physics of Superconductor.
4. De Gennes, P.G., Superconductivity of Metals & Alloys.
5. Tilley, D.R. and Tilley, J.; Superfluidity & Superconductivity.
6. Poole, C.P. and Hamd, Jr., Book of Superconductivity.
7. Wahab, M.; Solid State Physics.
8. Pillai, S.O.; Solid State Physics.
9. Kahani, S.L. and Kakani, S.; Modern Physics.
10. Kittle, C.; Solid State Physics.

Course Title: Biophysics

Course Code: PHY-5108 Credit Hour: 03

1. **Structure of Macro Molecules:** Atomic and molecular forces; Behavior of macromolecules; Physics techniques for structure determination (X-ray diffraction, spectroscopy and NMR).

2. **Properties and Structure of Nucleic Acid:** DNA; RNA; Viruses; Method of replication.

3. **Protein Structures:** Amino Acids; Primary; Secondary and Tertiary structures.

4. **Basic Enzyme Behavior:** Michelis Menten mechanism and NWC model, Hemoglobin.

5. **The Cell membrane:** Basic membrane 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, satiated and cardiac muscles; Muscle action potential.
8. **Cardio-vascular System:** Mechanics of fluids and its application to blood flow.

BOOKS RECOMMENDED:

1. Hughes, W.T.; Aspects of Biophysics.
2. Hughes, D.; Notes on lonizing Radiation.
3. Ruch and Patton; Physiology and Biophysics.
4. Davidovits, P.; Physics of Biology and Medicine.

Course Title: Nano-Physics and Nano-Electronics

Course Code: PHY-5109 Credit Hour: 03

1. **Basic Properties of Nanoparticle:** Particle size; Top down and bottom up ideas; Particles shape; Size effect and properties of nanoparticles; Particle density; Melting point; Wettability; Specific surface area and pore; Surface characteristics; Mechanical properties; Electrical properties; Magnetic properties; Optical properties.
2. **Nano Systems:** An artificial and tunable atom (quantum dot); Quantum wire; Quantum Hall effect; Carbon nano-tube; Si Nanowire, Thin films.
3. **Experimental Approaches to Nanofabrication and Nanotechnology:** Silicon Technology; Patterning; Masks and Photolithography; Etching Silicon; Methods of deposition of metal and insulating films. Lateral resolution limited by wavelength of light; Optical and X-ray lithography; Electron beam lithography; sacrificial layers; Single electron transistors; Future of Silicon computer Technology.
4. **Nanostructure Electronics and Chemical Characterization:** X-ray Photoelectron Spectroscopy (XPS): Fundamentals: Photoelectric effect; binding energy and chemical shift; spin-orbit splitting; initial and final state effects; Information extracted: Surface composition and chemical state of surface species; Ultraviolet Photoelectron Spectroscopy (UPS): Information extracted: Band structure; occupied band states of clean solid surfaces as well as bonding orbital states of adsorbed molecules.

BOOKS RECOMMENDED:

1. Wiesendanger R.; Scanning Probe Microscopy and Spectroscopy Methods and Applications.
2. Gersten, J. I. and Smith F.W.; The physics and Chemistry of Materials.
3. Bhushan, B., Fuchs, H. and Tomitori, M.; Applied Scnning Probe Methods IX Characterization(Nano Science and Technology).
4. Vickerman J.C.: Surface Analysis (The principal Techniques).
5. Wolf, E.; Nanophysics and Nanotechnology.
6. Briggs, D. and Seah, M.P.; Practical Surface Analysis-Auger and X-ray Photeelectron Spectroscopy.
7. Magonov, S.N. and Whangbo, Myung-H.; Surace Analysis with STM and AFM: Experimental and

Theoretical Aspects of Image Analysis.
8. Bandyapadya, A.K.; Introduction to nanotechnology.

Course Title: Advanced Plasma Physics

Course Code: PHY-5110 **Credit Hour: 03**

1. **Review of Waves in Plasmas:** Ion-acoustic waves: Basic concept; Derivation of dispersion relation; Physical interpretation; Lower hybrid waves: Basic concept; Derivation of lower-hybrid frequency; Physical interpretation; Upper-hybrid waves: Basic concept; Derivation of upper-hybrid frequency; Physical interpretation.

