B.Sc. (Physical Sciences/ Mathematical Sciences) with Mathematics as one of the Core Disciplines

Semester-I

Category III

DISCIPLINE SPECIFIC CORE COURSE: TOPICS IN CALCULUS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Topics in Calculus	4	3	1	0	Class XII pass with Mathematics	Nil

Learning Objectives

The primary objective of this course is to:

- Introduce the basic tools of calculus which are helpful in understanding their applications in many real-world problems.
- Understand/create various mathematical models in everyday life.

Learning outcomes

This course will enable the students to:

- Understand continuity and differentiability in terms of limits and graphs of certain functions.
- Describe asymptotic behaviour in terms of limits involving infinity.
- Use of derivatives to explore the behaviour of a given function locating and classify its extrema and graphing the function.
- Apply the concepts of asymptotes, and inflexion points in tracing of cartesian curves.
- Compute the reduction formulae of standard transcendental functions with applications.

SYLLABUS OF DSC

Theory

Unit – 1 **(20 hours)**

Limits, Continuity and Differentiability

Limit of a function, $\varepsilon - \delta$ definition of a limit, Infinite limits, Continuity and types of discontinuities; Differentiability of a function, Successive differentiation: Calculation of the nth derivatives, Leibnitz theorem; Partial differentiation, Euler's theorem on homogeneous functions.

Unit – 2 **(20 hours)**

Mean Value Theorems and its Applications

Rolle's theorem, Mean value theorems and applications to monotonic functions and inequalities; Taylor's theorem, Taylor's series, Maclaurin's series expansions of e^x, $\sin x$, $\cos x$, $\log(1+x)$ and $(1+x)^m$; Indeterminate forms.

Unit – 3 **(20 hours)**

Tracing of Curves and Reduction Formulae

Asymptotes (parallel to axes and oblique), Concavity and inflexion points, Singular points, Tangents at the origin and nature of singular points, Curve tracing (cartesian and polar equations). Reduction formulae for $\int \sin^n x\,dx, \int \cos^n x\,dx,$ and $\int \sin^m x \cos^n x\,dx$ and their applications.

Practical component (if any) – NIL

Essential Readings

- Prasad, Gorakh (2016). Differential Calculus (19th ed.). Pothishala Pvt. Ltd. Allahabad.
- Prasad, Gorakh (2015). Integral Calculus. Pothishala Pvt. Ltd. Allahabad.

Suggestive Readings

- Apostol, T. M. (2007). Calculus: One-Variable Calculus with An Introduction to Linear Algebra (2nd ed.). Vol. 1. Wiley India Pvt. Ltd.
- Ross, Kenneth. A. (2013). Elementary Analysis: The Theory of Calculus (2nd ed.). Undergraduate Texts in Mathematics, Springer. Indian reprint.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Semester II

DISCIPLINE SPECIFIC CORE COURSE – 2 (Discipline A-2): Elementary Linear Algebra

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Elementary Linear Algebra	4	3	1	0	XII pass with Mathematics	NIL

Learning Objectives: The objective of the course is to introduce the concept of vectors in ^{n}, understanding the nature of solution of system of linear equations, and to view the $m \times n$ matrices as a linear function from ^{n} to ^{m} and vice versa. The concepts of linear independence and dependence, rank and linear transformations has been explained through matrices.

Learning Outcomes: This course will enable the students to:

- Visualize the space ^{n} in terms of vectors and the interrelation of vectors with matrices.
- Familiarize with concepts of bases, dimension and minimal spanning sets in vector spaces.
- Learn about linear transformation and its corresponding matrix.

SYLLABUS OF DSC-2

UNIT – I: Euclidean Space ^{n} and Matrices (6 Weeks)

Fundamental operations with vectors in Euclidean space ^{n}, Linear combinations of vectors, Dot product and their properties, Cauchy-Schwarz inequality, Triangle inequality, Solving system of linear equations using Gaussian elimination, Application: Curve Fitting, Gauss-Jordan row reduction, Reduced row echelon form, Application: Solving several systems simultaneously, Equivalent systems, Rank and row space of a matrix, Eigenvalues, Eigenvectors, Eigenspace, Diagonalization, Characteristic polynomial of a matrix.

UNIT – II: Introduction to Vector Spaces (4 Weeks)

Definition, Examples and some elementary properties of vector spaces, Subspaces, Span, Linear independence and linear dependence of vectors, Basis and dimension of a vector space, Maximal linearly independent sets, Minimal spanning sets.

UNIT – III: Linear Transformations (5 Weeks)

Linear transformations**:** Definition, Examples and elementary properties, The matrix of a linear transformation, Kernel and range of a linear transformation, The dimension theorem,

one-to-one and onto linear transformations, Invertible linear transformations, Isomorphic vector spaces.

Recommended Reading:

1. Andrilli, S., & Hecker, D. (2016). *Elementary Linear Algebr*a (5th ed.). Elsevier India.

Suggestive Readings:

i. Lay, David C., Lay, Steven R., & McDonald, Judi J. (2016). *Linear Algebra and its Applications* (5th ed.). Pearson Education.
ii. Kolman, Bernard, & Hill, David R. (2001). *Introductory Linear Algebra with Applications* (7th ed.). Pearson Education, Delhi. First Indian Reprint 2003.

B.Sc. (Physical Sciences/Mathematical Sciences) with Mathematics as one of the Core Discipline Sem-III

Category-III

DISCIPLINE SPECIFIC CORE COURSE – A-3:
DIFFERENTIAL EQUATIONS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Differential Equations	4	3	1	0	Class XII pass with Mathematics	Nil

Learning Objectives

The primary objective of this course is to introduce:

- Ordinary and partial differential equations.
- Basic theory of higher order linear differential equations, Wronskian and its properties.
- Various techniques to find the solutions of above differential equations which provide a basis to model complex real-world situations.

Learning Outcomes

This course will enable the students to:

- Solve the exact, linear, Bernoulli equations, find orthogonal trajectories and solve rate problems.
- Apply the method of undetermined coefficients and variation of parameters to solve linear differential equations.
- Solve Cauchy-Euler equations and System of linear differential equations.
- Formulate and solve various types of first and second order partial differential equations.

SYLLABUS of Discipline A-3

Unit – 1 **(15 hours)**

Ordinary Differential Equations

First order ordinary differential equations: Basic concepts and ideas, First order Exact differential equations, Integrating factors and rules to find integrating factors, Linear equations and Bernoulli equations, Initial value problems, Applications of first order differential equations: Orthogonal trajectories and Rate problems; Basic theory of higher order linear differential equations, Wronskian and its properties.

Unit – 2 **(12 hours)**

Explicit Methods of Solving Higher-Order Linear Differential Equations

Linear homogeneous equations with constant coefficients, Linear non-homogeneous equations, Method of undetermined coefficients, Method of variation of parameters, Two-point boundary value problems, Cauchy-Euler equations, System of linear differential equations.

Unit – 3 **(18 hours)**

First and Second Order Partial Differential Equations

Classification and Construction of first-order partial differential equations, Method of characteristics and general solutions of first-order partial differential equations, Canonical forms and method of separation of variables for first order partial differential equations; Classification and reduction to canonical forms of second-order linear partial differential equations and their general solutions.

