

PHYSICS

Third Semester Unitwise Course Distribution

	NKD	HB	PB
PHY-HC-3016 Mathematical Physics II		Unit I: Forbenius Method an...(18) Unit II: Partial Differential Eq...(14) Unit III: Some Special Integr...(04) Unit IV: Matrix (15) Unit V: Fourier Series (09)	
PHY-HC-3026 Thermal Physics	Unit I: Zeroth Law and Fir... (08) Unit II: Second Law of The...(10) Unit III: Entropy (07) Unit IV: Thermodynamic Po...(07) Unit V: Maxwell's Thermod...(07)		Unit VI: Distribution of veloci....(07) Unit VII: Molecular Collisions (04) Unit VIII: Real Gases (10)
PHY-HC-3036 Digital Sys. and Appl.	Unit III: Digital Circuits (06) Unit IV: Boolean Algebra (06) Unit V: Data Processing Ci....(04) Unit VI: Arithmetic Circuits (05)		Unit I: Introduction to CRO (03) Unit II: Integrated Circuits (03) Unit VII: Sequential Circuits (06) Unit VIII: Timers: IC 555 (03) Unit IX: Shift Registers (02) Unit X: Counters (4 bits) (04) Unt XI: Computer Organisa....(06) Unit XII: Intel 8085 Micropro....(08) Unit XIII: Introduction to Ass....(04)
PHY-HG/RC-3016 Thermal Phy. & Stat. Mech.	Unit I: Laws of Thermodyna...(22) Unit II: Thermodynamic Pot...(10)		Unit III: Kinetic Theory of Ga...(10) Unit IV: Theory of Radiation (06) Unit V: Statistical Mechanics (12)
PHY-SE-3024 Comp. Phys. Skills		Unit I: Introduction (04) Unit II: Basics of Scientific P...(10) Unit III: Scientific Programm...(18) Unit IV: Visualization (05)	

PHY-HC-3016

Mathematical Physics II

Total Lectures: 60 Credits: 6 (Theory: 04, Lab: 02)

Course Outcome: After successful completion of the course, students will be able to solve differential equation using power series solution method, solve differential equation using separation of variables method, special integrals, different properties of matrix, Fourier series.

Theory

Unit I: Frobenius Method and Special Functions (Lectures 18)

Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equations. Legendre, Hermite and Laguerre Differential Equations. Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations. Expansion of function in a series of Legendre Polynomials.

Unit II: Partial Differential Equations (Lectures 14)

Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. Wave equation and its solution for vibrational modes of a stretched string, rectangular and circular membranes. Diffusion Equation.

Unit III: Some Special Integrals (Lectures 04)

Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions.

Unit IV: Matrix (Lectures 15)

Matrix algebra using index notation, Properties of matrices, Special matrix with their properties: Transpose matrix, complex conjugate matrix, Hermitian matrix, Anti-Hermitian matrix, special square matrix, unit matrix, diagonal matrix, co-factor matrix, adjoint of a matrix, self-adjoint matrix, symmetric matrix, anti-symmetric matrix, unitary matrix, orthogonal matrix, trace of a matrix, inverse matrix. Determinant, Rank, Eigen value, Eigen vector and diagonalisation of matrix.

Unit V: Fourier Series (Lectures 09)

Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Complex representation of Fourier series. Expansion of functions with arbitrary period. Application to square and triangular waves.

Reference Books

- [1] Mathematical Methods for Physicists, G. B. Arfken, H. J. Weber, and F. E. Harris, 2013, 7th Edn., Elsevier.
- [2] An introduction to ordinary differential equations, E. A. Coddington, 2009, PHI
- [3] Learning Differential Equations, George F. Simmons, 2007, McGraw Hill.
- [4] Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
- [5] Mathematical Methods for Scientists and Engineers, D. A. McQuarrie, 2003, Viva Book
- [6] Advanced Engineering Mathematics, D. G. Zill and W. S. Wright, 5 Ed., 2012, Jones and Bartlett Learning
- [7] Mathematical Physics, Goswami, 1st edition, Cengage Learning
- [8] Engineering Mathematics, S. Pal and S. C. Bhunia, 2015, Oxford University Press
- [9] Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India
- [10] Essential Mathematical Methods, K. F. Riley and M. P. Hobson, 2011, Cambridge University Press

Lab

Aim

The aim of this Lab is to use the computational methods to solve physical problems. Course will consist of lectures (both theory and practical) in the Lab. Evaluation done not on the programming but on the basis of formulating the problem.

