UNIVERSITY OF DHAKA
DEPARTMENT OF PHYSICS
Four Year Honours Courses

Effective from Session 2015-2016

The B.S. (Hons) Degree Program in Physics: The B.S. (Hons) degree program in Physics department, Faculty of Science, University of Dhaka is a 4-year program consisting of four academic sessions, each having duration of 12 calendar months;

Definition of a credit

The credit is defined as follows:
i) For theoretical courses, 15 class lectures = 1 credit
ii) Each class is of 50 minutes duration.
iii) For Lab courses, 30 hour lab work = 1 credit
(Existing / previous full unit course is equivalent to 4 credits.)

Credit requirements for the 4 year B.S. (Hons)

1. Total Number of Credits required are136 distributed over 4 years.
2. The year-wise distribution of 136 credits is as follows:-

	Non-Major	Major				
		Theory	Expt.	Viva	Total	Grand Total
First Year	14	12	8	2	22	34
Second Year	10	18	8	2	25	35
Third Year	-	21	8	2	34	34
Fourth Year	-	24	8	2	31	31
	24	75	32	8	112	134

3. Rules regarding examinations,
The rules regarding examinations, fees and promotion etc. will remain the same as contained in the ″Rules for Honours Courses under the Integrated Courses System of the University Of Dhaka" relevant to the session and any subsequent changes.

4. Course name, Major Courses and credits.

Major Subject Courses

(A) First Year Honours22

1.	PH 101	Mechanics and Properties of Matter	3
2.	PH 102	Thermal Physics	3
3.	PH 103	Electricity and Magnetism	3
4.	PH 104	Introduction to Computer and Programming	3
5.	PL 101	Practical Laboratory	8
6.	PV 102	Viva-Voce Examination	2
			22

(B) Second Year Honours 25

1.	PH 201	Optics	3
2.	PH 202	Electronics-I	3
3.	PH 203	Mathematical Physics	3
4.	PH 204	Atomic and Molecular Physics	3
5.	PH 205	Waves, Oscillations and Advanced Mechanics	3
6.	PL 201	Practical Laboratory	8
7.	PV 202	Viva-Voce Examination	2
			25

(C) Third Year Honours 34

1.	PH 301	Classical Mechanics and Relativity	3
2.	PH 302	Quantum Mechanics -I	3
3.	PH 303	Solid State Physics -I	3
4.	PH 304	Nuclear Physics	3
5.	PH 305	Classical Electrodynamics	3

6.	PH 306	Lasers and Photonics	3
7.	PH 307	Computational Physics	3
8.	PH 308	Introduction to Astrophysics	3
9.	PL 301	Practical Laboratory	8
10.	PV 302	Viva-Voce Examination	2
			34

(D)	Fourth Year Honours		31
1.	PH 401	Statistical Mechanics	3
2.	PH 402	Quantum Mechanics II	3
3.	PH 403	Electronics II	3
4.	PH 404	Methods of Experimental Physics	3
5.	PH 405	Solid State Physics II	3
6.	PH 406	Nuclear and Particle Physics	3
7.	PH 407	Introduction to Material Science & Nanotechnology	3
8.	PL 401	Practical Laboratory	8
9.	PV 402	Viva-Voce Examination	2
			31

Non-Major Courses:

The division of Non-Major units year-wise is as follows:

(1) First Year:

Mathematics:		**04 Credits**
Math-102	Differential Calculus-1	(2 Credits)
Math-103	Analytic & Vector Geometry	(2 Credits)
Chemistry:		**06 Credits**
CM-100	Fundamentals of Chemistry	(4 Credits)
CHGL-101	General Chemistry Lab	(2 Credits)
Statistics:		**02 Credits**
Stat-102	Introduction to Probability	(2 Credits)
		14 Credits

(ii) Second Year:

Mathematics:		**08 Credits**
Math-202	Differential Calculus-II	(2 Credits)
Math-203	Ordinary Differential Equation	(2 Credits)
Math-204	Numerical Analysis -I	(2 Credits)
Math-206	Linear Algebra for Physicists	(2 Credits)
Statistics:		**02 Credits**
Stat-201	Principles of Statistics	(2 Credits)

Second Year Total -10 Credits; Grand Total -22Credits

Detailed Syllabus of these Courses will be supplied by the respective Departments.

First Year B.S. (Hons.) Major Courses in Physics:

PH 101: Mechanics and Properties of Matter (3 Credits)

1. Preamble:

Measurement of Physical variables, Dimensions of Physical Variables and rudimentary dimensional analysis Scaling. 2 lect

2. Particle Kinematics and Dynamics:

a) Motion in one dimension, x vs t, v vs. t graphs and their properties.

Motion in two and three dimensions, e.g. projectile motion, circular motion. Notion of force and Newton's laws of motion. Frictional forces.

Application of Newton's laws: Free body diagrams, Inclined plane 6 lect

3. Momentum Conservation and System of Particles:

a) Conservation of momentum : Rocket motion. Center of Mass and its Motion.

b) Collision : Elastic and Inelastic collisions in one dimension. Impulse. 5 lect.

4. Energy Conservation:

Work and Energy. The Work-kinetic energy theorem. Conservative Forces and Potential Energy and their relation. Conservation of Energy. 6 lect.

5. Rotational Motion:

Rotational Kinematics, Moment of Intertia and its calculation, Radius of Gyration, Parallel-axis theorem, Perpendicular- axis theorem. Rolling motion, Motion of a Gyroscope: Precessions. 6 lect.

6. Gravitation:

Newton's Law of Gravitation. Derivation of Kepler laws of planetary motion from Newton's laws. Gravitational Potential, Escape Velocity, Calculation of Potential and Force in simple cases. 5 lect

7. Elasticity:

Hooke's Law, Elastic Moduli and their interrelation, Bending of a cantilever. Torsion. 4 lect

8. Surface Tension and Viscosity:

i) Adhesive and Cohesive Forces, Molecular origin of Surface Tension, Excess Pressure due to surface tension at an interface. Capillarity.

ii) Newton's law of Viscosity, Poiseulle's Formula, Stokes Law. Terminal Velocity for Falling bodies. 7 lect.

9. Rudiments of Fluid Dynamics :

Streamlined Flow, Bernoulli's equation, Equation of Continuity, Euler's Equation. 4 lect.

References :

1. Fundamentals of Physics- Robert Resnick, David Halliday and Jearl Walker, 10th Edition. John Wiley & Sons
2. Physics- R. Resnick, D. Halliday and K. Krane. John Wiley and Sons
3. Properties of Matter-Newman and Searle.
4. Elements of Properties of Matter -Mathur, D. S

PH-102: Thermal Physics (3 credits)

1. Kinetic theory of Gases I: Basic Assumptions of Kinetic Theory, Calculation of pressure exerted by the gas, Kinetic interpretation of Temperature, Root-Mean Square speed, Degrees of freedom, law of equipartition of energy. 4 lect

2. Kinetic Theory of Gases II: Distribution of molecular velocities in a perfect gas: Maxwell-Boltzmann Distribution law, Determination of average speed, root mean square speed, and most probable speed, Temperature dependence, Energy distribution function of Maxwell-Boltzmann velocity distribution. Mean free path: Expression for mean free path (Zeroth order approximation and first order approximation), Van der waals equation of state: Assumptions in deriving Van der walls equation of state, Critical constant, Law of corresponding states. 6 Lect

3. Transport phenomena: Viscosity, diffusion, transport coefficients and size of molecules, relationship between transport coefficients, Brownian motion, vertical distribution of Brownian particles, Einstein's Theory of Brownian motion. 5 Lect

4. Basic Concepts of Thermodynamics: Thermodynamic state of a system, Thermal Equilibrium, Zeroth law of Thermodynamics, Internal Energy of System-Concept of heat, Equation of State: The Ideal Gas Equation, Indicator Diagram, First law of Thermodynamics, Thermodynamic Process-Isothermal, Adiabatic, Isobaric, Isochoric, Adiabatic relations of system for perfect gas, Work done during Isothermal and Adiabatic changes, Reversible and Irreversible changes. 6 lect

5. Second Law of Thermodynamics and Entropy: Conversion of Heat into Work and its converse, Reversible and Irreversible Processes, Examples of Irreversible Processes, Carnot's Cycle and Carnot's Heat Engine and its efficiency, Second law of Thermodynamics: Statements, Carnot Theorem, Entropy, Principle of Increase in Entropy, Generalized form of the First and Second laws: (i) Entropy changes for an Ideal Gas and (ii) Entropy of van der Waals' gas, and Third law of thermodynamics. 7 lect

6. Heat engines & Refrigerators: Heat Engines: Otto cycle and its efficiency, Diesel cycle and its efficiency, Comparison between Otto and Diesel cycle, Refrigerators: General Principle and Coefficient of performance of refrigerator, The Carnot Refrigerator, Simple structure of vapor compression refrigerator, Air conditioning: principle and its applications. 4 lect

7. Thermodynamics relations: Thermodynamical functions: Internal energy (U), Helmholtz function (F), Enthalpy (H), Gibbs function (G) and the relations between them, Two mathematical conditions for exact differentials (Properties), derivation of Maxwell thermodynamical relations from thermodynamical functions, Application of Maxwell relations: relations between two specific heats of gas, Internal Energy equations for (i) ideal gas and (ii) Van der Waals gas, Relation between isothermal compressibility and isentropic compressibility, Derivation of Clausius-Clapeyron and Clausius equation, variation of intrinsic energy with volume for (i) perfect gas (ii)Vander wall gas (iii) solids and liquids, T-S diagrams and First, Second and Third TdS relations. 9 lect

8. Production of low temperature: Adiabatic demagnetization, Joule-Thomson effect (Throttling process for (i) ideal gas and (ii) Van der Waals gas and thermoelectric phenomena; Seebeck, Peltier and Thompson effects. 4 lect

References :

1. Fundamentals of Physics- Robert Resnick, David Halliday and Jearl Walker, 10th Edition. John Wiley & Sons
2. Heat and Thermodynamics- Mark W. Zemansky and Richard H. Dittman, 7th ed. McGraw-Hill
3. Heat and Thermodynamics-F. Sears and G.L. Salinger, 3rd. Ed. , Addision- Wesley.
4. An Introduction to Thermal Physics-Daniel V. Schroeder, 1st Edition, Addison-Wesley Publishing Company
5. Fundamentals of Statistical and Thermal Physics-F. Reif, McGraw-Hill.

PH 103 : Electricity and Magnatism (3 credits)

1. Mathematical Preliminaries:

Scalar and Vector Fields. Gradient, Divergence and Curt. Gauss' and Stokes' Theorems-appilications. Grad. Div. Curl and Laplacian in Cartesian, Curvilinear (Spherical Polar and Cylindrical) coordinates. 6 lect.