Essential Readings

1. Myint-U, Tyn and Debnath, Lokenath (2007). Linear Partial Differential Equations for Scientist and Engineers (4th ed.). Birkhäuser. Indian Reprint.
2. Ross, Shepley L. (1984). Differential Equations (3rd ed.). John Wiley & Sons.

Suggestive Readings

- Edwards, C. Henry, Penney, David E., & Calvis, David T. (2015). Differential Equations and Boundary Value Problems: Computing and Modeling (5th ed.). Pearson Education.
- Kreyszig, Erwin. (2011). Advanced Engineering Mathematics (10th ed.). Wiley India.
- Sneddon I. N. (2006). Elements of Partial Differential Equations. Dover Publications.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE -1(i): COMBINATORICS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Combinatorics	4	3	1	0	Class XII pass with Mathematics	Nil

Learning Objectives

The primary objective of this course is to:

- Introduce various techniques of permutations, combinations and inclusion-exclusion.
- Learn basic models of generating functions and recurrence relations in their application to the theory of integer partitions.

Learning Outcomes

After completing the course, student will:

- Enhance the mathematical logical skills by learning different enumeration techniques.
- Be able to apply these techniques in solving problems in other areas of mathematics.
- Be trained to provide reasoning and arguments to justify conclusions.

SYLLABUS OF DSE-1(i)

Unit - 1 **(15 hours)**

Basics of Combinatorics

Basic counting principles, Permutations and Combinations (with and without repetitions), Binomial coefficients, Multinomial coefficients, Counting subsets of size k; Set-partitions, The inclusion-exclusion principle and applications.

Unit - 2 **(18 hours)**

Generating Functions and Recurrence Relations

Generating functions: Generating function models, Calculating coefficients of generating functions, Polynomial expansions, Binomial identity, Exponential generating functions.
Recurrence relations: Recurrence relation models, Divide-and-conquer relations, Solution of linear recurrence relations, Solutions by generating functions.

Unit – 3 **(12 hours)**

Partition

Partition theory of integers: Ordered partition, Unordered partition, Ferrers diagram, Conjugate of partition, Self-conjugate partition, Durfee square, Euler's pentagonal theorem.

Essential Readings

1. Sane, Sharad S. (2013). Combinatorial Techniques. Hindustan Book Agency (India).
2. Tucker, Alan (2012). Applied Combinatorics (6th ed.). John Wiley & Sons, Inc.

Suggested Readings

- Brualdi, Richard A. (2009). Introductory Combinatorics (5th ed.). Pearson Education Inc.
- Cameron, Peter J. (1994). Combinatorics: Topics, Techniques, Algorithms. Cambridge University Press.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE-1(ii): ELEMENTS OF NUMBER THEORY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Elements of Number Theory	4	3	1	0	Class XII pass with Mathematics	Nil

Learning Objectives

The primary objective of this course is to introduce:

- The Euclidean algorithm and linear Diophantine equations, the Fundamental theorem of arithmetic and some of the open problems of number theory viz. the Goldbach conjecture.
- The modular arithmetic, linear congruence equations, system of linear congruence equations, arithmetic functions and multiplicative functions, e.g., Euler's Phi-function.
- Introduction of the simple encryption and decryption techniques, and the numbers of specific forms viz. Mersenne numbers, Fermat numbers etc.

Learning Outcomes

This course will enable the students to:

- Get familiar with the basic number-theoretic techniques.
- Comprehend some of the open problems in number theory.
- Learn the properties and use of number-theoretic functions and special types of numbers.
- Acquire knowledge about public-key cryptosystems, particularly RSA.

SYLLABUS OF DSE-1(ii)

Unit – 1 **(12 hours)**

Divisibility and Prime Numbers

Revisiting: The division algorithm, divisibility and the greatest common divisor. Euclid's lemma; The Euclidean algorithm, Linear Diophantine equations; The Fundamental theorem of Arithmetic, The sieve of Eratosthenes, Euclid theorem and the Goldbach conjecture; The Fibonacci sequence and its nature.

Unit – 2 **(21 hours)**

Theory of Congruences and Number-Theoretic Functions

Congruence relation and its basic properties, Linear congruences and the Chinese remainder theorem, System of linear congruences in two variables; Fermat's little theorem and its generalization, Wilson's theorem and its converse; Number-theoretic functions for sum and the number of divisors of a positive integer, Multiplicative functions, The greatest integer function; Euler's Phi-function and its properties.

Unit – 3 **(12 hours)**

Public Key Encryption and Numbers of Special Form

Basics of cryptography, Hill's cipher, Public-key cryptosystems and RSA encryption and decryption technique; Introduction to perfect numbers, Mersenne numbers and Fermat numbers.

Essential Reading

1. Burton, David M. (2011). Elementary Number Theory (7th ed.). McGraw-Hill Education Pvt. Ltd. Indian Reprint 2017.

Suggestive Readings

- Jones, G. A., & Jones, J. Mary. (2005). Elementary Number Theory. Springer Undergraduate Mathematics Series (SUMS). Indian Reprint.
- Robbins, Neville (2007). Beginning Number Theory (2nd ed.). Narosa Publishing House Pvt. Ltd. Delhi.
- Rosen, Kenneth H. (2011). Elementary Number Theory and its Applications (6th ed.). Pearson Education. Indian Reprint 2015.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE - DSE-1(iii): THEORY OF EQUATIONS AND SYMMETRIES

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Theory of Equations and Symmetries	4	3	1	0	Class X pass with Mathematics	Nil

Learning Objectives

The goal of this paper is to acquaint students with certain ideas about:

- Integral roots, rational roots, an upper bound on number of positive or negative roots of a polynomial.
- Finding roots of cubic and quartic equations in special cases using elementary symmetric functions.
- Using Cardon's and Descartes' methods, respectively.

Learning Outcomes

After completion of this paper, the students will be able to:

- Understand the nature of the roots of polynomial equations and their symmetries.
- Solve cubic and quartic polynomial equations with special condition on roots and in general.
- Find symmetric functions in terms of the elementary symmetric polynomials.

SYLLABUS OF DSE-1(iii)

Unit – 1 (18 hours)

Polynomial Equations and Properties

General properties of polynomials and equations; Fundamental theorem of algebra and its consequences; Theorems on imaginary, integral and rational roots; Descartes' rule of signs for positive and negative roots; Relations between the roots and coefficients of equations, Applications to solution of equations when an additional relation among the roots is given; De Moivre's theorem for rational indices, the *n*th roots of unity and symmetries of the solutions.

Unit – 2 (12 hours)

Cubic and Biquadratic (Quartic) Equations

Transformation of equations (multiplication, reciprocal, increase/diminish in the roots by a given quantity), Removal of terms; Cardon's method of solving cubic and Descartes' method of solving biquadratic equations.

Unit – 3 (15 hours)

Symmetric Functions

Elementary symmetric functions and symmetric functions of the roots of an equation; Newton's theorem on sums of the like powers of the roots; Computation of symmetric functions such as $\sum \alpha^2\beta$, $\sum \alpha^2\beta^2$, $\sum \alpha^2\beta\gamma$, $\sum \frac{1}{\alpha^2\beta\gamma}$, $\sum \alpha^{-3}$, $\sum (\beta+\gamma-\alpha)^2$, $\sum \frac{\alpha^2+\beta\gamma}{\beta+\gamma}$, ... of polynomial equations; Transformation of equations by symmetric functions and in general.