Introduction to Numerical computation softwares Introduction to Scilab/Mathematica/Matlab/Python, Advantages and disadvantages, Scilab / Mathematica / Matlab/ Python environment, Command window, Figure window, Edit window, Variables and arrays, Initialising variables in Scilab / Mathematica / Matlab/ Python, Multidimensional arrays, Subarray, Special values, Displaying output data, data file, Scalar and array operations, Hierarchy of operations, Built in Scilab / Mathematica / Matlab/Python functions, Introduction to plotting, 2D and 3D plotting.

Curve fitting, Least square fit, Goodness of fit, standard deviation Ohms law to calculate R , Hooke's law to calculate spring constant.

Solution of Linear system of equations Solution of Linear system of equations by Gauss elimination method and Gauss Seidal method. Diagonalisation of matrices, Inverse of a matrix, Eigen vectors, eigenvalues problems. Solution of mesh equations of electric circuits (3 meshes) Solution of coupled spring mass systems (3 masses).

Generation of Special functions Generation of Special functions using User defined functions in Scilab / Mathematica / Matlab. Generating and plotting Legendre Polynomials Generating and plotting Hermite function.

First order ODE Solution of first order Differential equation Euler, modified Euler and Runge-Kutta second order methods. First order differential equation (a) Current in RC, LC circuits with DC source (b) Classical equations of motion.

Second order ODE Second order differential equation. Fixed difference method. Second order Differential Equation (a) Harmonic oscillator (no friction) (b) Damped Harmonic oscillator (c) Over damped (d) Critical damped.

Partial Differential Equation (PDE) Solution of Partial Differential Equation: (a) Wave equation (b) Heat equation.

PHY-HC-3026

Thermal Physics

Total Lectures: 60 Credits: 6 (Theory: 04, Lab:02)

Course Outcome: Upon successful completion, students will have the knowledge and skills to identify and describe the statistical nature of concepts and laws in thermodynamics, in particular: entropy, temperature, Thermodynamics potentials, Free energies, Maxwell's relations in thermodynamics, behaviour of real gases.

Theory

Introduction to Thermodynamics

Unit I: Zeroth and First Law of Thermodynamics (Lectures 08)

Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between C_p and C_v , Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Coefficient.

Unit II: Second Law of Thermodynamics (Lectures 10)

Reversible and Irreversible process with examples. Conversion of Work into Heat and Heat into Work. Heat Engines. Carnot's Cycle, Carnot engine & efficiency. Refrigerator & coefficient of performance, 2nd Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence. Carnot's Theorem. Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale.

Unit III: Entropy (Lectures 07)

Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. Entropy of the Universe. Entropy Changes in Reversible and Irreversible Processes. Principle of Increase of Entropy. Temperature-Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero.

Unit IV: Thermodynamic Potentials (Lectures 07)

Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Their Definitions, Properties and Applications. Surface Films and Variation of Surface Tension with Temperature. Magnetic Work, Cooling due to adiabatic demagnetization, First and second order Phase Transitions with examples, Clausius Clapeyron Equation and Ehrenfest equations.

Unit V: Maxwell's Thermodynamic Relations (Lectures 07)

Derivations and applications of Maxwell's Relations, Maxwell's Relations:(1) Clausius Clapeyron equation, (2) Values of C_p-C_v , (3) TdS Equations, (4) Joule-Kelvin coefficient for Ideal and Van der Waal Gases, (5) Energy equations, (6) Change of Temperature during Adiabatic Process.

Kinetic Theory of Gases

Unit VI: Distribution of Velocities (Lectures 07)

Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Doppler Broadening of Spectral Lines and Stern's Experiment. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific heats of Gases.

Unit VII: Molecular Collisions (Lectures 04)

Mean Free Path. Collision Probability. Estimates of Mean Free Path. Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance.

Unit VIII: Real Gases (Lectures 10)

Behaviour of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation. Andrew's Experiments on CO_2 Gas. Critical Constants. Continuity of Liquid and Gaseous State. Vapour and Gas. Boyle Temperature. Van der Waal's Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Comparison with Experimental Curves. P-V Diagrams. Joule's Experiment. Free Adiabatic Expansion of a Perfect Gas. Joule-Thomson Porous Plug Experiment. Joule-Thomson Effect for Real and Van der Waal Gases. Temperature of Inversion. Joule-Thomson Cooling.

Lab

1. To determine Mechanical Equivalent of Heat, J , by Callender and Barne's constant flow method.
2. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.
3. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
4. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.
5. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).
6. To study the variation of Thermo-emf of a Thermocouple with Difference of Temperature of its Two Junctions.
7. To calibrate a thermocouple to measure temperature in a specified Range using (1) Null Method, (2) Direct measurement using Op-Amp difference amplifier and to determine Neutral Temperature.