2. **Nonlinear Waves in Plasmas:** Solitary waves; Shock waves; Ion-acoustic solitary waves: Derivation of Korteweg-de Vries (K-dV) interpretation 2 topics Ion-acoustic shock waves: Derivation of Burgers equation; Stationary shock wave solution of Burgers equation; Physical interpretation.

3. **Concept of Dusty Plasma Physics:** Definition of dusty plasmas; Characteristics of dusty plasmas; Differences between electron-ion plasma and dusty plasma; Occurrence of dusty plasmas; Typical dusty plasma parameters in space and laboratory devices; Aspects of dusty plasma physics.

4. **Linear Waves in Dusty Plasmas:** Dust-ion-acoustic waves; Dust-acoustic waves; Dust-lower-hybrid waves; Dust cyclotron waves; Shear dust-Alfven waves; Compressional dust Alfven waves.

5. **Nonlinear Waves in Dusty Plasmas**: Dust-ion-acoustic solitary wafves: K-dV equation; Stationary solitary wave solution of K-dV equation; Physical interpretation; Dust acoustic solitary waves: K-dV equation;Stationary solitary waves solution of K-dV equation; Physical interpretation; Dust-ion-acoustic shock waves: Burgers equation;Stationary shock wave solution of Burgers equation; Physical interpretation.

BOOKS RECOMMENDED:

1. Chen, F.F.; Introduction to Plasma Physics and Controlled Fusion.
2. Shukla, P.K. and Mamun, A.A.; Introduction to Dusty Plasma Physics.

Course Title: Particle Physics

Course Code: PHY-5111 **Credit Hour: 03**

1. **History of Particle Physics:** The Photon; Mesons; Neutrinos; antiparticles; Strange Particles; The Quark Model; The Standard Model.

2. **Elementary Particle Dynamics:** The Four forces; Quantum Electrodynamics (QED); Quantum Chromodynamics (QCD); Weak Interactions; Weak and Electromagnetic Couplings of W and Z, Decays and Conservation Laws; Unification Schemes.

3. **Symmetries:** Groups and Conservation Laws; CP; Neutral Kaons; CP Violation; Time Reversal and the TCP Theorem.

4. **The Feynman Calculus:** Decays and Scattering, The Golden Rule for Decays, Golden Rule for Scattering; Two-body Scattering in the CM Frame; Feynman Rules for a Toy Theory; Lifetime of the A,A+A$\pm$B+B Scattering; Higher- order Diagrams.

5. **Quantum Electrodynamics and Chromodynamics:** The Feynman Rules for QED; Casimir's Trick; Feynman Rules for Chromodynamics; Pair Annihilation in QCD.

6. **Interactions and Mechanisms in Particle Physics:** Charged Weak Interactions; Flavor Oscillations; Neutral Weak Interactions and Electroweak Mixing; Gauge Theories and Higgs Mechanism.

BOOKS RECOMMENDED:

1. Martin, B.R.; Nuclear and Particle Physics: An Introduction, (Second Edition).
2. Martin, B.R. and Shaw, G.; Particle Physics, (Third Edition).
3. Bergstrom, L. and Goobar, A.; Cosmology and Particle Astrophysics (2nd edition).
4. Griffiths, D.; Introduction to Particle Physics.
5. Coughlan, G.D., Dodd, J.E. and Gripaios, B.M.; Ideas of Particle Physics.
6. Perkins, D.H.; Introduction to High energy Physics.

Course Title: Fiber Optics and Optical Fiber Communication

Course Code: PHY-5112 Credit Hour: 03

1. **Basic Characteristics:** Propagation of light in different media; Propagation of light in an optical fiber; Modes of Propagation; Number of modes and cut-off parameters of fibers.

2. **Transmission Characteristics:** Material absorption loss; Band loss; Splice loss; Rayleigh scattering loss; Different types of dispersions; polarization.

3. **Fabrication of Optical Fiber:** Liquid phase technology; Vapour phase deposition technology; Fluoride gas fibers.

4. **Fiber Optic Communication Systems:** Transmitter for fiber optic communication; High performance transmitter circuit LED-Analog transmitter; LASER transmitter; Digital laser transmitter; Analog laser transmitter with A/D conversion and digital multiplexing; Fiber optic receiver; Fiber based modems: Trans receiver; LED analog modulation; Digital modulation; Laser modulation; Pulse code modulation (PCM); Intensity modulation (IM).