Essential Readings

1. Burnside, W.S., & Panton, A.W. (1979). The Theory of Equations (11th ed.). Vol. 1. Dover Publications, Inc. (4th Indian reprint. S. Chand & Co. New Delhi).
2. Dickson, Leonard Eugene (2009). First Course in the Theory of Equations. John Wiley & Sons, Inc. The Project Gutenberg eBook: http://www.gutenberg.org/ebooks/29785

Suggestive Readings

- Prasad, Chandrika (2017). Text Book of Algebra and Theory of Equations. Pothishala Pvt Ltd.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

BSc. Physical Sciences/ Mathematical Sciences with Computer Science as one of the Core disciplines SEM I

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Programming fundamentals using C++	4	3	0	1	Class XII pass	Nil

Learning Objectives

The Learning Objectives of this course are as follows:

- Introduce programming concepts using C++ to students.
- Develop structured as well as object-oriented programming skills using C++ programming language.
- Achieve competence amongst its students to develop correct and efficient C++ programs to solve problems spanning multiple domains.

Learning outcomes

This course will enable the students to:

- Write simple programs using built-in data types of C++.
- Implement arrays and user defined functions in C++.
- Write programs using dynamic memory allocation, handling external files, interrupts and exceptions.
- Solve problems spanning multiple domains using suitable programming constructs in C++.
- Solve problems spanning multiple domains using the concepts of object oriented programming in C++.

SYLLABUS OF DSC

Theory

Unit – 1 **(3 hours)**

Introduction to C++

Need and characteristics of Object-Oriented Programming, Structure of a C++ Program (main () function, header files, output, input, comments), compile and execute a simple program

Unit – 2 **(12 hours)**

Programming Fundamentals

Data types, Variables, Operators, Expressions, Arrays, Keywords, Decision making constructs, Iteration, Type Casting, Input-output statements, Functions, Command Line Arguments/Parameters

Unit – 3 **(9 hours)**

Object Oriented Programming

Concepts of Abstraction, Encapsulation. Creating Classes and objects, Modifiers and Access Control, Constructors, Destructors, Implementation of Inheritance and Polymorphism, Template functions and classes.

Unit – 4 **(9 hours)**

Pointers and References

Static and dynamic memory allocation, Pointer and Reference Variables, Implementing Runtime polymorphism using pointers and references.

Unit – 5 **(12 hours)**

Exception and File Handling

Using try, catch, throw, throws and finally; Nested try, File I/O Basics, File Operations

Practical **(30 hours)**

List of Practicals:

1. Write a program to compute the sum of the first n terms of the following series:

$$SS = 1 - 2^{nn} + 3^{nn} - 4^{nn} + \ldots$$

   The number of terms n is to be taken from the user through the command line. If the command line argument is not found then prompt the user to enter the value of n.

2. Write a program to display the following pattern:

   A

   BA

   CBA

   DCBA

   The number of rows n, is to be taken from the user.

3. Write a program to compute the factors of a given number using the default argument.
4. Write a menu driven program to perform the following operations on an array:
   a. Find the minimum, maximum and average of the array elements
   b. Search an element in the array using linear search
   c. Search an element in the array using binary search (both iterative and recursive versions)
   d. Display the address of every element of the array
5. Write a menu driven program to perform the following operations on a string:

a. Calculate length of the string (use pointers)
b. Check whether the first character of every word in the string is in uppercase or not
c. Reverse the string
d. Display the address of every character in the string

6. Create a class Triangle. Include overloaded functions for calculating the area of a triangle.
7. Create a template class TwoDim which contains x and y coordinates. Define default constructor, parameterized constructor and void print() function to print the coordinates. Now reuse this class in ThreeDim adding a new dimension as z. Define the constructors and void print() in the subclass. Implement main() to show runtime polymorphism.
8. Copy the contents of one text file to another file and display the number of characters copied.

Essential Readings

- Stephen Prata, C++ Primer Plus, 6th Edition, Pearson India, 2015.
- E Balaguruswamy, Object Oriented Programming with C++, 8th edition, McGraw-Hill Education, 2020.
- D.S. Malik, C++ Programming: From Problem Analysis to Program Design, 6th edition, Cengage Learning, 2013.

Suggestive Readings

- Herbert Schildt, C++: The Complete Reference, 4th Edition, McGraw Hill, 2003.
- A. B. Forouzan, Richard F. Gilberg, Computer Science: A Structured Approach using C++, 2nd edition, Cengage Learning, 2010.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

BSc. (Physical Sciences/ Mathematical Sciences) with ComputerScience as one of the Core Disciplines SEM II

Category II

DISCIPLINE SPECIFIC CORE COURSE (DSC-2): Data Structures using C++

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSC02: Data Structures using C++	**4**	**3**	**0**	**1**	**Class XII pass with Mathematics**	Nil

Learning Objectives

The course aims at developing the ability to use basic data structures like arrays, stacks, queues, lists, trees to solve problems. C++ is chosen as the language to understand implementation of these data structures.

Learning outcomes

On successful completion of the course, students will be able to:

- Compare two functions for their rates of growth.
- Understand abstract specification of data-structures and their implementation.
- Compute time and space complexity of operations on a data-structure.
- Identify the appropriate data structure(s) for a given application and understand the trade-offs involved in terms of time and space complexity.
- Apply recursive techniques to solve problems.

SYLLABUS OF DSC-2 UNIT – I (06 Hours)

Growth of Functions, Recurrence Relations. Functions used in analysis, asymptotic notations, asymptotic analysis, solving recurrences using recursion tree, Master Theorem.

UNIT – II (12 Hours)

Arrays, Linked Lists, Stacks, Queues, Deques. Arrays: array operations, applications, sorting, two-dimensional arrays, dynamic allocation of arrays; Linked Lists: singly linked lists, doubly linked lists, circularly linked lists, Stacks: stack as an ADT, implementing stacks using arrays, implementing stacks using linked lists, applications of stacks; Queues:

queue as an ADT, implementing queues using arrays, implementing queues using linked lists, double-ended queue as an ADT. Time complexity analysis of operations on all data structures.

UNIT – III (06 Hours)

Sorting: Insertion Sort, Count Sort and their complexity analysis.

UNIT – IV (03 Hours)

Recursion: Recursive functions, linear recursion, binary recursion.UNIT – V (06 Hours)

Trees, Binary Trees. Trees: definition and properties, binary trees: definition and properties, traversal of binary trees and their time complexity analysis.

UNIT – VI (09 Hours)

Binary Search Trees, Balanced Search Trees: Binary Search Trees: insert, delete (by copying), search operations, time complexity analysis of these operations; Balanced Search Trees and (2,4) Trees: motivation and introduction.

UNIT – VII (03 Hours)

Binary Heap, Priority Queue: Binary Heaps: motivation and introduction, application of heaps - Priority Queues.

Practical component (if any) – 30 Hours

1. Perform matrix addition and multiplication.
2. Implement following recursive functions:
    a. Factorial of a number
    b. N^{th} fibonacci number
    c. Power function: x^y
3. Implement singly linked lists.
4. Implement doubly linked lists.
5. Implement circular linked lists.
6. Implement stack data structure and its operations using arrays.
7. Implement stack data structure and its operations using linked lists.
8. Convert Prefix expression to Infix and Postfix expressions, and evaluate.
9. Implement queue data structure and its operations using arrays.
10. Implement queue data structure and its operations using linked lists.
11. Implement Binary Trees and its traversals.

