Syllabus contents for the B.Sc. Physics (Hon's), 3rd Semester during Monsoon Semester (2020-21)

CODE: PAS201
Type: Core Course
Credit: 4
MATHEMATICAL PHYSICS-II

Fourier Series:

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. Expansion of non-periodic functions over an interval. Even and odd functions and their Fourier expansions. Application. Summing of Infinite Series. Term-by-Term differentiation and integration of Fourier Series. Parseval Identity. **(12 Lectures)**

Frobenius Method and Special Functions:

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

Integrals:

Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Bessel Functions of the First Kind: Generating Function, simple recurrence relations. Zeros of Bessel Functions (Jo(x) and J1(x))and Orthogonality. **(30 Lectures)**

Partial Differential Equations:

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. **(18 Lectures)**

CODE: PAS201 L
Type: Core Course
Credit: 2
MATHEMATICAL PHYSICS LAB-II

60 Lectures

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

Topics	**Description with Applications**
Introduction to Numerical computation software Scilab	Introduction to Scilab, Advantages and disadvantages,Scilab environment, Command window, Figure window, Edit window, Variables and arrays, Initialising variables in Scilab, Multidimensional arrays, Subarray, Special values, Displaying output data, data file, Scalar and array operations, Hierarchy of operations, Built in Scilab functions, Introduction to plotting, 2D and 3D plotting (2), Branching Statements and program design, Relational & logical operators, the while loop, for loop, details of loop operations, break & continue statements, nested loops, logical arrays and vectorization (2) User defined functions, Introduction to Scilab functions, Variable passing in Scilab, optional arguments, preserving data between calls to a function, Complex and Character data, string function, Multidimensional arrays (2) an introduction to Scilab file processing, file opening and closing, Binary I/o functions, comparing binary and formatted functions, Numerical methods and developing the skills of writing a program (2).
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 by Gauss elimination method and Gauss Seidal method. Diagonalization of matrices, Inverse of a matrix, Eigen vectors, eigen values problems	Solution of mesh equations of electric circuits (3 meshes) Solution of coupled spring mass systems (3 masses)

Solution of ODE
 	
First order Differential equation Euler, modified Euler and Runge-Kutta second order methods
 	
Second order differential equation
Fixed difference method
	First order differential equation
	• Radioactive decay
	• Current in RC, LC circuits with DC source
	• Newton's law of cooling
	• Classical equations of motion
	Second order Differential Equation
	• Harmonic oscillator (no friction)
	• Damped Harmonic oscillator
	    • Over damped
	    • Critical damped
	    • Oscillatory
	• Forced Harmonic oscillator
	    • Transient and
	    • Steady state solution
	• Apply above to LCR circuits also

Using Scicos / xcos	• Generating square wave, sine wave, saw tooth wave • Solution to harmonic oscillator • Study of beat phenomenon • Phase space plots

Reference Books:

- Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press
- Complex Variables, A.S. Fokas & M.J. Ablowitz, 8th Ed., 2011, Cambridge Univ. Press
- First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A.V. Wouwer, P. Saucez, C.V. Fernández. 2014 Springer
- Scilab by example: M. Affouf 2012, ISBN: 978-1479203444
- Scilab (A free software to Matlab): H.Ramchandran, A.S.Nair. 2011 S.Chand & Company
- Scilab Image Processing: Lambert M. Surhone. 2010 Betascript Publishing

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CODE: PAS 202
Type: Core Course
Credit: 4
THER MAL PHYSICS

Zeroth and First Law of Thermodynamics:

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 CP and CV, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Co-efficient.
(8 Lectures)

Second Law of Thermodynamics:

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: Thermody- namic Scale of Temperature and its Equivalence to Perfect Gas Scale**.** **(10 Lectures)**

Entropy:

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. **(7 Lectures)**

Thermodynamic Potentials:

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. **(7 Lectures)**

Maxwell's Thermodynamic Relations:

Derivations and applications of Maxwell's Relations, Maxwell's Relations:(1) Clausius Clapeyron equation, (2) Values of Cp-Cv, (3) TdS Equations, (4) Joule-Kelvin coefficient for Ideal and Van der Waal Gases, (5) Energy equations, (6) Change of Temperature during Adiabatic Process. **(7 Lectures)**
Kinetic Theory of Gases

Distribution of Velocities:

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. **(7 Lectures)**

Molecular Collisions:

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. **(4 Lectures)**

Real Gases:

Behavior of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation. Andrew's Experiments on CO2 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.
(10 Lectures)

CODE: PAS 202 L
Type: Core Course
Credit: 2
THER MAL PHYSICS LAB

60 Lectures

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

- Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Laboratory Manual of Physics for undergraduate classes,D.P.Khandelwal,1985, Vani Pub.