Reference Books

- [1] Heat and Thermodynamics, M. W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
- [2] A Treatise on Heat, Meghnad Saha, and B. N. Srivastava, 1958, Indian Press
- [3] Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
- [4] Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
- [5] Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.
- [6] Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford University Press
- [7] Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications.

PHY-HC-3036

Digital Systems & Applications

Total Lectures: 60 Credits: 6 (Theory: 04, Lab: 02)

Course Outcome: After successful completion of the course student will be able to understand the working principle of CRO, develop a digital logic and apply it to solve real life problems, Analyze, design and implement combinational logic circuits, Classify different semiconductor memories, Analyze, design and implement sequential logic circuits, Analyze digital system design using PLD, Simulate and implement combinational and sequential circuits.

Theory

Unit I: Introduction to CRO (Lectures 03)

Block Diagram of CRO. Electron Gun, Deflection System and Time Base. Deflection Sensitivity. Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference.

Unit II: Integrated Circuits (qualitative treatment only) (Lectures 03)

Active & Passive components. Discrete components. Wafer. Chip. Advantages and drawbacks of ICs. Scale of integration: SSI, MSI, LSI and VLSI (basic idea and definitions only). Classification of ICs. Examples of Linear and Digital ICs.

Unit III: Digital Circuits (Lectures 06)

Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. AND, OR and NOT Gates (realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates.

Unit IV: Boolean Algebra (Lectures 06)

De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Idea of Minterms and Maxterms. Conversion of a Truth table into Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map.

Unit V: Data Processing Circuits (Lectures 04)

Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders.

Unit VI: Arithmetic Circuits (Lectures 05)

Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor.

Unit VII: Sequential Circuits (Lectures 06)

SR, D, and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip-Flops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. M/S JK Flip-Flop.

Unit VIII: Timers: IC 555 (Lectures 03)

Block diagram and applications: Astable multivibrator and Monostable multivibrator.

Unit IX: Shift Registers (Lectures 02)

Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers (only up to 4 bits)

Unit X: Counters (4 bits) (Lectures 04)

Ring Counter, Asynchronous counters, Decade Counter. Synchronous Counter.

Unit XI: Computer Organization (Lectures 06)

Input/Output Devices. Data storage (idea of RAM and ROM). Computer memory. Memory organization & addressing.

Unit XII: Intel 8085 Microprocessor Architecture (Lectures 08)

Main features of 8085. Block diagram. Components. Pin-out diagram. Buses. Registers. ALU. Memory. Stack memory. Timing & Control circuitry.

Unit XIII: Introduction to Assembly Language (Lectures 04)

1 byte, 2 byte, & 3 byte instructions.

Lab

A minimum of eight experiments to be done.

1. To measure (a) Voltage, and (b) Time period of a periodic waveform using CRO.
2. To test a Diode and Transistor using a Multimeter.
3. To design a switch (NOT gate) using a transistor.
4. To verify and design AND, OR, NOT and XOR gates using NAND gates.
5. To design a combinational logic system for a specified Truth Table.
6. To convert a Boolean expression into logic circuit and design it using logic gate ICs.
7. Half Adder, Full Adder and 4-bit binary Adder.
8. Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder IC.
9. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.
10. To build JK Master-slave flip-flop using Flip-Flop ICs .
11. To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timing diagram.
12. To make a 4-bit Shift Register (serial and parallel) using D-type/JK Flip-Flop ICs.
13. To design an astable multivibrator of given specifications using 555 Timer.
14. To design a monostable multivibrator of given specifications using 555 Timer.
15. Write the following programs using 8085 Microprocessor
 - (a) Addition and subtraction of numbers using direct addressing mode
 - (b) Addition and subtraction of numbers using indirect addressing mode
 - (c) Multiplication by repeated addition
 - (d) Division by repeated subtraction
 - (e) Handling of 16-bit Numbers
 - (f) Use of CALL and RETURN Instruction
 - (g) Block data handling

Reference Books

- [1] Digital Principles and Applications, A. P. Malvino, D. P. Leach and Saha, 7th Ed., 2011, Tata McGraw
- [2] Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
- [3] Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
- [4] Digital Electronics G. K. Kharate ,2010, Oxford University Press
- [5] Digital Systems: Principles & Applications, R. J. Tocci, N. S. Widmer, 2001, PHI Learning
- [6] Logic circuit design, Shimon P. Vingron, 2012, Springer.
- [7] Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
- [8] Digital Electronics, S. K. Mandal, 2010, 1st edition, McGraw Hill
- [9] Microprocessor Architecture Programming & applications with 8085, 2002, R. S. Goankar, Prentice Hall.