Essential/recommended readings

1. Goodrich, M., Tamassia, R., & Mount, D., *Data Structures and Algorithms Analysis in C++*, 2nd edition. Wiley, 2011.
2. Cormen, T.H., Leiserson, C.E., Rivest, R. L., Stein C., *Introduction to Algorithms*, 3rd edition, Prentice Hall of India, 2010.
3. Drozdek, A., *Data Structures and Algorithms in C++*, 4th edition, Cengage Learning, 2012.

Suggestive readings

(i) Sahni, S. *Data Structures, Algorithms and applications in C++*. 2nd Edition. Universities Press, 2011.

(ii)Tanenbaum, A. M., Augenstein, M. J., & Langsam Y., *Data Structures Using C and C++*. 2nd edition. Prentice Hall of India, 2009.

BSc. (Physical Sciences/ Mathematical Sciences) with ComputerScience as one of the Core Disciplines SEM III

DISCIPLINE SPECIFIC CORE COURSE (DSC-3): Computer System Architecture

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSC03: Computer System Architecture	**4**	**3**	**0**	**1**	**Passed 12th class with Mathematics**	NIL

Learning Objectives

This course introduces students to the fundamental concepts of digital computer organization, design, and architecture. It aims to develop a basic understanding of the building blocks of a computer system and highlights how these blocks are organized together to architect a digital computer system.

Learning outcomes

On successful completion of the course, students will be able to:

- Design combinatorial circuits using basic building blocks. Simplify these circuits using Boolean algebra and Karnaugh maps. Differentiate between combinational circuits and sequential circuits.
- Represent data in binary form, convert numeric data between different number systems, and perform arithmetic operations in binary.
- Determine various stages of the instruction cycle and describe interrupts and their handling.
- Explain how the CPU communicates with memory and I/O devices.
- Simulate the design of a basic computer using a software tool.

SYLLABUS OF DSC-3

Unit 1 (9 hours)

Digital Logic Circuits: Digital Logic Gates, Flip flops and their characteristic table, Logic circuit simplification using Boolean algebra and Karnaugh map, Don't care conditions, Combinational circuits, Introduction to Sequential Circuits

Unit 2 (7 hours)

Digital Components: Decoders, Encoders, Multiplexers, Binary Adder, Binary Adder Subtractor, Binary Incrementor, Registers, and Memory Units

Unit 3 (13 hours)

Data Representation: Binary representation of both numeric and alphanumeric data, representation of numeric data in different number systems, (Binary, Octal, Decimal and Hexadecimal), conversion from one number system to another, complements, representation of signed and unsigned numbers, addition and subtraction of signed and unsigned numbers and overflow detection.

Unit 4 (9 hours)

Basic Computer Organization and Design: Stored program organization, Computer registers, Instruction set and their completeness, Instruction cycle, Memory reference instructions, Register reference instructions, Input- Output reference instructions, Interrupt cycle, Addressing modes.

Unit 5 (7 hours)

Input-Output Organization: I/O interface, I/O vs. Memory Bus, Isolated I/O, Memory Mapped I/O, Direct Memory Access.

Essential/recommended readings

1. M. Morris Mano, *Computer System Architecture*, 3rd edition, Pearson Education, 2017.
2. Linda Null, Julia Lobur, *Essentials of Computer Organization and Architecture*, 5th Edition, 2019.

Additional References

1. D. Comer, *Essentials of Computer Architecture*, 2nd edition, CRC Press, 2017.

Suggested Practical List (If any): (30 Hours)

Practical exercises such as

(Use Simulator – CPU Sim 3.6.9 or any higher version for the implementation)

1. Create a machine based on the following architecture:

Registers

IR	DR	AC	AR	PC	I	E
16 bits	16 bits	16 bits	12 bits	12 bits	1 bit	1 bit

Memory 4096 words	

16 bits per word	Instruction format 15 12 11 0 Opcode | Address

Basic Computer Instructions

Memory Reference			Register Reference	
Symbol	Hex		Symbol	Hex
AND	0xxx	Direct Addressing	CLA	7800
ADD	1xxx		CLE	7400
LDA	2xxx		CMA	7200
STA	3xxx		CME	7100
			HLT	7001

Refer to Chapter-5 for a description of the instructions.

Design the register set, the memory, and the instruction set. Use this machine for the assignments in this section.

1. Implement fetch sequence
2. Write an assembly program to simulate the addition of two numbers when one is stored in memory and another is entered by the user.
3. Write an assembly program to simulate addition of two numbers when both numbers are taken as inputs from user.
4. Write an assembly program to simulate subtraction of two numbers when one number is stored in memory and another is entered by the user.

5. Write an assembly program to simulate subtraction of two numbers when both numbers are taken as inputs from user

6. Write an assembly program to simulate the following logical operations on two user-entered numbers.

i. AND

ii. OR

iii. NOT

7. Write an assembly language program to simulate the machine for following register reference instructions and determine the contents of AC, E, PC, AR and IR registers in decimal after the execution:

i. CLE

ii. CLA

iii. CMA

iv. CME

Discipline Specific Electives

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSE 01a PYTHON Programming for Data Handling	**4**	**3**	**0**	**1**	Pass in Class XII	NIL

Learning Objectives

The course introduces students to the concept of data handling using files and GUI designing. This would equip the students with knowledge to work on real world data from various

applications and GUI development for effective data handling.

Learning outcomes

On successful completion of the course, students will be able to:

- Learn constructs of Python language
- Perform data handling with files using Python.
- Design and implement GUI applications using Tkinter.

SYLLABUS OF DSE 01a

Unit 1 (15 Hours)

Introduction to Python Programming, Basic Constructs, and Python Built-in Data Structures: Introduction to Python programming language, Basic syntax, variables, and data types in Python, Functions and modular programming; Conditional statements (if, elif, else); Looping structures (for and while loops); Mutable and Immutable Data Structures, Strings-Indexing, slicing, traversal, operations; Lists-indexing, slicing, traversal, operations; tuples, dictionaries, and sets and their operations in Python

Unit 2 (5 Hours)

File Handling: Opening, reading, writing, and closing files; File modes and file object methods; Reading and writing text and binary files; Working with CSV files

Unit 3 (15 Hours)

Designing GUI Applications with Tkinter (15): What is Tkinter? Creating a Tkinter window, Layout managers, Tkinter widgets -Entry, Spinbox, Combobox, Checkbutton, Text, Button, LabelFrame; Implementing the application - LabelInput class, building of form, adding LabelFrame and other widgets, retrieving data from form, resetting form, building our application class.

Unit 4 (10 Hours)

Combining Python file handling and Tkinter: Creating a simple Tkinter application, Reading and writing to csv files in a Tkinter application

Essential/recommended readings

1. Taneja S., Kumar, N. Python Programming- A modular approach, 1st Edition, Pearson Education India, 2018,

2. Moore, Alan D. Python GUI Programming with Tkinter: Develop responsive and powerful GUI applications with Tkinter. Packt Publishing Ltd, 2021.