5. **Fiber optic sensors and measurement systems:** Fiber optic sensors; Intensity modulated sensors; Liquid level type hybrid sensor; Internal effect intensity modulated sensor; Diffraction grating sensors; Diffraction grating sensors and Interferometric sensors; Measurement of numerical aperture (NA); Measurements of Fiber-attenuation; Measurements of dispersion losses; Measurements of refractive index; Cut-off wavelength measurement.

BOOKS RECOMMENDED:

1. Ghatak A. and Thyagarajan, Z.K.; Introduction of Fiber Optics.
2. Senior, J.M.; Optical Fiber Communication.
3. Keiser, G.; Optical Fiber Communication.
4. Lacy, E.A.; Fiber Optics.

Course Title: Advanced Astrophysics

Course Code: PHY-5113 Credit Hour: 03

1. **Introduction:** Stellar magnitude sequence**;**absolute magnitude and the distance modulus; the celestial co-ordinates; luminosities of stars; statistical parallax.
2. **Classification of Stars:** Saha's equation of thermal ionization; Harvard system of spectral classifications; the luminosity effect on stellar spectra; relativistic equation of stellar structure; binary star; white dwarf; neutron star; black hole; rotating black hole and Kerr metric.
3. **Cosmology:** Introduction, cosmological principle; red-shift and expansion of the universe, FRW metric; energy-momentum tensor for various forms of matter; CMBR.
4. **Models of the Universe:** Big-Bang model; initial condition of the universe; monopole problem; production of light elements; primordial abundances and primordial nucleosynthesis.
5. **Standard Cosmology:** The Friedmann equation, Hubble's law, the expansion age of the universe; thermo dynamical entropy production and horizon problem.

BOOKS RECOMMENDED:

1. Kolb, R. and Turner, M.S.; The Early Universe.
2. Basu, B.; An introduction to Astrophysics
3. Bose, S.K.; An introduction to General Relativity.
4. Narlikar,J.V,; Introduction to Cosmology.
5. Bhatia, V.; Text Book of Astronomy and Astrophysics.

Course Title: Physics Practical

Course Code: PHY-5114 Credit Hour: 03

Electronics Lab

1. Construct and study of a voltage follower by using voltage shunt feedback amplifier using μA 7411C and see the waveform on the oscilloscope.
2. Demonstrate the operation and current-voltage characteristics of a typical LED.
3. Design, construct and test an Astablemultivibrator and determine:
   i. Frequency of oscillation
   ii. Time period of oscillation by using Timer 555 IC..
4. Design, construct and test a Monostable multivibrator using Timer 555 IC and hence determine the triggering network with minimum triggering voltage and maximum triggering frequency.
5. Design, construct and test a Bistablemultivibrator using Timer 555 IC.
6. Circuit design, implementation and construction of the truth table of various logic gates(according to course teacher instruction)

Nuclear Physics Lab

1. Determination the current-voltage characteristics of an ionization chamber and the range of alpha particles.
2. Determination of the half-life of a radioisotope using 7 mCi Ra-Be neutron source.
3. To study determination of beta particle range and end point energy.

Solid State Physics Lab

1. Studies of magnetic properties of a ferromagnetic sample using an oscilloscope.
2. Determination of Hall constant, Hall mobility and other parameters of semiconducting sample.

Renewable Energy Lab

1. Performance study of a photovoltaic cell.
2. Measurements of absorptance and emittance of solar selective surfaces.

Atmospheric Physics Lab

1. **a.** Prepare a pressure chart with the given data and analyze it. Find out wind speed at 10 different points in between 200 and 250 latitudes.
b. Prepare a synoptic chart for the given cloudiness data and relate it with pressure chart.
c. Plot the pressure data for August for Bangladesh and calculate wind speed at 10 different points.

2. **a.** Prepare a pressure chart with the given data and analyze it. Find out wind speed at 10

different points in between 200 and 250 latitudes.

b. Prepare a synoptic chart for the given rainfall data and compare it with pressure chart, analyze them.

c. Plot the pressure data for November for Bangladesh and calculate wind speed at 10 different points.

N.B.: Depending on the availability of the experimental setup, course teachers will be decided how many experimental should be conducted.