2. Electric Field:

a) Point charges and Coulomb's law. Definition of the electric field. Superposition principle. Electric field lines. Field due to a dipole. Torque on a dipole in uniform E-field. 3 lect.

b) Gauss' law. Coulomb's law from Gauss' law. Cases with planar, spherical and cylindrical symmetry. Gauss' law in differential form. 3 lect.

c) Static electric field as a conservative vector field ($\nabla \times \mathbf{E}=0$). Notion of a potential Equipotential; surfaces. Potential and potential energy for a system of charges. 4 lect.

d) Capacitance and capacitors. Analogy with springs. Parallel plate capacitors and spherical Capacitors. Energy stored in a capacitor. Capacitors in parallel and in series, Capacitors used as charge accelerators. Concept of electron-volts. Eelectric field as the carrier of electrical evergy and electrical energy density in terms of electric field. 5 lect.

e) Dielectric media. Polarization vector and Displacement vector. Capacitor with a dielectric, Gauss's law with dielectrics. 2 lect.

3. Current and Magnetic Field :

a) Motion of charge carriers in matter. Current density, drift velocity, the Durde model. Ohmic conductors and Ohm's law. (The laws of resistivity). Resistance and resistivity. Addition of resistances. 2 lect.

b) Electromotive force and potential drop. Kirchoff's laws : Junction and Loop rules. Their physical basis. Problems involving Multiloop circuits with resistors and batteries, ammeter. Voltmeter and their use. 2 lect.

c) Single loop RC circuit. Charge, Charging and discharging of a capacitor and the Time constant. Energy transformation in the RC circuit. 2 lect.

d) Definition of magnetic field : Lorentz Force. Properties of static magnetic field. Gauss' law for magnetic fields. Absence of magnetic monopoles. Motion of charged particles in magnetic field : Hall effect. 4 lect.

e) Magnetic fields due to currents : Biot-Savart law. Magnetic fields due to current carrying areas and straight lines. Ring current as a magnetic dipole. Ampere's law comparison between Biot-savart and Ampere law. Field due to an infinite straight wire, ideal solenoid and a toroid. 2 lect.

f) Magnetic properties of matter. paramagnet, diamagnet and ferromagnet. Magnetization vector. Hysteriesis. 2 lect.

4. Time Varying Phenomena:

a) Faraday's law of induction. Lenz law. Inductance-self and mutual inductance. Application : Transformers. 2 lect.

b) Inductors. Single loop RL circuit and the Time constant. Energy stored in magnetic fields. Energy transformation in an RL circuit. Analogy of inductor with mass. 2 lect.

c) Induced Electric field from time-varying magnetic fields-closed electric field lines. Synchrotron vs. Cyclotron. 2 lect.

d) RC and LC circuits. Energy transformation in LC circuit. 2 lect.

References :

1. Fundamentals of Physics- Robert Resnick, David Halliday and Jearl Walker, 10th Edition. John Wiley & Sons

2. Physics-R. Resnick, D. Halliday and Krane. 6th ed. John Wiley and Sons.

3. Foundations of Electromagnetic Theory-J. Reitz, F. Milford and R. Christy, Addison Wesley.

PH-104 Introduction to Computer and Programming (3 Credits)

Part II of this course will be a laboratory-based course. Both part will start simultaneously with one Theory (50 mins) and one Laboratory class (170 mins) per week

PART-I:COMPUTING BASICS

Generations of Computer. Types of Computer, Block Diagram of a Computer. Functions of the Different Units: Input unit, Output unit, Memory unit, CPU: ALU, CU. 2 lect.

1. Input and Output Devices (Basic Idea): Keyboard, Data Scanning Devices, Card Reader, Digitizers, Monitor, Printer, Projector, etc. 1 lect.

2. Memories (Basic Idea): Registers, Cache Memory, Primary Memory, Secondary Memories. 1 lect.

3. Software: System Software: Operating System and Utility Software, Application Software, Linux Operating System: Some Basic Commands in Linux. 1 lect.

4. Number System and Codes: Binary Number System: Decimal to Binary and Binary to Decimal Conversion. Octal Number System, Hexadecimal Number System. BCD Code, Alphanumeric Codes: ASCII Code, Parity Bit. 3 lect.

5. Digital Arithmetic: Binary Addition, Signed Numbers, 2's-Complement System, Addition and Subtraction in 2's Complement System, BCD addition, Design of a Half and Full Adder. 3 lect.

6. Logic Gates and Boolean algebra: Boolean Constant and Variables, Truth Tables, *Basic Logic Operations and Gates*: OR, AND, and NOT, Universal Gates: NAND and NOR, *Complex Gates*: XOR & NOR, Boolean Theorems, DeMorgan's Theorem. Universality of NAND and NOR Gates. 4 lect.

7. Flip-Flops: Latch, Clock Signals and Clocked Flip-Flops. S-C Flip-Flop, J-K Flip-Flop, D Flip-Flop, Asynchronous Inputs, Master-Slave Flip-Flop, Data Storage and Transfer, Shift Register. 3 lect.

8. Counters and Registers: Asynchronous Counters, Decade/BCD Counters, Synchronous Counters, Up/Down Counter, Counter Applications: Frequency Counter. 3 lect.

Part – II: PROGRAMMING (C/C++)

1. Programming Language Translators: Assembler, Compiler and Interpreter. **Computer Languages:** Machine language, Assembly language, High level language. **Flow Chart** and **Algorithms.** 1 lect.

2.C Fundamentals: An Overview of "C/C++" Programming, Identifiers and Key words, Data Types, Constants, Variable and Arrays, Declarations, Expressions, Statements, Symbolic Constants. 4 lect.

3. Operators and Expressions: Arithmetic Operations, Increment and Decrement, Unary Operators, Relation and Logical Operators, Assignment Operators, Type Conversion in Assignments, Multiple Assignments, Conditional Operator, Library Functions. 4 lect.

4. Data Input and Output: Single Character Input, Single Character Output, Entering Input Data, Writing Output Data. 3 lect.

5. Control Statements: *if Statement, if-else Statements, Nested if Statements, for Loop, while Loop, do-while Loop, Nested Loops, switch Statement, continue Statement, break Statement, goto Statement.* 5 lect.

6. Functions: Defining Functions, Accessing Functions, Passing Argument to Functions, Recursion, Function Prototypes. 3 lect.

7. Arrays and Strings: Declaring Arrays, Initializing Arrays, Processing Arrays, Passing Arrays to a Function, Multidimensional Arrays, String, Building Arrays of String. 4 lect.

References :

1. Tocci and Widmer. Digital Systems, Prentice Hall
2. Morris Mano,Digital Logic & Computer Design
3. Alvis J. Evans. Basic Digital Electronics
4. Herbert Schildt. C: The Complete Reference
5. Herbert Schildt. C++: The Complete Reference
6. Kernighan B.W. and Ritchie D.M. C Programming Language.
7. King K. N.C Programming: A Modern Approach.
8. Greg Perry. Absolute Beginner's Guide To C.
9. Sinha P.K. Computer Fundamentals

Second Year B.S. (Hons.) Major Courses in Physics

PH 201: Optics **(3 Credits)**

1. Optics: Past, present and future 1 lect.

2. Review of wave propagation: Travelling wave; Phase and group velocity, superluminal light; Energy and power of a wave. Velocity of light in vacuum in terms of ϵ_0 and μ_0.Poynting vector and intensity of light.Wavefront and Huygens principle. 2 lect.

3. Geometrical optics and Aberrations: Ray tracing through optical systems; Matrix formulation of geometric optics; Transfer matrices of lenses and mirrors and for free propagation; Examples; Seidel aberrations; Spherical aberration; Coma; astigmatism; Curvature of field; Distortion; Aspherical surfaces; Chromatic aberration; Achromatic doublets; example. 5 lect.

4. Interference of light: General considerations, superposition of vector fields; Conditions of interference; Division of wave front and amplitude; Young's experiment; Fresnel bi-prism; Fringes with quasi-monochromatic and white light, fringes of equal inclination and thickness; Haidinger and Fizeau fringes; Newton's rings; Michelson interferometer; Measurement of wavelength and separation of sodium D1 and D2 doublets; Michelson Stellar Interferometer; Mach-Zehnder interferometer. 7 lect.

5. Multiple-beam Interference: Multiple reflections from a plane-parallel plate; Fabry-perot interferometer; Free spectral range and chromatic resolving power; Antireflection coatings; Interference filter; examples. 5 lect.

6. Fraunhofer diffraction: Huygens-Fresnel principle; Fresnel and Fraunhofer diffraction; Fraunhofer diffraction from a single, double and multiple slits; Circular aperture; Resolution of imaging systems; Diffraction grating; Transmission and reflection gratings; Spectrometer, its resolving power. 7 lect.

7. Diffraction theory and Fresnel diffraction: the integral theorem of Kirchhoff; Fresnel zone plate and Fresnel lens; Rectangular aperture; Fresnel integrals; Cornu spiral; Fresnel diffraction by slit. 6 lect.

8. Polarization : Definition of Polarization ; plane, circular and elliptic polarization; Malus law; Polarization by polarizer and by reflection; Birefringence; Brewster's law; Polarization by scattering; Ordinary and extraordinary rays; Nicol and Wollaston prisms; Birefringent crystal; Optic axis; Birefringence in negative and positive uni-axial crystals, full wave, half- wave and quarter-wave plates ; Optical activity. 8 lect.

9. Dispersion and Scattering : Normal and anomalous dispersion; Cauchy and Sellmeir equation; Rayleigh scattering; The blueness of sky and the redness at the sunset and sunrise; Mie scattering qualitative. 4 lect.

References :

1. E. Hecht, Optics (4th ed.), Pearson Education (2002)
2. F.A. Jenkins and H.E. White, Fundamentals of Optics (4th ed.), Mc Grew-Hill.
3. Born and Wolf, Principles of Optics. (7th ed.), Cambridge Univ. Press (2001).
4. Fundamentals of physics: Halliday- Resnick-Walker. 4th edition
5. Optics – Bruno Rossi

PH-202: Electronics (3 credits)

1. Semiconductors Diode: 6 lect.

Semiconductors Materials: Ge, Si, and GaAs, Extrinsic Materials: n-Type and p-Type. Semiconductor Diode: p-n Junction, Forward and Reverse Bias, I-V Curve, Diode Equation, Breakdown: Avalanche and Zener Mechanism, PIV Rating, DC & AC Resistance, Maximum Current and Power Dissipation Rating, Reverse Recovery Time, Diode Testing, Zener Diode, Light Emitting Diodes.

2. Diode Applications: 5 lect.
Load-Line Analysis, Q-point, Diode Logic Circuits (AND, OR and NOT Gates), Half-Wave Rectification, Full-Wave Rectification: Bridge Network, Center-Tapped Transformer, Average Voltage, Capacitor Smoothing, Ripple Voltage & Factor, Zener Voltage Regulator, Diode Clipping and Clamping Circuits.