Additional References:

1. Guttag, J.V. Introduction to computation and programming using Python, 2nd edition, MIT

Online references/material:

1. https://docs.python.org/3/library/csv.html

Suggested Practical List (If any): (30 Hours)

1. Installing and setting up Python and relevant libraries; Python development environments(e.g., Anaconda, Jupyter Notebook) Write a Python program to calculate the factorial of a number.
2. Write a Python program to generate prime numbers between 1 to n, where n is provided as input by the user.
3. Write a Python program to find the sum and average of numbers in a given list.
4. Given two sets, set1 and set2, write a Python program to find their union, intersection and difference.
5. Given a list of numbers, write a Python program to count the number of times an element occurs in a list and create a dictionary with *element:count* as *key:value* pairs.
6. Write a Python program to swap the first two and last two characters in a given string.
7. Write a Python program to create a text file having names of ten Indian cities.
8. Write a Python program to create a text file having atleast five lines about your college using `writelines()` function.
9. Write a Python program which reads the data from three input files having Employee Names and merges them into one output file.
10. Write a Python program to count the number of vowels in a file and write the *vowel : count* in a dictionary.
11. Write a Python program to create a CSV file having student data: RollNo, Enrollment No, Name, Course, Semester.
12. Write a Python program library to read the CSV file created in the above program and filter out records of II semester students.
13. Write a Python program using tkinter library to create a GUI to enter registration details for an event.
14. Write a Python program using tkinter library to create a calculator to perform addition, subtraction, multiplication and division of two numbers entered by the user.
15. Write a Python program using tkinter library to create an age calculator to calculate age when DOB is entered.
16. Write a Python program using tkinter library to read and write student data to and from a CSV file (refer question 11).

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Android Programming using Java	**4**	**3**	**0**	**1**	Pass in Class XII	NIL

Learning Objective

The course enables the students to understand Android architecture and its key features, making them competent to develop Android applications using Java.

Learning outcomes

On successful completion of the course, students will be able to:

- logically organize Java classes and interfaces using packages.
- understand the design of the Android operating system.
- design user interfaces using various dialog boxes, menus, etc.
- design Android applications with interaction among various activities/applications.

SYLLABUS OF DSE 01b

Unit 1 (15 hours)

Review of Object Oriented Programming and Java Fundamentals: Structure of Java programs, classes and objects, data types, type casting, looping constructs, inheritance.

Unit 2 (2 hours)

Interfaces: Interface basics, defining, implementing and extending interfaces.

Unit 3 (4 hours)

Packages: Basics of packages, creating and accessing packages.

Unit 4 (7 hours)

GUI Programming: AWT classes, event handling.

Unit 5 (5 hours)

Introduction to Android Programming: Introduction to Android Operating System, Android SDK, AVD, components of an Android Application, parcels, and bundles.

Unit 6 (6 hours)

User Interface Architecture: Android Architecture, Contexts in Android, Intents and Intent Filters, Activity Life Cycle, Activity Stack, Fragments, and Fragments Life Cycle.

Unit 7 (6 hours)

User Interface Design: Android Layouts, Views, Spinner, Menu, Toggle Buttons, Radio Buttons, Check Boxes, Alert Box, and Toasts.

Essential/recommended readings

1. Schildt H. Java: The Complete Reference. 12th edition. McGraw-Hill Education, 2021
2. Griffiths D. & Griffiths D. Head First Android Development. O'Reilly, 2017
3. Meier R. Professional AndroidTM 4 Application Development. John Wiley & Sons, Inc., 2012

Additional Resources:

1. Horstmann, C. S. Core Java - Vol. I – Fundamentals. 12th edition. Pearson Education, 2021
2. Murphy M. L. The Busy Coder's Guide to Android Development. CommonsWare, 2018
3. Phillips B., Stewart C., Hardy B. & Marsicano K. Android Programming: The Big Nerd Ranch Guide. Big Nerd Ranch, LLC, 2015
4. Sheusi J. C. Android Application Development for Java Programmers. Cengage Learning, 2013

Suggested Practical List (If any): (30 Hours)

1. Write a function to find whether a number is prime or not. Use this function to determine the nth prime number. Read n from the user.

2. Design a class Complex having a real part (x) and an imaginary part (y). Provide methods to perform the following on complex numbers:

    a. Add two complex numbers.

b. Multiply two complex numbers.

c. toString() method to display complex numbers in the form: x + i y

3. Create a class TwoDim which contains private members as x and y coordinates in package P1. Define the default constructor, a parameterized constructor and override toString() method to display the co-ordinates. Now reuse this class and in package P2 create another class ThreeDim, adding a new dimension as z as its private member. Define the constructors for the subclass and override toString() method in the subclass also. Write appropriate methods to show dynamic method dispatch. The main() function should be in a package P.

4. Write a program to create an Applet. Create a frame as a child of an applet. Implement mouseClicked( ), mouseEntered( ) and mouseExited( ) events for the applet. Frame is visible when mouse enters applet window and hidden when mouse exits from the applet window.

5. Write a program to display a string in a frame window with pink color as background.

6. Write a program to create an Applet that has two buttons named “Red” and “Blue”. When a button is pressed, the background color of the applet is set to the color named by the button’s label.

7. Create a “Hello World” application. That will display “Hello World” in the middle of the screen in the emulator. Also display “Hello World” in the middle of the screen in the Android Phone.

8. Create an Android application with a login module. (Check username and password).

9. Create a Spinner with strings taken from resource folder (res >> value folder) and on changing the spinner value, Image will change.

10. Create a Menu with 5 options and a selected option should appear in the text box.

11. Create an application with three option buttons, on selecting a button colour of the screen will change.

12. Create an Application to display various Activity and Fragment Life Cycle Methods.

13. Create an application with 2 fragments, one to set the background and other to set the fore-color of the text.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

BSc. Physical Sciences

B. Sc. Physical Science with Physics as Major discipline in SEM I

Multidisciplinary

DISCIPLINE SPECIFIC CORE COURSE – 1 (PHYSICS DSC - 1)
MECHANICS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THECOURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Mechanics **Physics DSC 1**	**4**	**2**	**0**	**2**	**Class XII pass with Physics and Mathematics as main subjects**	**Physics and Mathematics syllabus of class XII**

Learning Objectives

This course reviews the concepts of mechanics learnt at school from a more advanced perspective and goes on to build new concepts. It begins with dynamics of a system of particles and ends with the special theory of relativity. Students will appreciate the concept of rotational motion, gravitation and oscillations. The students will be able to apply the concepts learnt to several real world problems.

Learning outcomes:

Upon completion of this course, students are expected to understand the following concepts.

- Laws of motion and their application to various dynamical situations.
- Conservation of momentum, angular momentum and energy. Their application tobasic problems.
- Particle collision (elastic and in-elastic collisions)
- Motion of simple pendulum
- Postulates of special theory of relativity, inertial and non-inertial frame of referenceand their transformation, relativistic effects on the mass and energy of a moving body.

In the laboratory course, after acquiring knowledge of how to handle measuring instruments (like screw gauge, vernier calliper and travelling microscope) student shall

embark on verifying various principles and associated measurable quantities.

SYLLABUS OF PHYSICS DSC – 1

THEORY COMPONENT

Unit 1: Review of vectors and ordinary differential equation (4 Hours) Gradient of a scalar field, divergence and curl of vectors field, polar and axial vectors Second order homogeneous ordinary differential equations with constant coefficients (Operator Method Only).