M.Sc. 2nd SEMESTER

Course Title: Advanced Electronics and Telecommunication

Course Code: PHY-5201 Credit Hour: 03

1. **Operational Amplifier with Negative Feedback:** Introduction; Block diagram representation of feedback configurations; Voltage series feedback amplifier; Negative feedback; Closed-loop voltage gain; Difference input voltage ideally zero; Input and output resistance with feedback; Bandwidth; Total output offset; Voltage follower; Closed loop voltage gain; Inverting input terminal at virtual ground; Current to voltage converter; Inverter; Differential amplifiers; Differential amplifier with one op-amp: Voltage gain; input resistances; Differential amplifiers with two Op-Amps: Voltage gain, Input resistances; Output resistance and bandwidth of differential amplifiers.
2. **Linear Applications of Op-Amp:** Introduction; DC & AC amplifiers; AC amplifiers with a single supply voltage; The peaking amplifiers; Summing; scaling and averaging amplifiers; Instrumentation amplifiers.
3. **Opto-Electronics:** Light emitting diodes (LED); Liquid crystal displays (LCDs); Seven segment LED and LCD displays; Photodetectors and source detector combinations; Basic photodetector parameters; Photodiodes; Solar cells; Phototransistors and photodarlington; Photofield effect transistor; Opto-isolators; Bulk-photoconductor opto-isolators; LED-phototransistor opto-isolators; Laser diodes.
4. **Introduction of Telecommunication:** Evaluation of telecommunications; Simple telecommunication; Basic of a switching system; Major Telecommunication networks; Rotary dial telephone; Signaling tones; Touch tone dial telephone.
5. **Communication Systems:** Background and importance; Analog and digital communications; Transmission of voices and picture data; Basic constituents of communication system; Signal types and sources; Signal encoding technics: signal encoding criteria; Digital data analog signals; Analog data analog signals; Analog data digital signals; Fiber optics in communications.

BOOKS RECOMMENDED:

1. Gayakwad, R.A; Op-Amps and Linear Integrated Circuits.
2. Bell, D.A.; Operational Amplifiers and Linear ICs.
3. Sarkar, S.K.; Operational Amplifiers and Their Applications.
4. Bell, D.A.; Electronics Devices and Circuits.
5. Deboo, G. and Burrons; Integrated Circuits of Semiconductor Devices.
6. Tocci, Ronald J.; Digital Systems, Principles & Applications.
7. Schilling, T.; Principles of Communication System.
8. Schilling, W,;Wireless Communication and Networks.
9. Viswanathan, T,; Telecommunication Switching Systems and Networks.

Course Title: Condensed Matter Physics

Course Code: PHY-5202 Credit Hour: 03

1. **Beyond the Independent Electron Approximation:** Review on free electron theory and nearly free electron theory; The Hartree-Fock equations; Thomas-Fermi theory of screening; Fermi-Liquid theory.
2. **Band Structure of Solids:** Formation of energy bands in a periodic potential, Fermi surface; The Plane wave Method; Tight-binding method; Cellular Method; Orthogonalized Plane Wave (OPW) method; Pseudopotential method.
3. **Magnetic Properties of Solids:** Review on diamagnetism and paramagnetism; Introductory remarks on Ferro, Anti-ferro and Ferrimagnetism; Weiss theory of Ferromagnetism; The exchange interaction; The Heisenberg model; The Bloch Wall; Origin of domains; Neel model of Antiferromagnetism; Nell model of Ferrimagnetism, The Bloch T3/2 law; Magnons in antiferromagnets; Zero-point energy.
4. **Theoretical Aspects of Superconductivity:** London equation; London penetration depth; Coherence length; Flux quantization; Electron-Phonon interaction; electron-electron interaction, Cooper pairs, BCS theory of superconductivity; Existence of energy gap; BCS ground state energy; Electron tunneling and Josephson effect, High Tc superconductor, SQUID.
5. **Plasmons,Polaritons and Polarons:** Dielectric function of theelectron gas, Plasma optics; Dispersion relation for electromagnetic waves; Longitudinal Plasma oscillation; Plasmons, Polaritons; Polarons.
6. **Non-Crystalline Solids:** Glasses; Amorphous semiconductors; amorphous ferromagnets; Ceramics, Polymers, Complex fluids; Liquid crystals.
7. **Surface and Interface Physics:** Surface crystallography; Surface electronic structure; Nucleation and growth; Kinetics and growth modes; Diffusion phenomena; surface defects; native defects; Stacking faults; Twin boundaries.