3. Bipolar Junction Transistor (BJT): 9 lect.
Transistor Construction: npn & pnp Transistor, Transistor Operation, Transistor Configurations: CB, CE & CC Configurations, Alpha and Beta, Input Characteristics, Output Characteristics, Cut-off, Saturation and Active Region, Transistor Amplifying Action, Transistor Switching Networks, Transistor Testing and Terminal Identification Transistor Biasing: Load Line & Operating Point, Fixed Bias, Collector Feedback, Emitter Bias and Voltage Dividers Bias Configurations, Bias Stabilization.

4. Electronic Circuits Analysis: 5 lect.

Constant Voltage and Constant Current Sources, Current Mirror Circuits, Current Source Circuits: BT Constant Current Source, Transistor/Zener Constant Current Source. Thevenin's and Norton's Theorems, Superposition Theorem, Two-Port Network and Hybrid Equivalent Model, Ebers-Moll Model.

5. Field Effect Transistor: 5 lect.
JFETS: Construction, Input and Output Characteristics, Transfer Characteristics, Depletion-Type MOSFET, Enhancement-Type MOSFET, VMOS, CMOS, FET Biasing.

6. BJT and JFET Frequency Response: 4 lect.
Decibels, Low-Frequency Analysis, Bode Plot, Low-Frequency Response: BJT Amplifier and FET Amplifier, Miller Effect Capacitance. High-Frequency Response: BJT and FET Amplifier, Multistage Frequency Effects.

7. Negative Feedback: 3 lect.
Basic Feedback Concepts, Feedback Connection Types, Practical Feedback Circuits, Analysis for Gain, Distortion, Bandwidth, Input Impedance and Output Impedance, Feedback Amplifier- Phase and Frequency.

8. Operational Amplifier: 6 lect.
Op-Amp Basic, Differential Amplifier Circuit (Double Ended Input, Single Ended Output), Differential and Common Mode Operation, Common Mode Rejection Ratio, Equivalent Circuit, Ideal Op-Amp Approximations, Inverting Amplifier, Non-inverting Amplifier, Adder, Subtractor, Comparator, Integrator, Differentiator, Frequency Response, Gain-Bandwidth Product, Active filters, Applications in millivolt Meter and Current Meter.
5 lect.

9. Fabrication of IC: 2 lect.
Monolithic and Hybrid Circuits, Fabrication of Monolithic Circuits, Very Large Scale Integration (VLSI).

References :

1. Robert L. Boylestad, and Louis Nashelsky. Electronic Devices and Circuit Theory. Prentice-Hall, India.
2. David A. Bell. Electronic Devices and Circuits Prentice Hall, India.
3. Malvino, A.P. Electronic Principles, Tata McGraw Hill.
4. Brophy, J. J. Basic Electronics for Scientists, McGraw-Hill.
5. Millman, J. and Halkias, C.C. Electronic Devices and Circuits, McGraw Hill.
6. Ramakant A. Gayakwad. Op-Amps and Linear Integrated Circuits.

PH-203: Mathematical Physics: (3 Credits)

1. Tensors: 6 Lect.

Definition of Tensor ; Importance of Tensor in Physics ; Rank, Contravariant and Convariant Tensor ; Transformation of Coordinates ; Kronecker Delta and Levi-Civita Tensor ; Einstein Summation Convention ; Direct Product ; Symmetric and Anti-symmetric Tensors ; Contraction ; Tensor Equations ; Matric Tensors and their Determinants ; General Coordinate Transformations and Tensors.

2. Techniques of Complex Variables: 12 lect.

Functions of a Complex Variable ; The Cauchy-Riemann Relations ; Power Series in a Complex Variable ; Elementary Functions ; Multivalued Functions and Branch Cuts; Jordan's Lemma; Singularities and Zeroses of Complex Functions; Complex Integrals; Green's Theorem ; Cauchy's Theorem; Cauchy's Integral Formula; Taylor and Laurent Series ; Residue Theorem; Finding Residues; Evaluation of Definite Integrals Using the Method of Residue ; Integrals of Sinusoidal Functions ; Infinite Integrals.

3. Fourier Series: 4 Lect.

Fourier Series; The Dirichlet Conditions; The Fourier Coefficients; Symmetry Considerations; Discontinuous Functions; Non-periodic Functions; Integration and Differentiation; Application of Fourier Series; Complex Fourier series; Parseval's Theorem.

4. Integral Transforms: 8 Lect.

Fourier Transforms: The Uncertainty Principle; Fraunhofer Diffraction; The Dirac δ-Function; Relation of the δ-Function to Fourier Transforms; Properties of Fourier Transforms; Odd and Even Functions; Convolution and Deconvolution; Correlation Functions and Energy Spectra; Paseval's theorem; Fourier Transforms in Higher Dimensions.

Laplace Transforms: Laplace Transforms of Derivatives and Integrals; Inverse Laplace Transformation; Laplace Transformations of Special Functions; Applications of Laplace Transformations.

5. Gamma and Beta Functions: 3 Lect.

Definitions ; Fundamental Property of Gamma Funtions ; The Value of $\Gamma(1/2)$ and Graph the Gamma Funtion ; Transformation of Gamma Funtion ; Different Forms of Beta Function ; Relation Between Beta and Gamma functions ; Reduction of Definite Integrals to Gamma Functions.

6. Series Solutions of Ordinary Differential Equations: 12 Lect.

Second-order Linear Ordinary Differential Equations; Ordinary and Singular Points; Series Solutions About an Ordinary Point; Series Solutions About a Regular Singular Point; Series Solution of Differential Equations by Frobenius Method; Polynomial Solutions.

Legendre's Differential Equation, Genarating Function for $P_n(x)$, Recurrence Realations for $P_n(x)$, Rodrigue's Formula for Legendre Polynomial, Orthogonality of Legendre's Polynomials, Series of Legendre's Polynomials, Associated-Legendre's Polynomials, Orthogonality of Associated Legendre's Polynomials.

Bessel's Differential Equation, Genarating Function for $J_n(x)$, Recurrence Realations for $J_n(x)$, Integral Representations for $J_n(x)$, Orthogonality pf Bessel's Equation, Bessel's Function of Second Kind.

Hermite's and Laguerre's Differential Equations, Polynomials, Generating Functions, Recurrence Relations and Orthogonality Properties.

References :

1. G.F Arfken: Mathematical Methods for Physicists, Academic Press, NY.
2. L. Pipes and A. Garvill: Applied Mathematics for Engineers and Physicists, McGraw-Hill.
3. K. Riley and M. Hobson: Mathematical Methods for Physics and Engineering, Cambridge.
4. M.R. Spiegel: Complex Variables, McGraw-Hill
5. Mary Boas: Mathematical Physics in the Physical Sceinces

PH- 204: Atomic and Molecular Physics (3 credit)

1. Radiation:
Blackbody readiation. Thermodynamics of radiation. Stefan's law. Rayleigh-Jeans law and Ultraviolet catastriphe. Wien's displacement law. Planck's distribution law for blackbody radiation and Quantum hypothesis. 9 Lect.

2. Particle Properties of Wave: Photoelectric Effect, Production of X-ray, Origin of X-ray, X-ray spectrum, Compton Effect, Pair Production 5 Lect

3. **Wave Properties of Particles:** Wave Particle Duality, De Broglie Waves, Particle Diffraction, Davission-Germer Experiment. Schrödinger equation (wave mechanics), Particle in a box, Uncertainty Principle and its application. 6 Lect

4. **Atomic Structure**: Rutherford Experiment and Rutherford Nuclear Model, Atomic Spectra and Bohr Atom Model, Energy Levels and Spectra, Atomic Excitation and Franck-Hertz Experiment. 5 Lect.

5. **Many–Electron Atoms:** Electron Spin, Stern- Gerlach Experiment-Pauli's Exclusion Principle, Quantum Number, Principle Quantum Number, Orbital Quantum Number, Magnetic Quantum Number, Spin Quantum Number, Selection rules, allowed and forbidden transition, Symmetric and Anti-symmetric Wave Functions, Periodic Table, Atomic Structures, Vector Atom Model, Explaining the Fine Structure, Hyperfine Structure, Zeeman Effect, (Normal and Anomalous) Stark effect, Paschen-Back Effect.
10 Lect.

6. **Molecules:** Molecules: Molecular Bond, Electron Sharing by Atoms of Molecules, H^{2+} Molecular Ion, H_2 Molecule, Complex Molecules, rotation and Vibration of Molecules and Energy Levels due to Rotation and Vibration. Molecular spectra, Hund's Rule, Raman Effect and Application of Raman Effect. 10 Lect.

References :

1. Beiser, A.: Concepts of Modern Physics, McGraw-Hill Inc.
2. Beiser,A:Perspective of Modern Physics, McGraw-Hill Inc.
3. Theraja B.L. : Modern Physics. S. Chand & Company Ltd. New Delhi.
4. Ghosal S. N. : Atomic Physics. S. Chand & Company Ltd. New Delhi.
5. Tcebeg: Modern Physics

PH 205: Waves, Oscillations and Advanced Mechanics (3 Credits)

1. Oscillations :

a) Simple Harmonic Motion (SHM). Mass-Spring system, Energy conservation in mass energy system. Damped SHM-Under-damped, over-damped motion. Critical damping.
b) ForcedOscillations, Resonance.
c) Superpositon of Periodic Motion :Beats, Lissajous Figures.
10 lect

2. **Time Varying Fields**

a) Damped Oscillation in LCR circuits. 2 lect.

b) Alternating Currents ; RMS value, Use of Complex Variables and phasors for Linear circuit analysis. Impedance, reactance, Q-factor and Power factor. Response of RC, LR and LRC circuits to alternating voltage sources. 5 lect.

c) Displacement current. Maxwell's modification of ampere's law. Induced magnetic Field. Equation of continuity. Maxwell's equations. 2 lect.

d) Plane, Transverse Electromagnetic waves and Speed of Light from Maxwell's equations. 3 lect.

3. Waves:

Waves in Elastic Media; transverse and longitudinal waves; amplitude and phase; phase velocity and group velocity; wavefronts; mathematical representation of plane and spherical wavefronts; principle of superposition, standing waves, Huygens' principle.5 lect

4. Kinematics of Rigid Body Motion : 6 lect

Rotation as orthogonal transformations, Euler Angles, Rotating coordinates. Coriolis Force.

5. Dynamics of Rigid Body Motion : 7 lect

Moment of Inertia, Principles Axis Transformation, Introduction to Euler-Lagrange Equation of of motion, Motion of a heavy symmetrical top.

6. Small Oscillations : 5 lect

Normal Coordinates, Normal Modes, Free vibrations of a linear triatomic molecule.