Unit 2: Fundamentals of Dynamics (7 Hours) Dynamics of a system of particles, centre of mass, determination of centre of mass fordiscrete and continuous systems having spherical symmetry
Conservation of momentum and energy, Conservative and non-Conservative forces, work – energy theorem for conservative forces, force as a gradient of potential energy.Particle collision (Elastic and in-elastic collisions)

Unit 3: Rotational Dynamics and Oscillatory Motion (8 Hours) Angular momentum, torque, conservation of angular momentum, Moment of inertia, Theorem of parallel and perpendicular axes (statements only). Calculation of moment of inertia of discrete and continuous objects (1-D and 2-D).
Idea of simple harmonic motion, differential equation of simple harmonic motion and its solution, Motion of simple pendulum, damped harmonic oscillator

Unit 4: Gravitation (3 Hours)
Newton's Law of Gravitation, Motion of a particle in a central force field, Kepler's Laws (statements only)

Unit 5: Special Theory of Relativity (8 Hours) Frames of reference, Galilean transformations, inertial and non-inertial frames, Michelson Morley's Experiment, postulates of special theory of relativity, length contraction, time dilation, relativistic transformation of velocity, relativistic variation of mass.

References:
Essential Readings:

1) Vector Analysis – Schaum's Outline, M.R. Spiegel, S. Lipschutz, D. Spellman, 2ndEdn., 2009, McGraw- Hill Education.
2) An Introduction to Mechanics (2/e), Daniel Kleppner and Robert Kolenkow, 2014,Cambridge University Press.
3) Mechanics Berkeley Physics Course, Vol. 1, 2/e: Charles Kittel, et. al., 2017, McGraw Hill Education
4) Mechanics, D. S. Mathur, P. S. Hemne, 2012, S. Chand.
5) Intermediate Dynamics, Patrick Hamill, 2010, Jones and Bartlett Publishers.

Additional Readings:

1) Feynman Lectures, Vol. 1, R. P. Feynman, R. B. Leighton, M. Sands, 2008,

PearsonEducation.
2) University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
3) University Physics, H. D. Young, R. A. Freedman, 14/e, 2015, Pearson Education.
4) Fundamentals of Physics, Resnick, Halliday and Walker 10/e, 2013, Wiley.
5) Engineering Mechanics, Basudeb Bhattacharya, 2/e, 2015, Oxford University Press.
6) Physics for Scientists and Engineers, Randall D Knight, 3/e, 2016, Pearson Education.

PRACTICAL COMPONENT (60 Hours)

The teacher is expected to give basic idea and working of various apparatus and instruments related to different experiments. Students should also be given knowledge of recording and analysing experimental data.

Every student should perform at least 06 experiments from the following list.

1) Measurement of length (or diameter) using vernier calliper, screw gauge and travelling microscope.
2) Study the random error in observations.
3) Determination of height of a building using a sextant.
4) Study of motion of the spring and calculate (a) spring constant and, (b) accelerationdue to gravity
5) Determination of moment of inertia of a flywheel.
6) Determination of g and velocity for a freely falling body using digital timing technique.
7) Determination of modulus of rigidity of a wire using Maxwell's needle.
8) Determination of elastic constants of a wire by Searle's method.
9) Determination of value of g using bar pendulum.
10) Determination of value of g using Kater's pendulum.

References (for Laboratory Work):

1) Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, 1971, AsiaPublishing House.
2) Engineering Practical Physics, S. Panigrahi and B. Mallick, 2015, Cengage LearningIndia Pvt. Ltd.
3) Practical Physics, G. L. Squires, 2015, 4/e, Cambridge University Press.
4) A Textbook of Practical Physics, I. Prakash and Ramakrishna, 11/e, 2011, KitabMahal.
5) B. Sc. Practical Physics, Geeta Sanon, R. Chand and Co., 2016.

B. Sc. Physical Science with Physics as Major discipline in SEM II

DISCIPLINE SPECIFIC CORE COURSE (PHYSICS DSC - 2): ELECTRICITY AND MAGNETISM

Course Title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Electricity and Magnetism Physics DSC 2	4	2	0	2	Class XII pass with Physics and Mathematics as main subjects	Physics and Mathematics syllabus of class XII

LEARNING OBJECTIVES

This course reviews the concepts of electricity and magnetism learnt at school from a more advanced perspective and goes on to build new concepts. The course covers static and dynamic electric and magnetic fields, and the principles of electromagnetic induction. It also includes analysis of electrical circuits and introduction of network theorems. The students will be able to apply the concepts learnt to several real world problems.

LEARNING OUTCOMES

After completing this course, students will be able to,

- Apply Coulomb's law and Gauss' law for calculating the electric field due to various charge distributions
- Calculate the force experienced by a moving charge in a magnetic field
- Determine the magnetic force generated by a current carrying conductor
- Illustrate the concept of electromagnetic induction and demonstrate the capability of Faraday's and Lenz's laws for solving physics problems

In the laboratory course, students will be able to measure resistance (high and low), voltage, current, self and mutual inductance, capacitor, strength of magnetic field and its variation, study different electric circuits.

SYLLABUS OF PHYSICS DSC – 2

THEORY COMPONENT

Unit 1: (5 Weeks)

Electrostatics: Electric field, electric flux, Gauss' theorem in electrostatics, applications of Gauss' theorem (linear, plane and spherical charge distribution), line integral of electric field, electric potential due to a point charge, electric potential and electric field of a dipole and charged disc, capacitance due to parallel plates and spherical condenser. Electrostatic energy of system of charge (charged sphere), dielectric medium, dielectric polarization, displacement vector, Gauss' theorem in dielectrics, parallel plate capacitor filled with dielectric.

Unit 2: (4 Weeks)

Magnetostatics: Magnetic force between current elements and definition of magnetic field **B**, Biot-Savart's law and its applications (current carrying straight conductor, current carrying circular coil, current carrying solenoid), divergence and curl of magnetic field, Ampere's circuital law, magnetic properties of materials (magnetic intensity, magnetic induction, permeability, magnetic susceptibility), brief introduction of dia-, para- and ferro magnetic materials

Unit 3: (3.5 Weeks)

Electromagnetic Induction: Faraday's laws of electromagnetic induction, Lenz's law, self-inductance of single coil, mutual inductance of two coils, energy stored in magnetic field. Maxwell`s equations and equation of continuity of current, displacement current

Unit 4: (2.5 Weeks)

DC Circuits: Review of Kirchhoff's Voltage and Current Laws, Thevenin theorem, Norton theorem, Superposition theorem, Maximum Power Transfer theorem.

References:

Essential Readings:

1) Fundamentals of Electricity and Magnetism, Arthur F. Kip, 2nd Edn.1981, McGraw-Hill.
2) Electricity and Magnetism, J. H. Fewkes and J. Yarwood. Vol. I, 1991, Oxford Univ. Press
3) Electricity and Magnetism, D. C. Tayal, 1988, Himalaya Publishing House.
4) Fundamentals of Electromagnetics, M. A. W. Miah, 1982, Tata McGraw Hill
5) Introduction to Electrodynamics, D. J. Griffiths, 3rd Edn, 1998, Benjamin Cummings.