BOOKS RECOMMENDED:

1. Kittel, C.; Solid State Physics.
2. Dekker, A.J.; Solid State Physics.
3. Pillai, S.O.; Solid State Physics.
4. Kittel, C.; Quantum Theory of Solids.
5. Madelung, O.; Introduction to Solid State Theory.
6. Mott, N.F. and Davis, E.A.; Electronic Processes in Non-Crystalline Materials.
7. May, G. and Sze, Sl; Fundamentals of semiconductor fabrication.

Course Title: Atmospheric Physics

Course Code: PHY-5203 Credit Hour: 03

1. **Structure and Composition:** Classification and Composition of the atmosphere; Composition in upper layers (ionosphere, DEF layers) stratification; Basic laws; Geopotential and geopotential high; Lapse rates; Moisture variables; Atmospheric diagrams; Dissociation; Instability.
2. **Cloud Physics:** Cloud formation; Growth of cloud droplets by diffusion & coalescence; Precipitation and formation.
3. **Dynamic Meteorology:** Basic equation of motion geostrophic approximation; Thermal wind; PBL and Eckmann equation.
4. **Synoptic Meteorology:** Techniques of synoptic analysis; Air mass and its production; Fronts; Depression; Temperature field; Transformation of air mass.
5. **Ozone Physics:** Ozone in the earth's atmosphere; Vertical distribution of Ozone decay; Dynamics & transport of ozone; Greenhouse gases; Measurements of ozone.
6. **Tropical Meteorology:** Tropical depression & its classification; Weather system; Monsoon & its classification.
7. **Climatology:** Factors of climatic formation; Climatic classification; Theories of climate change.
8. **Radiation:** Absorption of atmospheric gases; Greenhouse effect.
9. **Satellite meteorology**: Orbits; Nephanalysis.

BOOKS RECOMMENDED:

1. Byers, H.R.; General Meteorology.
2. Holton, J.R.; An Introduction to Dynamic Meteorology.
3. Rogers, R.R.; A Short Course in Cloud Physics.

4. Ramage, C.S.; Monsoon Meteorology.
5. Wickhaum; The Practice of Weather Foprecasting.
6. Kondratyev, K.Y,; Radiation in The Atmosphere.
7. Reihl, H.; Tropical Meteorology.

Course Title: Advanced Reactor Physics

Course Code: PHY-5204 Credit Hour: 03

1. **Reactor Materials:** Radiation effects on materials; Structural materials; Moderation and reflector materials; Fuel materials; Production of reactor fuels; Properties of fuel element materials; Waste disposal; Breeding: General considerations, Breeding ratio, Breeding gain, Doubling time, Breeding reactors, Fast breeders, Thermal breeders, Advanced Breeding concepts; Nuclear Fuel Cycle: Uranium-plutonium cycle, Thorium-uranium cycle, Other fuel cycle, Uranium enrichment.
2. **Neutron Spectra in Various Energy Regions:** Neutron spectrum in an infinite assemble; High energy region; Slowing down region; Neutron spectra in a finite assembly; Effect of inelastic scattering on neutron spectrum; Thermal spectrum in an infinite medium; The Maxwellian spectrum; Diffusion heating and cooling; Neutron spectrum in an ideal proton gas; Solution of Wigner-Wilkins equation for a weak 1/v-type absorber; Neutron spectrum of heavy gas model; The effect of temperature model.
3. **Heterogeneous Reactors:** A qualitative discussion of lattice effects on keff; A unit cell; Eta; Thermal utilization; Resonance escape probability; Fast fission factor; Diffusion length.
4. **Heat Generation and Removal:** Heat generation in fuel elements; Heat removal from fuel elements; Heat transfer by conduction: Steady state case; Heat transfer by convection: Single phase flow, boiling heat transfer.
5. **Radiation Shielding:** Gamma-ray shielding: Buildup factors, Infinite planar and disc sources, The line sources, Multilayered shields; Nuclear design: Removal-attenuation calculations, Removal diffusion method, Exact methods, Coolant activation, Ducts in shields.

BOOKS RECOMMENDED:

10. Liverhant. S.E; Elementary Introduction to Nuclear Reactor Physics.
11. Glasstone. S and Edelund M.G; Elementary of Nuclear Reactor Theory.
12. Lamarsh.J.R.; Introduction to Nuclear Reactor Theory.
13. Glasstone S. and Sessonske; A Nuclear Reactor Engineering.
14. Beck L.K.; Nuclear Reactor for Research.
15. Suresh, C., Reroz, A., Kothari, L.S.; Physics of Nuclear Reactors.
16. Bell and Glasstine: Nuclear Reactor Theory.
17. James, J.D.: Nuclear Reactor Analysis.