Honours Generic Paper

PHY-HG-3016 (PHY-RC-3016)

Thermal Physics & Statistical Mechanics

Total Lectures: 60 Credits: 6 (Theory: 04, Lab : 02)

Course outcome: Upon completion of this course, students are expected learn the basic concepts of thermodynamics, the first and the second law of thermodynamics, the concept of entropy and the associated theorems, the thermodynamic potentials and their physical interpretations, Maxwell's thermodynamic relations, fundamentals of the kinetic theory of gases, Maxwell-Boltzmann distribution law, equipartition of energies, mean free path of molecular collisions, viscosity, thermal conductivity, diffusion and Brownian motion, black body radiations, Stefan-Boltzmann's law, Rayleigh-Jean's law and Planck's law and their significances, viz., the Bose-Einstein statistics and the Fermi-Dirac statistics. In the laboratory course, the students will be able to Measure of Planck's constant using black body radiation, determine Stefan's Constant, coefficient of thermal conductivity of a bad conductor and a good conductor, determine the temperature coefficient of resistance, study variation of thermo emf across two junctions of a thermocouple with temperature etc.

Theory

Unit I : Laws of Thermodynamics (Lectures 22)

Thermodynamic Description of system: Zeroth Law of thermodynamics and temperature. First law and internal energy, conversion of heat into work, Various Thermodynamical Processes, Applications of First Law: General Relation between CP & CV , Work Done during Isothermal and Adiabatic Processes, Compressibility & Expansion Coefficient, Reversible & irreversible processes, Second law & Entropy, Carnot's cycle & theorem, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero.

Unit II : Thermodynamic Potentials (Lectures 10)

Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations & applications - Joule-Thompson Effect, Clausius- Clapeyron Equation, Expression for (CP — CV), CP/CV , T dS equations.

Unit III : Kinetic Theory of Gases (Lectures 10)

Derivation of Maxwell's law of distribution of velocities and its experimental verification, Mean free path (Zeroth Order), Transport Phenomena: Viscosity, Conduction and Diffusion (for vertical case), Law of equipartition of energy (no derivation) and its applications to specific heat of gases; mono-atomic and diatomic gases.

Unit IV : Theory of Radiation (Lectures 06)

Blackbody radiation, Spectral distribution, Concept of Energy Density, Derivation of Planck's law, Deduction of Wien's distribution law, Rayleigh-Jeans Law, Stefan Boltzmann Law and Wien's displacement law from Planck's law.

Unit V : Statistical Mechanics (Lectures 12)

Phase space, Macrostate and Microstate, Entropy and Thermodynamic probability, Maxwell-Boltzmann law - distribution of velocity – Quantum statistics – Fermi-Dirac distribution law – electron gas – Bose-Einstein distribution law – photon gas – comparison of three statistics.

Reference Books

- [1] Heat and Thermodynamics, M. W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
- [2] A Treatise on Heat, Meghnad Saha, and B. N.Srivastava, 1958, Indian Press
- [3] Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
- [4] Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
- [5] Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.
- [6] Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford University Press
- [7] Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications.
- [8] Statistical Mechanics, R. K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
- [9] Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill
- [10] Statistical and Thermal Physics, S. Lokanathan and R. S. Gambhir. 1991, Prentice Hall

Lab

1. To determine Mechanical Equivalent of Heat, J , by Callender and Barne's constant flow method.
2. Measurement of Planck's constant using black body radiation.
3. To determine Stefan's Constant.
4. To determine the coefficient of thermal conductivity of copper by Searle's Apparatus.
5. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
6. To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.
7. To determine the temperature co-efficient of resistance by Platinum resistance thermometer.
8. To study the variation of thermo emf across two junctions of a thermocouple with temperature.
9. To record and analyze the cooling temperature of an hot object as a function of time using a thermocouple and suitable data acquisition system.
10. To calibrate Resistance Temperature Device (RTD) using Null Method/Off-Balance Bridge.

PHY-SE-3024

COMPUTATIONAL PHYSICS SKILLS

Credits: 4 (Theory: 2, Lab: 2)
Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor of Physics with adequate knowledge on computer programming/An MCA/M.Sc. with DCA.

The aim of this course is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics.