CODE: PAS203

Type: Core Course

Credit: 4

DIGITAL SYSTEMS AND APPLICATIONS

Integrated Circuits:

(Qualitative treatment only): 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 lCs. **(4 Lectures)**

Digital Circuits:

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 and application as Parity Checkers. **(7 Lectures)**

Boolean algebra:

De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Alge- bra. 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. **(7 Lectures)**

Data processing circuits:

Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders. **(5 Lectures)**

Arithmetic Circuits:

Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half Full Subtractors, 4-bit binary Adder/Subtractor. **(6 Lectures)**

Sequential Circuits:

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. **(7 Lectures)**

Timers:

IC 555: block diagram and applications: Astable multivibrator and Monostable multivibrator. **(4 Lectures)**

Shift registers:

Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers (only up to 4 bits). **(3 Lectures)**

Counters(4 bits):

Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter. **(5 Lectures)**

Intel 8085 Microprocessor Architecture:

Main features of 8085. Block diagram. Components. Pin-out diagram. Buses. Registers. ALU. Memory. Stack memory. Timing Control circuitry. Timing states. Instruction cycle, Timing diagram of MOV and MVI. **(8 Lectures)**

Introduction to Assembly Language:

1 byte, 2 byte 3 byte instructions. **(4 Lectures)**

CODE: PAS203 L

Type: Core Course

Credit: 2

DIGITAL SYSTEMS AND APPLICATIONS LAB

60 Lectures

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. To minimize a given logic circuit.
8. Half Adder, Full Adder and 4-bit binary Adder.
9. Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder I.C.

10. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.
11. To build JK Master-slave flip-flop using Flip-Flop ICs
12. To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timing diagram.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.
h) Other programs (e.g. Parity Check, using interrupts, etc.).

Reference Books:

- Modern Digital Electronics, R.P. Jain, 4th Edition, 2010, Tata McGraw Hill.
- Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
- Microprocessor Architecture Programming and applications with 8085, R.S. Goankar, 2002, Prentice Hall.
- Microprocessor 8085:Architecture, Programming and interfacing, A. Wadhwa, 2010, PHI Learning.

CODE: MTH 101
Type: Core Course
Credit: 4
Mathematics-I

Liner Vector Spaces: Abstract Systems. Binary Operations and Relations. Introduction to Groups and Fields. Vector Spaces and Subspaces. Linear Independence and Dependence of Vectors Basis and Dimensions of a Vector Space. Change of basis Homomorphism and Isomorphism of Vector Spaces. Linear Transformations. Algebra of Linear Transformations Non-singular Transformations, Representation of Linear Transformation by Matrices.
(12 Lectures)

Matrices: Addition and Multiplication of Matrices. Null Matrices. Diagonal, Scalar and Unit Matrices. Upper Triangular and Lower-Triangular Matrices. Transpose of a Matrix Symmetric and Skew-Symmetrie Matrices. Conjugate of Matrix.Hermitian and Skew- Hermitian Matrices. Singular and Non-Singular matrices. Orthogonal and Unitary Matrices. Trace of a Matrix. Inner Product.
(8 Lectures)

Eigenvalues and Eigenvectors Cayley -Hamilton Theorem. Diagonalization of Matrices. Solutions of Coupled Linear Ordinary Differential Equations. Functions of a Matrix**.** **(10 Lectures)**

Carteslan Tentars: Transformation of Co-ordinates. Einstein's Summation Convention Relation between Direction Cosines. Tensors. Algebra of Tensors. Sum, Difference and Product of Two Tensors. Contraction. Quotient Law of Tensors Symmetric and Anti symmetric Tensor, Invariant Tensors : Kronecker and Alternating Tensors Association of Antisymmetric Tenser of Order Two and Vectors. Vector Algebra and Calculus using Cartesian Tensors : Scalar and Vector Products, Scalar and Vector Triple Products. Differentiation Gradient, Divergence and Curl of Tensor Fields. Vector Identities Tensorial Formulation of Analytical Solid Geometry: Equation of a Line. Angle Between Lines Projection of a Line on another Line Condition for Two Lines to be Coplanar. Foot of the Perpendicular from a Point on Line Rotation Tensor (No Denvation) Isotropic Tensor. Tensorial Character of Physical Quantities, Moment of Inertia Tensor. Stress and Strain Tensors Symmetric Nature Elasticity Tense Generalized Hooke's Law. **(20 lectures)**

General Teasers: Transformation of Co-ordinates: Minkowski Space. Contravariant & Covariant Vectors Contravariant, Covariant und Mixed Tensors. Kronecker Delta and Permutation Tensors Algebra of Tensor, Sum, Difference & Product of Two Tensors Contraction. Quotient Law of Tensors Symmetric and Anti-symmetric Tensors Metric Tensor. **(10 Lectures)**

Reference Books:

- Mathematical Tools for Physics, James Nearing, 2010, Dover Publications
- Mathematical Methods for Physicists, G.B. Arken, HJ. Weber, and F.E. Haris,1970, Elsevier.
- Modern Mathematical Methods for Physicists and Engineers, C.D. Cantrell, 2011, Cambridge University Press
- Introduction to Manices and Inca Transformations, DT Finkbeiner, 1978, Dover Pub.
- Linor Algebra, W. Cheney, EW.Cuency & DR Kincaid, 2012, Jones & Bartlett Learning
- Mathematics for Physicists, Susan M, Lea, 2004, Thomson Brooks/Cole
- Mathematical Methods for Physics & Engineers, K.F.Riley, MP. Blobson, SJ Bence, 3rd ED, 2006, Cambridge University Press.