Course Title: Advanced Renewable Energy Physics

Course Code: PHY-5205 Credit Hour: 03

1. **Introduction:** Necessity of photovoltaic energy conversion; Characteristics of sunlight.
2. **Physics of Photovoltaic's:** Introduction; Interaction of light; Separation and collection of carriers; Efficiency; Influence of illumination on efficiency.
3. **Solar cell Materials:** Monocrystalline Si; Amorphous Si; Heterojunction and thin film cells.
4. **Technology of Cells:** Introduction; Production of Si; Si solar cell fabrication; Cell fabrication; Assembling and encapsulation of solar cells.
5. **Characterization of Solar Cells:** Determination of solar cell parameters; Efficiency measurement; Measurement; Module controls.
6. **Photovoltaic Module Operation:** Standard modules; Series-parallel connection of cells; Hot spot formation.
7. **Photovoltaic Systems:** Global radiation; Storage in PV system; Standalone PV system; System without battery; DC to AC conversion.
8. **Other Renewable Energy:** Biomass; Sources of biomass; Wind power; Wind power system; Transmission; Generation and control; Wind mill water power tidal power.

BOOKS RECOMMENDED:

1. Duffie, J.A.; Solar Engineering of Thermal Process.
2. Green, M.A.; Solar Cell.
3. Rai, G.D.; Solar Energy Utilization.
4. Rapp, D.; Solar Energy.
5. Magal; Solar Power Engineering.
6. Suktatme, S.P.; Solar Energy.
7. Fisk and Andersion; Introduction to Solar Technology.
8. Overstracten V.; Physics, Technology and use to Photovoltaic.

Course Title: Magnetism and Magnetic Materials

Course Code: PHY-5206 Credit Hour: 03

1. **Magnetism:** Origin of magnetism; Orbital angular momentum of the electron; Spin angular momentum of the electron; Nuclear spin angular momentum; Total magnetic moment; Hund's rule of electron configuration.
2. **Types of Magnetism:** Diamagnetism corresponding to diamagnetic materials; Para-magnetism related to paramagnetic; Ferromagnetism arising from ferromagnetic materials; Anti-ferromagnetism corresponding to antiferromagnetic materials and

Ferrimagnetism incorporated to ferromagnetic.

3. **Magnetic Materials:** Classification of magnetic materials; Crystalline and amorphous materials; Metallic; Semiconducting; Insulating; Dielectric; Piezoelectric; Ferroelectric and pyro electric materials; Properties of metals and non-metals; High temperature superconducting ceramics and amorphous materials; Electrical properties of alloys; Ceramics and polymers; Advanced magnetic material and its application.
4. **Ferrites:** Ferrites; Composition of ferrites; Structure of ferrites; Classification of ferrites; Properties of ferrites: Curie temperature, Magnetic susceptibility, Permeability, Dielectric constant, Quality factor, Loss factor.
5. **Magnetic Anisotropy:** Pair model and one ion model of magnetic anisotropy; Phenomenology of magnetostriction; Volume magnetostricition and form effect; Law of approach of saturation; Structure of domain Wall; Technological applications of magnetic materials.

BOOKS RECOMMENDED:

1. Goldman, A.; Modern Ferrite Technology.
2. Srinivastava, C.M. and Srinivasan, C.; Science of Engineering Materials.
3. Jakubovics, J.P.; Magnetism and Magnetic Materials.
4. Jiles, D.; Introduction to Magnetism and magnetic Materials.
5. Cullity, B.D.; Introduction to magnetic Materials.

Course Title: Thin Film Technology

Course Code: PHY-5207 Credit Hour: 03

1. **Preparation of Thin Films:** Vacuum evaporation; High vacuum technology; Nature of physical sputtering; Thin films by chemical method; Thin film substrates; Generation of pattern in thin films.
2. **Nature of Thin Films:** Condensation; Nucleation and growth of thin films; Determination of structures; Growth and structure of single crystal films; Film thickness and composition.
3. **Properties of Thin Films:** Mechanical properties of thin films; Electrical properties of metallic thin films; Electronic conduction through thin insulating films; Piezoelectric and piezoresistive properties of films; Dielectric properties and ferromagnetic properties.
4. **Application of Thin Films:** Thin film resistors; Thin film capacitors; Thin film active devices; Magnetic devices; Superconducting thin films and devices; Thin film in integrated circuits.