Additional Readings:

1) Electricity and Magnetism, Berkeley Physics Course, Edward M. Purcell, 1986, McGraw-Hill Education.
2) Problems and Solutions in Electromagnetics, Ajoy Ghatak, K Thyagarajan and Ravi Varshney.

3) University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
4) Schaum's Outline of Electric Circuits, J. Edminister and M. Nahvi, 3rd Edn., 1995,McGraw Hill.

PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)

The teacher is expected to give basic idea and working of various instruments and circuits related to different experiments. Students should also be given knowledge of recording and analyzing experimental data.
Every student should perform at least 06 experiments from the following list of experiments.

1) To use a multimeter for measuring resistances, a.c and d.c voltages, d.c. current, capacitance and for checking electrical fuses.
2) Ballistic Galvanometer:
    a) Measurement of charge and current sensitivity
    b) Measurement of critical damping resistance
    c) Determine a high resistance by leakage method
    d) Determine self-inductance of a coil by Rayleigh's method.
3) To compare capacitances using de Sauty's bridge.
4) Measurement of field strength B and its variation in a solenoid
5) To study the characteristics of a series RC Circuit.
6) To study a series LCR circuit and determine its resonant frequency and quality factor.
7) To study a parallel LCR circuit and determine its anti-resonant frequency and qualityfactor
8) To determine a low resistance by Carey Foster bridge.
9) To verify the Thevenin, superposition and maximum power transfer theorems
10) To verify Norton theorem

References (for Laboratory Work):

1) Advanced Practical Physics for Students, B. L. Flint and H. T. Worsnop, 1971, AsiaPublishing House.
2) Engineering Practical Physics, S. Panigrahi and B. Mallick, 2015, Cengage LearningIndia Pvt. Ltd.
3) A Textbook of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011,Kitab Mahal, New Delhi.
4) Practical Physics, G. L. Squires, 2015, 4th Edition, Cambridge University Press
5) Advanced Level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition,reprinted 1985, Heinemann Educational Publishers

Note: **Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.**

B. Sc. Physical Science with Physics as Major discipline in SEM III

DISCIPLINE SPECIFIC CORE COURSE – DSC 3: HEAT AND THERMODYNAMICS

Course Title & Code	Credits	Credit distribution of the course			Pre-requisite of the course
		Lecture	Tutorial	Practical	
HEAT AND THERMODYNAMICS DSC – 3	**4**	**2**	**0**	**2**	**--**

LEARNING OBJECTIVES

This course will review the basic concepts of Thermodynamics, Kinetic Theory of gases with a brief introduction to Statistical Mechanics. The primary goal is to make the student understand the applications of fundamental laws of thermodynamics to various systems and processes. This coursework will enable the students to understand the connection between the macroscopic observations of physical systems and microscopic behaviour of atoms andmolecule through a brief knowledge of statistical mechanics. The lab course deals with providing the knowledge of the concepts of Thermodynamics along with Planck's Law and Stefan Boltzmann laws related to black body radiation.

LEARNING OUTCOMES

At the end of this course, students will be able to

- gain an essence of 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 along with Maxwell's thermodynamic relations.
- Know the fundamentals of the kinetic theory of gases, Maxwell-Boltzman distribution law, mean free path of molecular collisions, viscosity, thermal conductivity and diffusion.
- Learn about the black body radiations, Stefan- Boltzmann's law, Rayleigh-Jean's law and Planck's law and their significances.
- gain the basic knowledge about quantum statistics: the Bose-Einstein statistics and the Fermi-Dirac statistics.
- In the laboratory course, the students are expected 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.

SYLLABUS OF DSC – 3

THEORY COMPONENT

Unit – I - Laws of Thermodynamics (10 Hours)

Fundamental basics of Thermodynamic system and variables, Zeroth Law of Thermodynamics and temperature, First law and internal energy, various thermodynamical processes, Applications of First Law: general relation between C_P and C_V, work done during various processes, Compressibility and Expansion Coefficient, reversible and irreversible processes, Second law: Kelvin-Planck and Clausius statements, Carnot engine, Carnot cycle and theorem, basic concept of Entropy, Entropy changes in reversible and irreversible processes, Clausius inequality, Entropy-temperature diagrams.

Unit – II - Thermodynamic Potentials and Maxwell's Relations (5 Hours)

Basic concept of Thermodynamic Potentials, Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy, derivation of Maxwell's Thermodynamic Relations and their applications in Clausius Clapeyron Equation, value of $C_P - C_v$, TdS Equations, Energy equations for ideal gases, evaluation of C_P/C_v

Unit – III - Kinetic Theory of Gases and Molecular Collisions (6 Hours)

Maxwell-Boltzmann Law of Distribution of Velocities in an ideal gas and its experimental verification, Mean, Root Mean Square and Most Probable Speeds, Mean Free Path (Zeroth order), Transport Phenomena in ideal gases: Viscosity, Thermal Conductivity and Diffusion (for vertical case)

Unit – IV - Theory of Radiation (5 Hours)

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

Unit – V - Statistical Mechanics (4 Hours)

Macrostate and Microstate, phase space, Entropy and thermodynamic probability, Maxwell-Boltzmann law, qualitative description of Quantum statistics – Bose Einstein and Fermi Dirac, comparison of three statistics.

References:

Essential Readings:

1) Heat and Thermodynamics: M. W. Zemansky and R. Dittman, 1981, Tata McGraw-Hill.
2) Thermal Physics: S. C. Garg, R. M. Bansal and C. K. Ghosh, 2nd Edition, Tata McGraw-Hill.
3) Thermodynamics, Kinetic Theory and Statistical Thermodynamics: Sears and Salinger, 1988, Narosa.
4) Concepts in Thermal Physics: Blundell and Blundell, 2nd Edition, 2009, Oxford University Press.
5) Thermal Physics, A. Kumar and S. P. Taneja, 2014, R. Chand Publications.
6) A Text Book of Heat and Thermodynamics for Degree Students, J. B. Rajam, 1981, S. Chand.

Additional Readings:

1) An Introduction to Thermal Physics: D. Schroeder, 2021, Oxford University Press (earlier published by Pearsons)
2) Thermal Physics: C. Kittel and H. Kroemer, 1980, 2nd Edition, W.H. Freeman
3) Heat, Thermodynamics and Statistical Physics, Brij Lal, N. Subrahmanyam and P. S. Hemne, S. Chand and Company

PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)

At least six experiments to be done from the following:

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 a bad conductor by Lee and Charlton's disc method using steam or electrical heating.
4) Measurement of Planck's constant using black body radiation.
5) To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer
6) To study the variation of thermos-emf across two junctions of a thermocouple with temperature.
7) To determine Stefan's Constant.
8) To determine the Temperature Coefficient of Resistance using Platinum Resistance Thermometer (PRT) by Callender-Griffith Bridge

References for laboratory work:

1) Advanced Practical Physics for students: B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House.
2) A Text Book of Practical Physics: Indu Prakash and Ramakrishna, 11th Edition, Kitab Mahal
3) Advanced level Practical Physics: Nelkon and Ogborn, 4th Ed, reprinted 1985, Heinemann Educational Publishers.
4) An Advanced Course in Practical Physics: D. Chattopadhyay& P. C. Rakshit, 1990, New Central Book Agency.
5) Practical Physics: G.L. Squires, 1985, Cambridge University Press.
6) B.Sc. Practical Physics: Harnam Singh, Dr P. S. Hemne, revised edition 2011, S. Chand and Co.
7) B. Sc. Practical Physics: C. L. Arora, 2001, S. Chand and Co.
8) B. Sc. Practical Physics: Geeta Sanon, R. Chand and Co.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE – DSE 13a PHYSICS: BIOPHYSICS

Course Title & Code	Credits	Credit distribution of the course			Pre-requisite of the course
		Lecture	Tutorial	Practical	
Biophysics DSE 13a PHYSICS	**4**	**4**	**0**	**0**	--

LEARNING OBJECTIVES

This course familiarizes the students with the basic facts and ideas of biology from a quantitative perspective. It shows them how ideas and methods of physics enrich our understanding of biological systems at diverse length and time scales. The course also gives them a flavour of the interface between biology, chemistry, physics and mathematics.