References :

1. Fundamentals of Physics- Robert Resnick, David Halliday and Jearl Walker, 10^{th} Edition. John Wiley & Sons
2. Physics-R. Resnick, D. Halliday and Krane. 6^{th} ed. John Wiley and Sons.
3. Foundations of Electromagnetic Theory-J. Reitz, F. Milford and R. Christy, Addison Wesley.
4. Classical Mechanics: H. Goldstein, Narosa Publ. New Delhi (3^{rd} Edition)
5. Mechanics – L.D. Landau and E.M. Lifsbitz, Butterworth-Heinemann.
6. Vibrations and Waves - A.P. French

Third Year B.S. (Hons.) Major Courses in Physics

PH 301 : Classical Mechanics & Relativity (3 credits)

1) Review of Newtonian Mechanics : 6 lect

Equation of Motion, Conservation Laws for a System of Particles, Degrees of Freedom, and Constraints.Generalized coordinates, and Generalized Forces, D' Alembert's Principles.

2) Lagrangian Mechanics : 10 lect

Lagrange equation of motion for holonomic constraint's, Variational Method, Euler-Lagrange Equations of Motion, Hamilton's Principles, Constraints and their treatment, Examples : free particle. Charged Particle in electromagnetic field.

3) Motion under Central Forces : 8 lect

Reduction of two body central force motion system to one body problem.

Reduced mass, Elliptic orbit, Keplerian motion. Scattering in a Central force Field : Rutherford Formula.

4) Hamiltonian Mechanics and Canonical Transformations : 10 lect

Principle of least Action, Hamiltonian Equations of Motion, Examples.

Canonical Co-ordinates, Canonical Transformation, Generating Function, Possion Bracket.

5) Relativistic Kinematics & Electrodynamics 11 lect

4-vector, Properties of 4-vector, Lorentz transformation of 4-vectors, The invariant interval, Relativity of simultaneity, Convariant Equations of Motion, Mass-Energy Relation. Relativistic Mechanics and its Lagrangian formulation, Lagrangian formulation of electrodynamics, covariant formulation of electrodynamics

References :

1. Classical Mechanics : H. Goldstein, Narosa Publ. New Delhi (3^{rd} Edition)
2. Mechanics – L.D. Landau and E.M. Lifsbitz, Butterworth-Heinemann.
3. Classical Mechanics (In Bangla), A. M. Harunar Rashid, Bangla Academy
4. Spacetime Physics-E.F. Taylor and J.A. Wheeler, W.H. Freeman and Co. (2^{nd} edition)
5. Relativity : Special, General and Cosmological- W. Rindler, Oxford University Press, (2001)
6. Einstein and Relativity Theory (in Bangla) :A.M. Harunar Rashid, Bangla Academy

PH-302: Quantum Mechanics –I **(3 credits)**

1. Concept of wave equations, wave Function & The Interpretation of the Wave Function, Wave Function for Particles Having a Definite Momentum, Wave packets, The Heisenberg Uncertainty Principle & Complementarity. **5** lect

2. The Schrödinger Equation:

The Time-dependent Schrödinger Equation, Conservation of Probability, Expectation Values- Operators, The Ehsenfest Theorem, The time-independent Schrödinger Equation, Stationary States, Energy Quantization, The Schrödinger Equation in Momentum Space **8** lect

3. Exactly Soluble Problem in One Dimension: **10** lect

(a) The Free Particle-Box Quantization, The Rectangular Potential Step, The Potential Barrier, The Infinite potential Well, The Square Well.

(b) The Linear Harmonic Oscillator:

Solution of the Schrödinger Equation & its Eigenvalues and Eigenfunctions.

(c) The Dirac Delta-Function Potential.

4. The Formalism of Quantum Mechanics: **8** lect

(a) Postulates: The State of a System, Dynamical Variables & Operators, Expansions in Eigenfunctions, Commuting Observables, Compatibility &The Heisenberg's Uncertainty Relation for Arbitrary Observables, Unitary Transformations, The Schrödinger Equation & the Time Evolution of a System.

(b) The Schrödinger & Heisenberg Pictures.

(c) Matrix Representation of Wave Functions & Operators.

(d) Linear Harmonic Oscillator-Ladder Operators, Calculation of Matrix Elements.

5. Spherically Symmetric Potential: **14** lect

(a) Central Potentials, Separation of the Schrödinger Equation in Spherical Polar Co-Ordinates.

(b) Solution of The angular Equation, Spherical Harmonics

(c) Orbital Angular Momentum, Orbital Angular Momentum & Special Rotations Operators for the Orbital angular Momentum, Their Commutations Relations, Angular Momentum Raising & Lowering Operators.

(d) Hydrogen Atom: Radial Wave Equation, Normalization of Radial Wave function & the Associated Probability Density, Eigenvalues & Eigen Functions of the Hydrogen Atom, The Radial Eigenfunctions of the Bound States.

References :

1. Quantum Mechanics: Concepts and Applications-Nouredine Zettili, Second Edition, John Wiley and Sons Ltd.
2. Introduction to Quantum Mechanics- B.H. Bransden, C.J. Joachain, Second Edition, Princeton Hall
3. Introduction to Quantum Mechanics-David J. Griffiths, Second Edition, Person New International Edition.
4. Quantum Physics- Stephen Gasiorowicz, Third Edition, John Wiley and Sons Inc.

PH 303: Solid State Physics-I (3 credits)

1) The Crystalline State : 11 lect

Primitive and conventional unit cell, Basis, Crystal Symmetry, Bravais Lattice, Crystal planes and Miller Indices, Some Crystal Structures, X-ray Diffraction, Bragg's law, Experimental methods: Laue, Rotating Crystal and Powder Methods, Reciprocal Lattice, Structiure Factor.

2) Classification of Crystals : 6 lect

Interatomic Force, Classification of Solids-Covalent, Ionic, Metal, Valence and Vander Waals Crystals, Lattice Energy of Ionic Crystal, Madelung Constant for ionic crystal.

3) Lattice vibrations : 8 lect

Failure of classical theory of Specific Heat, Phonons, Normal Modes of vibration in Monoatomic and Diatomic Linear Chains, Einstein Model and Debye theory of Specific Heat.

4) Anharmonic vibrations : Thermal Expansion. **3 lect**

5) Defects in Crystals : 4 lect

Types of Defects, Consequences of Defects on Mechanical Properties, Schottky and Frenkel type of Defect Concentration, Dislocations, Frank-Reed Mechanism.

6) Free Electron Theory of Metals : 14 lect

Classical Electron Theory, Sommerfield Theory, Box Quantization. Density of States, Fermi Surface, Fermi Energy, Electrical Conductivity,Thermal Conductivity, Wiedemanns Franz Law, Electronic Specific Heat.

References :

1. Solid State Physics : N.Y. Ashcroft and K.D. Mermin, Sauncers Co., Philadelphia.
2. An Introduction to Solid State Physics : C. Kittel, John Wiley and Sons, N.Y.
3. Introduction to Solid State Physics : A.J. Dekkar, Prentice-Hall N.J.
4. Introductory Solid State Physics : H.P. Myers.

PH 304: Nuclear Physics (3 credits)

1. Bulk Properties of Nucleus:

Nuclear energy scale, Nuclear size, Charge radius and charge density, Nuclear binding energy, Nuclear Force, Liquid drop model and semi-empirical mass formula, Shell model corrections 5 lect

2. Radioactivity:

Radioactive decay, Alpha, Beta and Gamma decay, Fermi-Kurie plot, Neutrino, Carbon dating 6 lect

3. Interaction of Radiation with Matter:

Interaction of charged particle with matter: bremsstrahlung, ionization and multiple scattering, Radiation length, Interaction of neutrons with matter, Interaction of photon with matter: Compton effect, photoelectric effect and pair production, Electromagnetic cascades, Cerenkov radiation 6 lect

4. Nuclear Shell Model:

Shell Model, Single particle potential, Wave function and energy levels, Magic numbers, prediction of spin and magnetic moments, Schimdt values and lines 6 lect

5. Nuclear Collective Model:

Rotational energy spectrum and nuclear wave functions for even-even and for odd A nuclei, Beta and Gamma vibrations in nuclei 5 lect

6. Nuclear Reaction:

Q value, Elastic and inelastic collision, Nuclear cross-section, Nuclear Fission, Nuclear Fusion, Nuclear reactor 6 lect

7. Two nucleon system; The Deuteron:

The Deuteron: experimental data, Theory of the Deuteron, Normalization of Deuteron wave function, Spin state of two nucleon system, Tensor force, Magnetic and quadrupole moments of Deuteron 5 lect

8. Nucleon-Nucleon Scattering:

Elements of partial wave analysis, Low energy n-p and n-n scattering, Partial wave analysis of n-p scattering, Scattering length, Effective range analysis 6 lect

References:

1. Introduction to Nuclear Physics, H. A. Enge
2. Elements of Nuclear Physics, W. E. Meyerhof
3. Introductory Nuclear Physics, Samuel S. M. Wong
4. Introductory Nuclear Physics, K. S. Krane

PH 305 : Classical Electrodynamics (3 Credits)

1) Framework : 5 lect

a) Review of Maxwell Equations in vacuum and in matter-integral and differential formulation, Boundary conditions at an interface for **E, D, B, H**.

b) Vector and Scalar potentials, Gauge invariance, Lorentz and Coulomb Gauge, Lorentz force in terms of potentials.

c) Poynting vector, Poynting's theorem and Energy-Momentum conservation for Electromagnetic fields and charges.

2) Boundary Value Problems in Electrostatics : 12 lect

a) Poisson equations and Laplace equations. Uniqueness of the solution with Dirichlet or Neuman equation.

b) Method of Image Charges. Solution of Lalplace's equations in two and three dimensions in Cartesian, Cylindrical and Spherical coordinates with azimuthal symmetry.
c) Multipole expansion of the potential due to a localized charge distribution : dipole and quadrupole moments.

d) Field inside dielectrics, Boundary value problems involving dielectrics.

3) Elements of Megnetostatics : 3 lect
Calculation of the vector potential for current carrying loop, Boundary value problems in magnetostatics.

4) Electromagnetic Wave equation : 9 lect

a) Plane waves and polarization of EM waves
b) Reflection and Refraction of electromagnetic waves at a plane interface between dielectrics. Fresnel equations, polarization by reflection and total internal reflection.
c) Dispersion characteristics of dielectrics, conductors and plasmas. Anomalous dispersion, plasma frequency
d) Waves in a conducting medium. Fields at the surface and within a conductor : attenuation phenomena and skin depth.

5) Wave Guides: 3 lect
Solution of the wave equation in a cylindrical and rectangular waveguide. TE, TM, and TEM modes and their differences. Cutoff frequencies, phase and group velocities in a waveguide.