BOOKS RECOMMENDED:

1. Maissel, L.1. and Glang, R.; Handbook of Thin Film Technology.
2. Hass, G.; Physics of Thin Films Vol I and II.
3. Holland, L.; Vacuum Deposition of Thin Films.
4. Chopra, K.L.; Thin Film Phenomena.

Course Title: Quantum Field Theory

Course Code: PHY-5208 Credit Hour: 03

1. **Classical Field Theory:** Action principle; Euler-Lagrange equations; Hamiltonian Formalism; Poisson brackets; Noether's theorem.

2. **Quantization of Scalar Field:** Equation of motion; field and canonical quantization; Fourier decomposition of fields; complex scalar field; creation and annihilation operators; particles and anti-particles.

3. **Quantization of fields:** Dirac equation, plane wave solution of Dirac equation; Fourier decomposition of the field; Quantization of electromagnetic field, problems with quantization.

4. **The S-matrix expansion:** Evaluation operator; S-matrix; Wick's theorem; Feynman diagram.

5. **Quantum Theory:** Introduction to gauge theories with SU (n) as gauge group; Higgs Mechanism; spontaneous symmetry breaking; elements of Salam-Weinberg theory.

BOOKS RECOMMENDED:

1. Lahiri, A. and Paul, P.B.; A first Book of Quantum Field theory.
2. Bjorken and Drell; Relativistic Quantum Fields.
3. Bogoliubov, N.N. and Shirkov, D.V.; Quantum Fields.
4. Huang, K.; Quarks Leptons & Gauge Fields.
5. Bilenky, S.M.; Introduction to Feynman Diagrams.

Course Title: Advanced Medical Physics

Course Code: PHY-5209 Credit Hour: 03

1. **Physics of the Human Body:** Introduction- Forces on and in the body; Energy, work and power of the body; The physics of the lungs and the breathing; Physics of the cardiovascular system-Major components of the cardiovascular system; Work done by heart, blood pressure, blood flow; Electricity within the body-Nervous system of the neuron, Electrical potential of nerves, electromyogram, Electrocardiogram, artificial

pacemaker.

2. **Radiation Detection:** Measurement ofionizing radiation-kerma; Relation of kerma to energy fluency for photons; Absorbed dose Exposure; Calculation of dose from exposure; Absorbed dose in any medium; Free-Air Ionization chambers-Current mode; Pulse mode; Determination of exposure with ionizations chamber; Bragg-Gray cavity theory; TLD-The thermoluminescence process; Phosphors; Randall-Wilkins Theory; Trap stability; TLD Readers; TLD forms; Calibration; Advantages and disadvantages.
3. **Modern Imaging Techniques:** Physics of X-ray production; Diagnostic and therapy x-ray tubes; X-ray circuit with rectification; Operating characteristics; X-ray Imaging: Contrast, Sharpness, Resolution, Films, Cassettes, Imaging intensifier, Exposure in diagnostic radiology; Ultrasound: Nature, Productions, Design, Image acquisition and storage, Image quality; Gamma camera: Gamma camera its collimator and quality control, Principles, Choice of radionuclide and radiopharmaceuticals, Imaging and function, Test on thyroid gland, Liver, Spleen, Kidney, Lunges, Brain, heart bone; Other devices: Computed tomography (CT), Magnetic Resonance Imaging (MRI).
4. **Physics of Radiotherapy:** Clinical Radiation Generators - Superficial and deep therapy (basic idea), Cobalt-60 unit (in brief); Functions used in Dose calculation-Phantom; Percentage Depth Dose (PDD) ; Back scattering Factor (BSF) ; Peak scatter factor; Tissue Air-Ratio (TAR) ; Scatter-Air-Ratio; Tissue-Maximum-Ratio (TMR);Ractor affecting PDD, BSF; TAR; TMR; Inverse square law; Relation between TAR & PDD; Equivalent fields; Treatment panning-Isodose chart; Isodose curve; Surface; Parameters of isodose curves; Wedge filters;Isocentric Techniques; Wedge field Techniques.

BOOKS RECOMMENDED:

1. Eric, H.J. and Giaccia, A.J.; Radiobiology for the Radiologist.
2. Medical Physics: Cameron J.R. and Skofronik J.G.
3. Casarett, A.P.; Radiation Biology.
4. Podgorsak, E. B.; Radiation Oncology: A handbook for Teachers and Students.
5. Khan, Faiz. M.; The Physics of Radiation Therapy.