- *Highlights the use of computational methods to solve physical problems*
- *Use of computer language as a tool in solving physics problems (applications)*
- *Course will consist of hands on training on the Problem solving on Computers.*

Theory

Unit I: Introduction (Lectures 3)

Importance of computers in Physics, paradigm for solving physics problems for solution. Introduction to various OS, Linux OS such as RedHat, Ubuntu, Scientific Linux, Usage of Basic linux commands. Text editors such as vi and Emacs.

Unit II: Basics of Scientific Programming (Lectures 4)

Algorithms and Flowcharts: Algorithm: Definition, properties and development. Flowchart: Concept of flowchart, symbols, guidelines, types. Examples: Cartesian to Spherical Polar Coordinates, Roots of Quadratic Equation, Sum of two matrices, Sum and Product of a finite series, calculation of $\sin(x)$ as a series, algorithm for plotting (1) Lissajous figures and (2) trajectory of a projectile thrown at an angle with the horizontal.

Unit III: Scientific Programming (Lectures 18)

Variables and Formatting: Introduction to HLL, Concepts of a Compiler. Character Set, Constants and their types, Variables and their types, Keywords, Variable Declaration and concept of instruction and program. Operators: Arithmetic, Relational, Logical and Assignment Operators. Expressions: Arithmetic, Relational, Logical, Character and Assignment Expressions. I/O Statements (unformatted/formatted), Executable and Non-Executable Statements, Layout of a Program, Format of writing Program and concept of coding, Initialization and Replacement Logic. Examples from physics problems.

Control Statements, Functions, and Subroutines: Types of Logic (Sequential, Selection, Repetition), Branching Statements (Logical IF, Arithmetic IF, Block IF, Nested Block IF, SELECT CASE and ELSE IF Ladder statements), Looping Statements (DO-CONTINUE, DO-ENDDO, DO-WHILE, Implied and Nested DO Loops), Jumping Statements (Unconditional GOTO, Computed GOTO, Assigned GOTO) Subscripted Variables (Arrays: Types of Arrays, DIMENSION Statement, Reading and Writing Arrays), Functions and Subroutines (Arithmetic Statement Function, Function Subprogram and Subroutine), RETURN, CALL, COMMON and EQUIVALENCE Statements), Structure, Disk I/O Statements, open a file, writing in a file, reading from a file.

Unit V: Visualization (Lectures 5)

Introduction to graphical analysis and its limitations. Introduction to Gnuplot. importance of visualization of computational and computational data, basic Gnuplot commands: simple plots, plotting data from a file, saving and exporting, multiple data sets per file, curve fitting – straight line, polynomials, user defined function. Physics with Gnuplot (equations, building functions, user defined variables and functions), Understanding data with Gnuplot

Reference Books:

- [1] Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.
- [2] Computer Programming in Fortran 77". V. Rajaraman (Publisher: PHI).
- [3] "LaTeX—A Document Preparation System", Leslie Lamport (Second Edition, Addison-Wesley, 1994).
- [4] Gnuplot in action: understanding data with graphs, Philip K Janert, (Manning 2010)
- [5] Schaum's Outline of Theory and Problems of Programming with Fortran, S Lipsdutz and A Poe, 1986Mc-Graw Hill Book Co.
- [6] Computational Physics: An Introduction, R. C. Verma, et al. New Age International Publishers, New Delhi(1999)
- [7] A first course in Numerical Methods, U.M. Ascher and C. Greif, 2012, PHI Learning Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn., 2007, Wiley India Edition.

Hands on exercises:

1. Usage of GUI Windows, Linux Commands, familiarity with DOS commands and working in an editor.
2. To print out all natural even/ odd numbers between given limits.
3. To find maximum, minimum and range of a given set of numbers.
4. Calculating Euler number using $\exp(x)$ series evaluated at $x=1$
5. To compile a frequency distribution and evaluate mean, standard deviation etc.
6. To evaluate sum of finite series and the area under a curve.
7. To find the product of two matrices
8. To find a set of prime numbers and Fibonacci series.
9. To write program to open a file and generate data for plotting using Gnuplot.
10. Plotting trajectory of a projectile projected horizontally.
11. Plotting trajectory of a projectile projected making an angle with the horizontally.
12. Creating an input Gnuplot file for plotting a data and saving the output for seeing on the screen. Saving it as an eps file and as a pdf file.
13. To find the roots of a quadratic equation.
14. Motion of a projectile using simulation and plot the output for visualization.
15. Numerical solution of equation of motion of simple harmonic oscillator and plot the outputs for visualization.
16. Motion of particle in a central force field and plot the output for visualization.