6) Electromagnetic Radiation: 12 lect

a) Green function techniques for solving wave equations advanced and retarded Green functions.
b) Solution of the wave equation in spherical coordinates.
c) Electric Dipole radiation from an oscillator, Larmor formula. Center-fed antennas, Yagi Antenna.
d) Radiation from point charges. Lienard-Wiechert potentials. Power radiated by a point charge: Classical Bremsstrahlung. Radiation reaction and Abraham-Lorentz formula.
e) Scattering of electromagnetic waves by charges: Thompson and Rayleigh scattering.

References :

1. Introduction of Electrodynamics, D.J. Griffiths, Prentic Hall, New Jersey
2. Foundations of Electromagnetic Theory-J.Reitz, F Milforc and R. Christy, Addison Wesley.
3. Classical Electrodynamics, J.D. Jackson, Third Ed., John Wiley and Sons.

PH 306: Lasers and Photonics (3 Credits)

1. Fourier Optics: Fourier transformation in 1-D and 2-D. Inverse transforms; examples; Dirac Delta Function; Optical Applications; Linear System; Impulse Response function; Point Spread Function; Convolution and Convolution theorems; Examples; Fourier Methods in Diffraction Theory; Fraunhofer Single and Double Slit Diffraction and Fourier Transform; Convolution Theory: Spectra and correlation; Interpretation of Parseval's Formula, Auto Correlation and Cross Correlation, Wiener-Khintchine Theorem.
9 lect.

2. Fibre Optics: Basic Concept; principle of light propagation in Optical Fibers; Acceptance Angle; Core and cladding; Numerical Aperture; Fibre Bundles; Coherent and Incoherent bundles; Types of Fibre: Step Index Fibre; Graded Index Fibre; Multimode and Single Mode Fibre; Fibre Loss: dB/km; Communication Windows; Dispersion in Fibre; Modal Dispersion; Modal delay calculation; Material Dispersion; Waveguide Dispersion; Optical Fibre Communications; EDFA; WDM; DWDM. 6 lect.

3. Electro/Magneto Optics: Faraday effect; Kerr Effect; Pockel Effect; Liquid crystal and liquid crystal display; Dichroism; Dichroic crystal. Mathematical description of polarization; Stokes parameter; Jones vectors; Jones and Muller matrices. 3 lect.

4. Lasers: Absorption, Spontaneous Emission and Stimulated Emission; Einstein A and B Coefficients; Population inversion and active medium; Pumping Schemes; Basic Laser Idea; Critical population inversion; Properties of laser beam; Monochromaticity, Coherence, Directionality and Brightness.
Different types of lasers: i) Solid state lasers; Ruby and Nd:YAG, ii) Gas lasers; He-Ne and Ar+ lasers. 10 lect.

5. Coherence and Correlation : First Order Coherence; Spatial and Temporal Coherence; Coherence length and Coherence time; Total and Partial Coherence; Visibility and Coherence; Mutual Coherence Function; Measurement of Spatial and Temporal Coherence; Coherence Property of Ordinary and Laser Light; Van Cittert-Zernike Theorem; Autocorrelation and Coherence; 2-D Angular Resolution; Correlation Interferometry-Intensity Interferometer-Hanbury-Brown and Twiss Experiment. 5 lect.

6. Detection and Display of optical signals : Thermal detectors of radiation.
Quantum detectos: photoemissive detectors, Photoconductive detectors, Junction photodiodes. Avalanch and PIN photodiodes. Image Detection : photographic film, CCD detectors, CCD noise, ICCD. Image Intensifier, Micro channel plates, Gated ICCD. CMOS detectors. Noise and sensitivity. Signal to noise ratio Physics of the human eye. 4 lect.

7. Quantam Information Processing and Quantam Computation: Quantam information. Quantam bit (qbit). Hilbert space. Qbit and digital bits, comparison. Physical systam as qbit. Quantum Register. Quantam gates. Some quantam gates and their matrix representation. Beam splitter as Hadamard gate. MZI as quantum NOT gate. Quantam Algorithms. Quantum entanglement from informatic – theoretic point of view. Quantam dots : Quantam confinement in semiconductors and its energy considerations. Applications of Quantum dots in quantum computation. Single ion trapping and its use in quantum computation. 8 lect

References :

1. Photonics, 6th edition, A. Yariv and P. Yeh (Wiley).
2. Fundamentals of Photonics, 2nd edition, Saleh and Teich (Wiley)
3. Optics, E. Hecht, 4th edition (Pearson)
4. Principles of Lasers, O.Svelto (4thed) Spinger
5. Optics and Photonics: An introduction – Smith and King.

PH 307: Computational Physics: (3 Credits)

The course will be a partial laboratory-based course with one Theory (50 mins) and one Laboratory class (170 mins) per week

I.**C/C++ Programming 45 Lect**

1.Review of C/C++: 3 Lect

Syntax of C/C++, Editing and typing the program, Debugging and testing, Conditions, loops, Arrays and pointers, Primitive File input/output operations.

2. Solving Problem Using C/C++ 26 Lect

A.**Solving Ordinary Differential Equation(ODE) with Initial Value : 4 Lect**

First Order ODE (Example: Euler Method for the Harmonic Oscillator), Second Order ODE (Example: Runge-Kutta Method for Harmonic Oscillator), Central Difference Method (Verlet Method for the Harmonic Oscillator).

B. Root Finding and Optimization : 3 Lect

Bisection and Newton-Raphson Method of Root Finding, Direct Optimization (Example Simulated annealing minimization of a function of many variables), Stochastic Optimization.

C. Numerical Differentiation : 3 Lect

Finite Difference Method, Two point formula, three point formula and five point formula.

D. Numerical Integration : 3 Lect

Newton-Cotes Method (Using Discrete Planes to appropriate an integral), Trapezoidal rule, Simpson 1/3 and 3/8 rule for integration, Romberg Integration, Monte Carlo Integration.

E. The Integral Transformation : 4 Lect

Theoretical Background, Discrete Fourier Transform, Fast Fourier Transform, Laplace transform, Power Spectrum.

F. Generation of Random Numbers : 5 Lect

Linear Congruential Generator, Non Uniform Random Numbers, Monte Carlo method.

G. Solving Linear System : 4 Lect

Gaussian Elimination, Gauss-Jordan Elimination, LU Decomposition, Eigenvalues and Eigenvectors.

Problems for this part

Study the Band Structure (Free Electron Theory, Kronig-Penney Model), Solving Schrödinger Equation for Different Kinds of Potential, Study Molecular Dynamics, Study the Schrödinger Equation and the Crank-Nicolson Method, Study Double pendulum, Cometary Orbits, LRC Circuits, Study Fourier Filtering and Smoothing

II **Matlab Programming 7 Lect**

A. Simple calculations and graphs: Entering vectors and matrices; built-in variables and functions; Arithmetic operations on matrices, Standard operation, Solving matrix equations using matrix division, Vectorized functions and operators; Curve fitting,

B. Programming in Matlab: Conditionals and loops, Scripts and functions, Advanced matrix computations, Eigenvalues and other numerical linear algebra computations, Advanced Graphics, Solving nonlinear problems in Matlab

III Mathematica Programming **7 Lect**

Conditionals and loops, Scripts and functions, Advanced matrix computations, Eigenvalues and other numerical linear algebra computations, Advanced Graphics, Solving nonlinear problems in Mathematica

IV Parallel Computing **2 lect**

What is parallel computing, use of parallel computing, parallel computer memory architecture, CPU vs GPU computing, Architecture of a modern GPU, designing a parallel program, debugging a parallel program

References :

1. 1.Nicholas Giordano and Hisao Nakanishi, Computational Physics, second edition, Prentice Hall (2005).
2. 2.Paul L. DeVries and Javier E. Hasbun, A First Course in Computational Physics, 2nd ed. Jones and Bartlett (2010).
3. 3.Marvin L. De Jong, Introduction to Computational Physics, Addison-Wesley (1991).
4. Tao Pang, An Introduction to Computational Physics.
5. An Introduction to Matlab–KristerAhlersten
6. Matlab: A Practical Introduction to Programming and Problem Solving - Stormy Attaway
7. Programming Massively Parallel Processors,A Hands-on Approach By David B. Kirk and Wen-mei W. Hwu

PH 308: Introduction to Astrophysics **(3 Credits)**

1. **The Celestial Sphere & Mechanics**: The Greek Tradition, The Copernican Revolution, Positions on the Celestial Sphere, Physics and Astronomy, Elliptical Orbits, The Virial Theorem. 4 lect

2. **Spectrum of Light**: Stellar Parallax, The Magnitude Scale, Review of The Wave Nature of Light, Blackbody Radiation and The Quantization of Energy, The Color Index 3 lect

3. The Theory of Special Relativity: The Failure of the Galilean Transformations, The Lorentz Transformations, Time and Space in Special Relativity, Relativistic doppler shift, Relativistic Momentum and Energy 4 lect

4. Telescopes: Basic Optics, Optical Telescopes, Radio Telescopes, Infrared, Ultraviolet, X-ray, and Gamma-Ray Astronomy, All-Sky Surveys and Virtual Observatories 4 lect

5. Planets and Moons: Our solar system, Physical Processes in the Solar System, Tidal Forces,
The Physics of Atmospheres, The Terrestrial Planets, The Giant Planets, Comets, Asteroids, Meteorites 6 lect

6. THE NATURE OF STARS: Binary Systems and Stellar Parameters, The Classification of Binary Stars, Mass Determination Using Visual Binaries, Eclipsing, Spectroscopic Binaries, The Formation of Spectral Lines, Saha equation, The Hertzsprung Russell Diagram 5 lect

7. The Sun: The Solar Interior, The Solar Atmosphere, The Solar Cycle 3 lect

8 Stellar Atmospheres and interior of stars:
The Description of the Radiation Field, Stellar Opacity, Radiative Transfer, The Interiors of Stars: Hydrostatic Equilibrium, Pressure Equation of State, Stellar Energy Sources, Energy Transport and Thermodynamics 3 lect

9 The Interstellar Medium and Star Formation: Interstellar Dust and Gas, The Formation of Protostars, Pre-Main-Sequence Evolution, Main Sequence and Post-Main-Sequence Stellar Evolution, Evolution on the Main Sequence, Late Stages of Stellar Evolution, Stellar Clusters 3 lect

10. The Fate of Massive Stars: Post-Main-Sequence Evolution of Massive Srs, Supernovae, Gamma-Ray Bursts, Cosmic Rays, The Degenerate Remnants of Stars, The Discovery of Sirius B, White Dwarfs, The Physics of Degenerate Matter, The Chandrasekhar Limit, The Cooling of White Dwarfs, Neutron Stars, Pulsars 4 lect

11 Formation of Planetary Systems : Characteristics of Extrasolar Planetary Systems, Planetary System Formation and Evolution, The Nature of Galaxies, The Hubble Sequence, The Structure of the Universe 4 lect

12 Cosmology: Newtonian Cosmology: The Early Universe 2 lect

References :

1. An Introduction to Modern Astrophysics (Second Edition) - Bradley W. Carroll, Dale A. Ostlie
2. Universe (5th edition) – William J Kaufmann, Roger A Freedman
3. Astronomy A Physical Perspective – Marc L Kutner

Fourth Year B.S. (Hons.) Major Courses in Physics

PH 401: Statistical Mechanics (3 credits)

1. **The scope of statistical physics**: Assembles, Phase space, Liouville Theorem. Distribution over energies, Weights of configuration, the most probable configuration, The Maxwell-Boltzmann Distribution. 5 Lect.