LEARNING OUTCOMES

After completing this course, students will

- Know basic facts about biological systems, including single cells, multicellular organisms and ecosystems from a quantitative perspective.
- Gain familiarity with various biological processes at different length and time scales, including molecular processes, organism level processes and evolution.
- Be able to apply the principles of physics from areas such as mechanics, electricity and magnetism, thermodynamics, statistical mechanics, and dynamical systems to understand certain living processes.
- Get exposure to complexity of life at i) the level of cell, ii) level of multi cellular organism and iii) at macroscopic system – ecosystem and biosphere.
- Gain a systems level perspective on organisms and appreciate how networks of interactions of many components give rise to complex behaviour.
- Perform mathematical and computational modelling of certain aspects of living systems.
- Get exposure to models of evolution.

SYLLABUS OF DSE 13a PHYSICS

THEORY COMPONENT

Unit – I **(4 Hours)**

Overview: The boundary, interior and exterior environment of living cells. Processes: exchange of matter and energy with environment, metabolism, maintenance, reproduction, evolution. Self-replication as a distinct property of biological systems. Time scales and spatial scales.

Unit - II **(16 Hours)**

Molecules of life: Metabolites, proteins and nucleic acids. Their sizes, types and roles in

structures and processes. Transport, energy storage, membrane formation, catalysis, replication, transcription, translation, signaling. Typical populations of molecules of various types present in cells, their rates of production and turnover. Energy required to make a bacterial cell. Simplified mathematical models of transcription and translation, small genetic circuits and signaling pathways to be studied analytically and computationally.

Unit - III **(16 Hours)**

Molecular motion in cells: Random walks and applications to biology: Diffusion; models of macromolecules. Molecular motors: Transport along microtubules. Flagellar motion: bacterial chemotaxis. Mechanical, entropic and chemical forces.

Unit - IV **(16 Hours)**

The complexity of life: At the level of a cell: Metabolic, regulatory and signaling networks in cells. Dynamics of metabolic networks; the stoichiometric matrix. The implausibility of life based on a simplified probability estimate, and the origin of life problem. At the level of a multicellular organism: Numbers and types of cells in multicellular organisms. Cellular differentiation and development. Brain structure: neurons and neural networks. At the level of an ecosystem and the biosphere: Foodwebs. Feedback cycles and self-sustaining ecosystems. Allometric scaling laws.

Unit - V **(8 Hours)**

Evolution: The mechanism of evolution: variation at the molecular level, selection at the level of the organism. Models of evolution. The concept of genotype-phenotype map.

References:

Essential Readings:

1) Biological Physics: Energy, Information, Life; Philip Nelson (W H Freeman & Co, NY, 2004)
2) Cell Biology by the Numbers; Ron Milo and Rob Phillips (Garland Science, Taylor & Francis Group, NY USA and Abingdon UK, 2016)
3) Physical Biology of the Cell (2nd Edition); Rob Phillips et al (Garland Science, Taylor & Francis Group, NY USA and Abingdon UK, 2013)
4) Evolution; M. Ridley (Blackwell Publishers, 2009, 3rd edition).

Additional Readings:

1) Physics in Molecular Biology; Kim Sneppen and Giovanni Zocchi (Cambridge University Press, Cambridge UK, 2005)
2) Biophysics: Searching for Principles; William Bialek (Princeton University Press, Princeton USA, 2012).

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE – 13b PHYSICS: MATHEMATICAL PHYSICS I

Course Title & Code	Credits	Credit distribution of the course			Pre-requisite of the course
		Lecture	Tutorial	Practical	
MATHEMATICAL PHYSICS I DSE – 13b Physics	**4**	**4**	**0**	**0**	--

LEARNING OBJECTIVES

The emphasis of course is to equip students with the mathematical tools required in solving problem of interest to physicists. The mathematical tools might be building blocks to understand the fundamental computational physics skills and hence enable them to solve a wide range of physics problems. Overall, to help students develop critical skills and knowledge that will prepare them not only for doing fundamental and applied research but also prepare them for a wide variety of careers

LEARNING OUTCOMES

After completing this course, student will be able to,

- Learn the functions more than one variable using the concepts of calculus.
- Solve first order differential equations and apply it to physical problems.
- Represent a periodic function by a sum of harmonics using Fourier series.
- Obtain power series solution of differential equation of 2^{nd} order with variable coefficients using Frobenius mehod.
- Learn beta and gamma functions.
- Learn complex analysis.

SYLLABUS OF DSE 13b - PHYSICS

THEORY COMPONENT

Unit – I **(16 Hours)**

Calculus of functions of more than one variable: Partial derivatives, chain rule for partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. Constrained Maximization using Lagrange Multipliers.

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. Even and odd functions and their Fourier expansions. Application to Summing of Infinite Series

Unit – II **(10 Hours)**

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 Differential Equations and its solution. Properties of Legendre Polynomials: Rodrigues Formula, Orthogonality. Simple recurrence relations

Unit – III **(14 Hours)**

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

Partial Differential Equations: Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular geometry. Solution of 1D wave equation

Unit – IV **(20 Hours)**

Complex Analysis: Introduction to complex variables, Functions of Complex variable, limit, continuity, Analytic functions, Cauchy-Riemann equations, singular points, Cauchy Integral Theorem, Cauchy's Integral Formula, Residues, Cauchy's residue theorem, application of contour integration in solving real integrals.

References:

Essential Readings:

1) An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning.
2) Differential Equations, George F. Simmons, 2007, McGraw Hill.
3) Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book.
4) Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5 Ed., 2012, Jones and Bartlett Learning.
5) Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
6) Fourier Analysis: With Applications to Boundary Value Problems, Murray Spiegel, 2017, McGraw Hill Education.
7) Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 7 Ed., 2013, Elsevier.
8) Essential Mathematical Methods, K. F.Riley and M. P.Hobson, 2011, Cambridge Univ.Press.

Additional Readings:

1) Introduction to Electrodynamics, Chapter 1, David J. Griffiths, 4 Ed., 2017, Cambridge University Press.
2) The Feynman Lectures on Physics, Volume II, Feynman, Leighton and Sands, 2008, Narosa Publishing House.
3) Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5 Ed., 2012, Jones and Bartlett Learning.
4) Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
5) Mathematical Physics, A.K. Ghatak, I. C. Goyal and S.J. Chua, Laxmi Publications Private Limited (2017).

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.