Course Title: Climatology

Course Code: PHY-5210 Credit Hour: 03

1. **Physical and Dynamic Climatology:** Scopes of Climatology; Energy balance and temperature; Moisture; Wind and pressure; Weather systems.
2. **Past and Future Climate:** Studying the past causes of change; Global warming.
3. **Regional Climatology:** Scales and classification; Tropical climates; Mid-latitude climates; Polar and highland climates.
4. **Applied Climatology:** Human response: health, architecture, urban design, etc; Climate

resources: Agriculture, energy, industry, etc; Human influence: Ozone depletion; Acid rain, etc.

5. **Climatologically Statistics:** Basic concepts; Linear regression; Meteorological and climatologically applications.

BOOKS RECOMMENDED:

1. Oliver and Hidore; Climatology: An Atmospheric Science, 3rd Edition.
2. Roger, G.B. and Chorley, R.J.; Atmosphere, Weather and Climate, 9th Edition.
3. Hartmann, D. L.; Global Physical Climatology (International Geophysics Series).
4. Rohli and Vega; Climatology, 2nd Edition.
5. Thompson-Perry; Applied Climatology: principles and practice.
6. Critchfield, H.J.; General Climatology

Course Title: Physics Practical

Course Code: PHY-5211 Credit Hour: 03

Electronics Lab

1. Construct a single decimal digit display system using different IC's and a 7-segment display unit.
2. Construct a 4- bit DAC using resistance network, signal generator and different IC's.
3. Construct an Analog to Digital convertor (ADC) circuits.
4. Construct and study of a voltage series feedback amplifier using μA 741 IC and hence to find the following:
    i. Gain with various combination of feedback,
    ii. Input output resistance with feedback,
    iii. Plot a frequency response curve and hence find the 3 dB point and Bandwidth from the graph.
5. Construct and study of a voltage follower by using voltage series feedback amplifier using μA 741 IC and see the waveform on the oscilloscope.
6. Construct and study of a voltage series feedback amplifier using μA 741 IC and hence to find the following:
    i. Gain with various combination of feedback,
    ii. Input output resistance with feedback,
    iii. Plot a frequency response curve and hence find the 3 dB point and Bandwidth from the graph.

Nuclear Physics Lab

1. Record the gamma ray spectrum for the Cs-137 by Nal (TI)/GM detection system and analyze of the spectrum as a function of the analyzer's window.
2. Record gamma ray spectrum for the Cs-137 by Nal (TI)/GM detection system and analyze of the spectrum as a function of the amplifiers gain.
3. Determination of the attenuation coefficient and half-life of gamma radiation.
4. Calculation of some nuclear properties by computer programs (according to course teachers instruction).
5. To investigate the statistics related to measurements with a Geiger counter: Poisson and Gaussian distribution.

Solid State Physics

1. Characterize a solar cell and verify the inverse square law of light.
2. Calculate the energy band gap of a semiconductor material.

Renewable Energy Physics

1. Study of a solar radiation from meteorological parameters for:
   i. Chittagong
   ii. Jessore
   iii. Dhaka
   iv. Bogra
   v. Cox's bazar
   vi. Sylhet
2. Computation measurement and analysis of solar radiation data and determination of global, diffuse and beam radiation for solar energy utilization.

Atmospheric Physics Lab

1. (a) Plot the given pressure data reduce to mean sea level in a synoptic chart, make an analysis of it and find wind speed at 10 different points from the chart.

   (b) Plot the given temperature data on a separate chart make an analysis of it, relate it with pressure chart.

   (c) Plot the pressure data for October for Bangladesh and calculate wind speed at 10 different points.

2. (a) Prepare a diagnostic chart for the given data and analyze it. Prepare a prognostic model for 24 hours and analyze it.

(b) Calculate wind speed at different points for both diagnostic and prognostic charts.

(c) Plot the pressure data for July for Bangladesh and calculate wind speed at 10 different points.

3. (a) Prepare a pressure chart with the given data and analyze it. Find out wind speed at 10 different points in between 200 and 250 latitudes.

(b) Prepare a synoptic chart for the given relative humidity data and compare it with pressure chart, analyze them.

(c) Plot the pressure data for March for Bangladesh and calculate wind speed at 10 different points.

N.B: Depending on the availability of the experimental setup, course teachers will be decided how many experiments should be conducted.