2. Statistical Ensembles: Micro-canonical, canonical and grand-canonical ensembles. Boltzmann formula. Entropy, Free energies and other thermodynamic functions. 4 Lect.

3. The Thermodynamics of Gases: The weight, $A_{max,}$ for a classical perfect gas. The Boltzmann partition function. The evaluation of the classical partition function. The semi-classical perfect gas components of the partition function. 7 Lect.

4. Particle Statistics :Principle of indistinguishability for quantum particles. Spin-statistics connection. Degenerate and non-degenerate system. 4 Lect.

5.Bose-Einstein Distribution: Bose-Einstein Gas, The Photon Gas, The Specific heats of solids, the phonon Gas, Bose-Einstein condensation. 6 Lect.

6. Fermi-Dirac Distribution: Fermi-Dirac Gas, the Electron Gas. 5 Lec

7.Applications of statistical thermodynamics: The paramagnetic gas, the harmonic oscillator, the diatomic molecule, the disordered lattice. 5 Lect.

8.Transport phenomena : Boltzmann transport equation. H-theorem, validity of equation. Mean free path. Viscosity and Diffusion. Electrical conductivity. Brownian motion. 7 Lect

9.Phase Transition: Phase, Phase transitions, Difference between first and second order phase transition, Phase diagram, Mean-field theory, Applications of Mean-field theory, Ising model, Flory-Huggins lattice model. 7 Lect

References:

1. An Introduction to statistical Physics, by A.J. Pointon, Longman.
2. Statistical Physics by L.D. Landau and E.M. Lifshitz Elsevier, 3rd Edition (Part one).
3. Thermodynamics and Statistical Mechanics by W. Greiner, L. Neise, and H. Stocker Springer, 2nd Edition.
4. The Physics of Phase Transitions (Concepts and Applications) by P. Papon, J. Leblond, and P.H.E. Meijer Springer, 2nd Edition.
5. Statistical Mechanics by R.K. Pathria Elsevier, 2nd Edition.

PH 402: Quantum Mechanics –II (3 credits)

1. Symmetry in Quantum Mechanics:
Conserved quantities, Degeneracies, Wigner's theorem, Parity operator 1 Lect

2. Angular Momentum:

a. Rotation, Angular momentum as generator of rotation, Commutation relations, Two-level system: spin 1/2 particle, Pauli matrices and Rotation operator for spin 1/2. 2 Lect

b. Orthogonal and Unitary transformation, Rotation operators with Euler angles, Eigenvalues and eigenstates of angular momentum: Ladder operators, Matrix elements of angular momentum operators, Representation of rotation operator: Wigner function 2 Lect

c. Addition of angular momentum, Clebsch-Gordon coefficient, Recursion relations for Clebsch-Gordoncoefficient, Examples 2 Lect

d. Tensor operators, Irreducible spherical tensors, Wigner-Eckart Theorem 2 Lect

3. Approximation Methods in Quantum Mechanics:
a. Time Independent Perturbation Theory:
Perturbation in non-degenerate case, Perturbation in degenerate case, Stark Effect, Hydrogen-like atoms: Fine structure and the Zeeman effect 8 Lect

b. **The Variational Method**:
Upper bound on ground state energy, Approximation to states, The Helium atom 2 Lect

c. The WKB approximation:
Semiclassical approximation, Approximation solutions, Validity conditions, Turning points, Connection formulas, Tunneling, Application: theory of alpha decay 5 Lect

4. Time-dependent problem:
a. The Interaction picture, Time-dependent two-state problems: Rabi's formula and resonance, Precession of spin 1/2 particle in a time varying magnetic field, Magnetic resonance, Ammonia

molecule and Maser, Sudden and Adiabatic approximations 2 Lect

b. Time-dependent perturbation theory: Dyson series, Transition probability, Fermi's golden rule, Harmonic perturbation, Absorption and stimulated emission of radiation, Selection rules 4 Lect

5. Scattering:
Lippmann-Schwinger Equation, Scattering amplitude, The kernel, Scattering amplitude for a central potential, Differential and total cross section, Optical theorem, The Born approximation, Review of partial wave analysis, Hard-sphere scattering 10 Lect

6. Identical Particles:
Permutation symmetry, States of non-interacting identical particles, Symmetrization postulates: Boson and Fermion, Pauli's exclusion principle, Slater determinant, Scattering of two bosons and two fermions, Bose Einstein condensation 5 Lect

References:

1. Modern Quantum Mechanics, J. J. Sakurai and J. Napolitano, 2nd edition
2. A Modern Approach to Quantum Mechanics, J. S. Townsand
3. Quantum Mechanics, Vol 1 and Vol 2, C. Cohen-Tannoudji, B. Diu and Franck Laloe
4. Quantum Mechanics: Fundamentals, K. Gottfried and T. Yan, 2nd edition
5. Introduction to Quantum Mechanics, D. J. Griffiths, 2nd edition
6. Introduction to Quantum Mechanics, B. H. Bransden and Joachain
7. Lectures on Quantum Mechanics, Steven Weinberg

PH-403: Electronics II (3 credits)

1. Power and Tuned Amplifiers: 7 lect.

Power Amplifier Types, Efficiency Requirement, Low Efficiency of Class A amplifiers, Class B Push-Pull Power Amplifiers: Output Power, Efficiency, Power Dissipation; Transformer Coupled and Complementary Symmetry Push-Pull Circuits, Cross-over Distortion and Elimination, Harmonic Distortion, Basic Principle of Tuned Amplifier, Analysis of Single and Double Tuned Amplifier.

2. Oscillator Circuits: 5 lect.
Positive Feedback, Barkhausen Criterion for Oscillation, RC Phase Shift, Wien Bridge, Hartley and Colpitts Oscillator Circuits. Crystal Oscillator, BJT Astable, Monostable & Bistable Multivibrators.

3. DC Stabilized Power Supply: 3 lect.
Series Voltage Regulation with Feedback using Transistor and Op-Amp, Load and Source Regulation, Current Limiting (short circuit protection), IC Regulators (Positive and Negative, Fixed and Variable Voltage Regulators).

4. pnpn and Other Devices: 3 lect
Silicon Controlled Rectifier (SCR): Construction, Operation, Characteristics, Ratings, Application: Half Wave Phase Control of Power, TRIAC: Construction, Operation and Characteristics, Application: Phase Control, Unijunction Transistor: Construction, Operation, Characteristics, UJT as Relaxation Oscillators.

5. Integrated Circuit Logic Families: 3 lect.
Diode Logic, DTL Logic, TTL Logic, Tristate TTL, MOS Logic, CMOS Logic. Comparison of Important Characteristics of IC Logic Families.

6. Medium Scale Integration Logic Circuits: 3 lect.
Decoders, Encoders, Multiplexer, Demultiplexer, Data Bus Operation.

7. The Memory Devices: 4 lect.
Memory Terminology, ROM Architecture, Flash Memory, Programmable Logic Devices, RAM Architecture, Dynamic Ram Structure and Operation, Expanding Word Size and Capacity.

8. Microprocessor: 6 lect.
Introduction to Microprocessor: Overview of computer architecture, Evolution of Microprocessors, Difference between microprocessor and microcontroller, **Introduction to 8086/8088**: Basic architecture of 8086, Memory segmentation, Flags, Addressing Modes, Pins & Signals, Single and Multi-processor systems, **Microprocessor Programming**: Instruction Sets, Introduction to Assembly Language Programming. *Over viewing other Microprocessors:* 80186, 80286, 80386, 80486 and Pentium Series Processors.

9. Interfacing: 1 lect.
Microcontroller, Working with Microcontroller, Working in Arduino platform

10. A/D, D/A Conversion & Data Acquisition: 4 lect.
Sampling Theory, Aliasing, Digital-Ramp, Successive Approximation, and Flash A/D Conversion, Weighted Resistor and R-2R Ladder D/A Converters, Data Acquisition.

11. Communication Systems: 6 lect.
Fundamentals of Radio Communication: AM & FM Modulation, Radio Transmission Technical Standards, Demodulation, Diode Detection, Block Diagram of Superheterodyne AM Receiver, Digital Modulation and Demodulation Technique. **Fundamentals of TV:** Analysis and synthesis of TV picture, Scanning, Standard scanning pattern, Synchronization, Blanking pulses, Composite video signal, Color video signals, Matrix circuits, Colourplexed Composite Video Signal, Signal Transmission, TV channels, Channel Bandwidth.

References :

1. Robert L. Boylestad, and Louis Nashelsky: Electronic Devices and Circuit Theory. Prentice-Hall, India.
2. David A. Bell: Electronic Devices and Circuits Prentice Hall, India
3. K.R. Botkar: Integrated Circuits
4. Tocci and Widmer. Digital Systems, Prentice Hall
5. Tocci, R.J. and Laskowski : Microprocessors and Microcomputers. Prentice-Hall International, 3rd Edition, 1987.
6. Barry B. Brey : The Intel Microprocessors
7. Simon Haykin: Communication Systems
8. Louis E. Frenzel: Communication Electronics
9. R. R. Gulati: Monochrome and Colour Television
10. Bernard Grob and Charles E. Herndon: Basic Television and Video Systems

PH 404: Methods of Experimental Physics (3 credits)

1. Optical and Spectroscopy Instruments: Phase contrast and Polarizing Microscope, Spectrophotometers, Optical Transmittance, Reflectance and Absorption coefficients. 4 Lect

2. Electrical Measurements: Potentiometer, High Impedance Voltmeters, Oscilloscope, DC Amplifier, Frequency Meter and Counter, Four point probe and Hall probe and Impedance Analyzer. **5** Lect

3. Thin Film Technique: Vacuum and Ultra-High Vacuum: Fundamentals of vacuum, free gas, volume and surface gas, flow of gas, pumping techniques: Rotary pump, Diffusion, Pump, Diffusion pump, Ion pump, Turbo pump, Pirani Gauge, Penning and Ionization Gauges, applications of vacuum techniques. Ion and thin film techniques: Thermal evaporation (electron gun, laser ablation, reactive deposition), Production and Characterization of Thin Film, Thickness Measurement. 7 Lect

4. Phase Sensitive Detection: Look-in Amplifier, SCR type Temperature Controller. 3 Lect

5. Methods of surface and structure analysis: X-ray diffraction technique. Neutron diffraction Fundamentals of electron microscopy: SEM, TEM, Electron diffraction and STEM. 8 Lect

6. Experiments at low temperatures: Cryogens, properties of materials at low temperatures, quantum liquids, He4 and He3 cryostats, closed cycle refrigerators, dilution refrigerators, Low temperature measurement techniques, Ultra-low temperatures, Pomeranchuk cooling, magnetic cooling. 5 Lect

7. Basic idea of Cleanroom Technology: Laminar and turbulent flow, different types of cleanrooms, Super cleanroom, ISO standard of cleanliness, different types of Filters: High Efficiency Particulate Air (HEPA) and Ultra-Low Particulate Air (ULPA) Filters and Physics of Filter. 5 Lect

8. Gamma-Camera and NMR/ Transducer: Principle and operation of Gamma Camera, NMR and NMR Imaging Techniques. 3 Lect

9. Detectors: modes of operation, efficiency, dead time, acceptance, resolution, photoubes, scintillators, Cherenkov detectors, transition radiation detectors, gas detectors: drift of electrons and ions, ionization chambers, proportional counters, multiwire proportional chambers, drift chambers, Geiger Mueller, Electromagnetic and Hadronic calorimeters. 5Lect

References :

1. Methods of Experimental Physics Vol. 2. Marton and Marton.Academic press, N.Y.
2. High Vacuum Techniques, J. Yarwood, Chapman and Hall.
3. Principles of Electronic Instrumentation, Diefen-derfer
4. Basic Electronics for Scientists, J. Brophy, N.Y.
5. Applied Optics Vol. IV, Kings Lake
6. Fundamentals of Optics, F.A. Jenkins and H.E. White, McGraw Hill, Singapore.
7. Vacuum Technology- A. Roth 2nd Edition
8. Handbook of Thin Film Technology- L.I. Maissel and R. Glang

PH 405: Solid State Physics -II **(3 credits)**

Band Theory of Solids : **12 lect**

Electron in Periodic Potential : Kroning-Penney model, Schrodinger Equation, Bloch Function, Brillouin Zones, Reduced Zone Scheme, Methods of Band Structure Calculation-LCAO and OPW methods.

Semiconductors **10 lect**

Direct and Indirect Band Gap Semiconductors. Extrinsic Semiconductor. Shallow Levels. Density of States. Charge Carrier Concentration. Fermi level in the energy gap. Carrier Life time. Recombination Process. P-N junction depletion Region. Junction Capacitance. Diode Current. Tunnel Diode. Metal-Semiconductor Junction. Surface States

Dielectric Properties of Insulators **8 lect**

Static Dielectric Constants. Clausius-Mosotti Relations, Complex Dielectric Constant, Debye Equation, Dielectric Loss. Relaxation Time. Polarization Mechanism.

Superconductivity **6 lect**

Types of Superconductivity, Magnetic Flux Quantization, Zero-Resistance Phenomenon. Meissner Effect. Critical Magnetic Field. London Equations. Penetration Depth-Coherence Length. Elements of BCS Theory. Josephson Effect: AC and DC. High T_c Superconductors.

Magnetism **9 lect**

Classification of Magnetic Materials. Classical and Quantum theory of Diamagnetism and Paramagnetism. Theory of Ferromagnetic and Anti- Ferromagnetic Orders. Magnetic Resonance.

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.

PH 406: Nuclear and Particle Physics **(3 Credits)**

1. Nuclear Force:

Natural units, Non-exchange and exchange forces, Yukawa theory: nuclear force and meson exchange, Pi-Meson, Propagators, Feynman diagrams, Interaction cross section, Decay and resonance 3 Lect

2. Gamma and Beta Decay:

Theory of Gamma emission, Selection rules, Mossbauer effect, Beta decay: Fermi's four fermion interaction, Weak interaction 3 Lect

3. Feynman Diagrams and Interaction Processes:

Propagators, Feynman diagrams, Interaction cross section, Decay and Resonance. 4 Lect

4. The Dirac Equation:
Particle and antiparticles, The Klein-Gordon equation, The Dirac equation, Properties of Dirac matrices, Positive and Negative energy solutions and Feynman-Stuckelberg interpretation, Electron spin and magnetic moment, Helicity and Chirality, Helicity conservation, The Weyl equation 7 Lect

5. Conservation Laws and Quantum Numbers:
Concepts of Group theory, Parity of particles and antiparticles, Parity of pion, Charge conjugation, Time reversal and CPT invariance, CP violation and T violation, Charge conservation and Gauge invariance, Baryon and Lepton Number conservation, Isospin symmetry, Isospin of two nucleon and pion-nucleon system, Strangeness, Hypercharge, G-parity 7 Lect

6. Quarks and Hadrons:
a. Evidence of quarks, Quark spin and Color, Quark quantum numbers, Quark-antiquark states: Mesons, Light pseudoscalar mesons: pi-mesons, K-mesons and eta meson, Three quark states: Baryons, Nucleon and Hyperons, Baryon Octet and Decuplet, Heavy quark states: charm, bottom and top quarks, Heavy quarkonium states, D-meson and B-mesons 6 lect

b. Deep inelastic scattering and nucleon structure: parton model, Gluon, Strong coupling and asymptotic freedom, quark-gluon plasma 4 lect

7. Weak Interactions:
a. Classifications of weak interactions, Low energy lepton processes, Paritynon-conservation in Beta decay, V-A interaction, Pion and Muon decay, CP violation in neutral K meson 5 Lect

8. Electroweak Interactions and Overview of the Standard Model:
Particle content of the Standard Model, Electroweak Interactions, Structure of weak currents,
Glashow-Salam-Weinberg Model, Discovery of W and Z boson, Higgs boson 5 Lect

References:

1. Nuclear and Particle Physics, B. Martin, 2nd edition
2. Introduction to High Energy Physics, D. H. Perkins, 4^{th} edition
3. Introduction to Elementary Particle Physics, A. Bettini
4. Modern Elementary Particle Physics, G. Kane
5. Introduction to Elementary Particles, D. J. Griffiths
6. Quarks and Leptons, F. Halzen and A. D. Martin
7. An Introduction to the Standard Model of Particle Physics, W. N. Cottingham and D. A. Greenwood

PH 407: Introduction to Material Science and Nanotechnology (3 Credits)

I. Material Science:

1. The Structure of Materials: Introduction and Objectives, Structure of Metals and Alloys, Structure of Ceramics and Glasses, Structure of Polymers, Structure of Composites, Structure of Biologics 6 Lect

2 Thermodynamics of Condensed Phases: Thermodynamics of Metals and Alloys, Thermodynamics of Ceramics and Glasses, Thermodynamics of Polymers, Thermodynamics of Composites, Thermodynamics of Biologics 5 Lect

3. Kinetic Processes in Materials: Kinetic Processes in Metals and Alloys, Kinetic Processes in Ceramics and Glasses, Kinetic Processes in Polymers, Kinetic Processes in Composites, Kinetic Processes in Biologics 6 Lect

4. Softmatter: The colloidal system, Forces act in the colloidal system, The DLVO theory, Amphiphiles (surfactants) in solution, Interfacial films and spontaneous curvature, Micellar shapes and phase behavior, The structure of Microemulsions. Self-organization of Macromolecules 6 lect

II. Nanotechnology

1 Introduction: Nanometers, Micrometers, Millimeters, Moore's Law, Esaki's Quantum Tunneling Diode, Quantum Dots of Many Colors, GMR 100Gb Hard Drive "Read" Heads, Accelerometers in your Car, Nanopore Filters, Nanoscale Elements in Traditional Technologies 3 lect

2 Systematics of Making Things Smaller, Pre-quantum: Mechanical Frequencies Increase in Small Systems, Scaling Relations Illustrated by a Simple Harmonic Oscillator, Scaling Relations Illustrated by Simple Circuit Elements, Thermal Time Constants and Temperature Differences Decrease, Viscous Forces Become Dominant for Small Particles in Fluid Media, Frictional Forces can Disappear in Symmetric Molecular Scale Systems 4 lect

3. What are Limits to Smallness: Particle (Quantum) Nature of Matter: Photons, Electrons, Atoms, Molecules**:** Biological Examples of Nanomotors and Nanodevices, Linear Spring Motors, Linear Engines on Tracks, RotaryMotors, Ion Channels, the Nano transistors of Biology, What are the Methods for Making Small Objects?, Approaches to Assembly of Small Three-dimensional Objects, Use of DNA Strands in Guiding Self-assembly of Nanometer Size Structures 4 lect

4. Quantum Nature of the Nanoworld: Review of Quantum mechanics, Maxwell's Equations; E and B as Wavefunctions for Photons, Optical Fiber Modes, Quantum States and Energies, Barrier Tunneling, The Trapped Particle in one Dimension, Penetration of a Barrier, Escape Time from a Well, Resonant Tunneling Diode, Trapped Particles in Two and Three Dimensions: Quantum Dot, 2D Bands and Quantum Wires, One-electron Atoms, Excitons, Magnetic Moments, Magnetization and Magnetic Susceptibility, Positronium and Excitons, Fermions, Bosons and Occupation Rules. 7 lect

5. Self-assembled Nanostructures in Nature and Industry: Carbon Atom, Methane, Ethane and Octane, Ethylene, Benzene, and Acetylene, C60 Buckyball, C Nanotube (~0.5 nm), Si Nanowire (~5 nm), InAs Quantum Dot (~5 nm), AgBr Nanocrystal (0.1–2 nm), Fe_3O_4 Magnetite and Fe_3S_4Greigite Nanoparticles in Magnetotactic Bacteria, Self-assembled Monolayers on Au and Other Smooth Surfaces 4 lect

References :

1. Nanophysics and Nanotechnology - Edward L. Wolf
2. Nanoscience -Nanotechnologies and Nanophysics - C. Dupas P. Houdy M. Lahmani
3. An introduction to materials engineering and science - Brian S. Mitchell
4. Materials Science and Engineering An Introduction - William D. Callister
5. Soft Matter Physics, M. Daoud, C. E. Williams (Eds.)

For Physics Non-Major Students
Physics Non-Major Courses for Students of Departments other Than Physics.

The B.S (Honours) students of departments other than Physics will have to take at least 2 units of Physics, if they opt to take Physics as a minor course, of which at least 0.5 unit will be on laboratory experiments. Students taking more than 2 units of Physics minor course will have to take at least 1 unit of laboratory experiment distributed evenly over first and 2nd year of the 4 years. Honours course.

FIRST YEAR MINOR COURSES IN PHYSICS

1. PM 111, Mechanics and Waves **2 credits**

(i) Vectors 11 lect.
Addition and Subtraction. Unit Vectors. Scalar and Vector Products. Scalar Triple Product. Vector Triple Product. Scalar and Vector Fields. Gradient, Divergence and Curl., Greens theorem, Gauss and Stoke’s Theorems. Curvilinear coordinates.

(ii) Particle Dynamics 4 lect.
Motion in One Dimension, Motion in Two and Three Dimension, Application of Newton’s Law, Conservation of Linear Momentum, Work and Energy. Conservation Laws. Conservative Force.

(iii) Simple Harmonic Motion 6 lect
Definition. Combination of Two SHM’s. Lissajou’s Figures. Damped SHM. Forced Oscillation. Resonance. Power and Intensity of Wave Motion, Principle of Superpositoin

(iv) Wave in Elastic Media
Longitudinal vibration. Vibration of Strings. Beats. Doppler Effect.

(v) Rotational Motion 5 lect
Toque, Neowton's Law of Rotation, Moment of Intertiaof Various Soid Bodies, Parallel Axis Theorem Radius of Gyration. Angular Momentum, Kater's Pendulum.

References :

1. Physics : R. Resnick and D. Halliday (Wiley Eastern, New Delhi). Bangla translation
1. published by the Bangla Academy is also available.
2. Gases, Liquids and Solids ; D. Tabor, Cambridge University Press, Cambridge.
3. The Mechanical Properties of Matter: M.T. Sprackling.
4. 4.The General Properties of Matter: F.W. Newman and V.H.L. Searle. Edward Arrold Publishers London.
5. Properties of Matter : S. Ahmed and A.K. Nath.

2. PM 112: Properties of Matter 2 credits

(i) Gravitation Theory 7 lect
Newton's Law. Gravitational Potential. Calculation of potential. Calculation of potential and Force in Simple Cases. Escape Velocity. PlanckMass.

(ii) Elementary Theory of Elasticity 7 lect
Hooke's Law. Elastic Modulii. Relations between the Modulii. Bending of Beams, Torsion.

(iii) Surface Tension 5 lect
Adhesive Force. Cohesive Force. Molecular Theory of Surface Tension.
Capillarity. Surface Tension of a Mercury Drop. Variation of Surface Tension with Temperature.

(iv) Viscosity 5 lect
Newton's Law of Streamline Flow. Poiseulle's Formula. Applications.
Variation of Viscosity with Temperature.

(v) Fluid Dynamics 5 lect
Streamline Flow. Turbulence. Reynold's Number. Bernoulli's Theorem Applications.

References :

1. Physics : R. Resnick and D. Halliday (Wiley Eastern, New Delhi). Bangla translation
1. published by the Bangla Academy is also available.
2. Gases, Liquids and Solids ; D. Tabor, Cambridge University Press, Cambridge.
3. The Mechanical Properties of Matter : M.T. Sprackling.
4. 4.The General Properties of Matter : F.W. Newman and V.H.L. Searle. Edward Arrold Publishers London.
5. Properties of Matter : S. Ahmed and A.K. Nath.

2. PM 122 : Electricity and Magnetism **2 credits**

(i) Electrostatics 10 lect

Electric Intensity and Potential. Gauss's Law. Electric Dipole. Density of Charge in a Polarised Dielectric. Gauss's Law for charges in a Dielectric. Capacitance Co-efficients of Potential, Capacitance and Induction Energy of Charged Systems. Electrical Images.

(ii) Magnetostatics 2 lect

Gauss's Law. Magnetic Dipole. Energy in a Magnetic Field.

(iii) Direct Current 4 lect

Current and Electromotive Force. Ohm's Law. Combination of Resistances and Kirchhoff's Law's Wheatstone Bridge.

(iv) Magnetic Field of a Current and Ampere's Law. Biot-Savart Law. Magnetic Fields of Simple Circuits. Galvanometers. Lorents Force. CRT. 5 lect

(v) Electromagnetic Induction 4 lect

Faraday's Law. Self-Inductance. Mutual Inductance.

(vi) Alternating Current 5 lect

Generation of AC. RMS Value. Power Factor. CR and LR Circuits. Gain, Decible.

References :

1. Physics : R, Resnick and D. Halliday, Wiley Eastern, New Delhi.
2. Principles of Electricity : L. Page and N.L. Adams. D.Van Nostrand Company, N.J.
3. Electricity and Magnetism : S.G. Starling, Longmann-Green and Co., London.
4. Electromagnetic Fields and waves : Paul Lorrain and Dale Corson. D.B. Taraporevala Sons and Co., Bombay.
5. Bidyat O Chumbak, A.M. Harun ar Rashid ; Techno Mission, Gulshan, Dhaka.
6. Fundations of Electromagnetic Theory : John R. Reitz, F.J. Milford and R.W. Christy Addison- Wesley. Mass, U.S.A.
7. Concepts of Electricity and Magnetism, M.S. Huq-A.K. Rafiqullah and A.K.Roy, Students' Publications, Dhaka

SECOND YEAR NON-MAJOR COURSES IN PHYSICS

1. PM-211: Optics **2 credits**

(i) Geometrical Optics 5 lect

Spherical Aberration. Chromatic Aberration. Astigmatism. Ray Matrices. Applications.

(ii) Coherence 5 lect

First Order Coherence, Spatial and temporal coherence Higher Order Coherence.

(iii) Interference Of Waves 10 lect

Principle of Superposition. Phase Velocity and Group velocity: Huygens Principle. Young's Experiment. Biprism. Newton's Rings Michelson's Interferometer. Shapes and Positions of Fringes.

(iv) Diffraction 10 lect

Diffraction. Fraunhofer Diffraction. Single, Double and Multiple, Slits. Diffraction grating. spectrometer. resolving Power.

References :

1. Optics; E. Hecht and A. Zajac; Addison-Wesley
2. Optics; Rossi.
3. Modern Optics by Guenther
4. Fundamentals of Optics: F.A. Jenkins and H.E. White. McGraw-Hill, Singapore.
5. Vibrations and Waves A.P. French, Nelson, London
6. Principles of Optics; M Born and E. Wolf. Pergamon Press

2. PM-223: Electricity and Magnetism 2 credits

(i) Varying Current
Transients, Decay and Growth of Current. LCR Circuit 4 lect

(ii) Thermo-electricity
Seebeck, Peltier and Thomson effects. Thermo couple. 4 lect

(iii) Magnetic Properties of materials magnetisation. B-H Curve. 3 lect

(iv) Alternating current. 7 lect
Use of Complex variable. LCR Circuits. Series and Parallel circuit. Q-Factor. Transformer.

(v) Semiconductors and rectification. 12 lect
Energy bands (Qualitative). Holes. Intrinsic and Extrinsic Semiconductors. P-N. Junction. Depletion Layer. Diode Equation and Characteristics. Half Wave and Full-Wave rectification.

References :

1. Physics, R. Resniek and D. Halliday; Wiley Eastern, New Delhi.
2. Principles of Electricity; L. Page and N.L. Adams, D. Van Nostrand Company. N.J.
3. Electricity and Magnetism : S.G. Starling; Longman Green and Co. London.
4. Electromagnetic Fields and Waves: Paul Lorrain and Dale Corson. D.B. Taraporevala Sons and Co., Bombay.
5. Foundations of Electromagnetic Theory: John R. Reitz, F.J Milford and R.W. Christy. Addison-Wesley, Mass, U.S.A.

PM- 224: THERMODYNAMICS 2 credits

1.Introduction: Application Areas of Thermodynamics, Units, Systems and Control Volumes, Density , State and Equilibrium, Proceses and Cycles, Temperature scales and the Zeroth law of Thermodynamics, Limitations of thermodynamics model.

2. Energy Conversion and General Energy Analysis: Froms of Energy, Some Physical Insight to Internal Energy, Mechanical Energy, Energy Transfer by Heat, The First Law of Thermodynamics, Energy Conversion Efficiencies, Energy and Environment.
3. Properties of Pure Substances: Pure Substance, Phases of a Pure Substance, Phase-Change Processes of Pure Substances, Property Tables, The Ideal-Gas Equation of State, Other Equations of State.
4. Energy Analysis of Closed Systems: Energy Balance for Closed Systems, Internal Energy, Enthalpy and Specific Heats of Ideal Gases, Solids and Liquids, Thermodynamic Aspects of Biological Systems.
5.The Second Law of Thermodynamic: Introduction to the Second Law, Thermal Energy Reservoirs, Heat Engines Reversible and Irreversible Process, The Carnot Cycle, The Carnot Principles,

Entropy, The Increase of Entropy Principle, Entropy Change of Pure Substances, Entropy Change of Liquids and Solids.

Reference:

1. Fundamentals of Thermodynamics, 6th Edition, Richard E. Sonntag, Claus Borgnakke, Gordon J. Van Wylen, Wiley.
2. Themodynamics-An Engineering Approach, Yunus A. Cengle & Michael Boles.
3. Thermodynamics of Natural Systems: 2nd Edition, Greg Anderson, Cambridge University Press.
4. Heat and Thermodynamics, Mark W. Zemansky and Richard H. Dittman, McGraw-Hill.
5. Basic and Applied Thermodynamics, PK Nag, McGraw-Hill.

PML 103 : 1st Year Physics Minor Practical 2 credits

1. Determination of the Value of g by compound pendulum.
2. Determination of the spring constant and effective mass of a given spiral spring and hence to calculate the rigidity modulus of the material of the spring.
3. Determination of Young's Modulus and Modulus of Rigidity of the material of a wire by (Searle's) dynamic method.
4. Detarmination of surface tension of water at room temperature by capillary tube method.
5. Determination of surface tension of mercury by Quincke's method.
6. Variation of viscosity of water with temperature.
7. Determination of the specific heat of a solid by the method of mixture with radiation correction.
8. Determination of the specific heat of a liquid by the method of cooling.
9. Varification of the laws of transveres vibration of a string. n-1, 1-T curves.

PML 204: 2nd Year Physics Non-Major Practical 2 credits

1. Experiments with a post office box:
   (i) Determination of an unknown resistance
   (ii) verification of the laws of combination of resistances.
2. Determination of the galvanometer resistance by half-deflection method.
3. Determination of the galvanometer resistance by Kelvin's method.
4. Determination of low resistance by the method of fall of potential.
5. Measurement of high resistance by the method of deflection.
6. Comparison of emf of two cells.
7. Measurement of the angle of a prism using a spectrometer and determination of refractive index of the materials of the prism by minimum deviation method.
8. Determination of wavelength of sodium light by means of Newton's rings.
9. Determination of wavelength of sodium light by using a biprism.
10. 10.Determination of wavelength of light using a plane diffraction grating