UNIVERSITY OF DELHI

DEPARTMENT: Chemistry/Physics/Mathematics
COURSE NAME: Bachelor of Science in Physical Sciences

(Semester-I)
Based on
Undergraduate Curriculum Framework 2022 (UGCF)
(Effective from Academic Year 2022-23)

University of Delhi

Course Title	Nature of the Course	Total Credits	Components			Eligibility Criteria/ Prerequisite	Contents of the course and reference is in -
			Lecture	Tutorial	Practical		
Basic Concepts of Organic Chemistry	DSC-Chemistry	04	02	-	02	Chemistry+Physics+Mathematics	**Annexure-I**
Mechanics	DSC-Physics	04	02	-	02	NA	**Annexure-II**
Topics in Calculus	DSC-Mathematics	04	02	-	02	NA	**Annexure-III**

Syllabus for Undergraduate Programme in Life Sciences (I Semester)

DISCIPLINE SPECIFIC CORE COURSES (DSC)

SEMESTER I

Course Code DSC-1: CHEMISTRY- I
Course Title: Basic Concepts of Organic Chemistry
Total Credits: 04 (Credits: Theory-02, Practical-02)
Total Lectures: Theory- 30, Practical-60

Objectives: The course is infused with the recapitulation of fundamentals of organic chemistry and the introduction of the concept of visualizing the organic molecules in a three-dimensional space. To establish the applications of these concepts, a study of diverse reactions through mechanisms is included. The constitution of the course strongly aids in the paramount learning of the basic concepts and their applications.

Learning Outcomes:
By the end of the course, the students will be able to:

- Understand and explain the differential behavior of organic compounds based on fundamental concepts learnt.
- Understand the fundamental concepts of stereochemistry.
- Formulate the mechanism of organic reactions by recalling and correlating the fundamental properties of the reactants involved.
- Learn and identify many organic reactions and their mechanisms including electrophilic addition, nucleophilic addition, nucleophilic substitution, electrophilic substitution and rearrangement reactions.

Unit 1: Fundamentals of organic chemistry   **Lectures: 05**

Types of Electronic displacements: Inductive effect, Resonance effect, Hyperconjugation,

Electromeric Effect. Reactive intermediates and their stability: carbocations, free radicals, carbanions, benzyne, carbenes.
Acidity and basicity in organic compounds (comparison of carboxylic acids, alcohols, phenols, primary, secondary and tertiary aliphatic amines, aniline and its derivatives)

UNIT 2: Stereochemistry   Lectures: 07

Types of projection formulae: Flying Wedge Formula, Newmann, Sawhorse and Fischer representations and their interconversion.
Stereoisomerism: Concept of chirality (upto two carbon atoms). Configurational isomerism: geometrical and optical isomerism; enantiomerism, diastereomerism and meso compounds). Threo and erythro; D and L; *Cis-trans* nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and *E*/Z nomenclature (for upto two C=C systems).
Conformational isomerism with respect to ethane, butane and cyclohexane.

UNIT 3: Types of Organic Reactions (Including reactions of alkenes, alkyl and aryl halides, alcohols, aldehydes, ketones)   Lectures: 18

Electrophilic addition reactions
Electrophilic addition reaction (with respect to propene, propyne, 3,3-dimethyl-1-butene): Hydration, Addition of HX in the absence and presence of peroxide, Hydroboration oxidation, Addition of bromine (with stereochemistry).

Nucleophilic addition reactions
Nucleophilic addition reaction of carbonyl compounds: Addition of HCN, ammonia derivatives (Hydroxylamine, Hydrazine, Semicarbazide and 2,4-DNP), the addition of carbanion (Aldol condensation, Claisen Schmidt, Benzoin condensation, Perkin reaction, reactions involving Grignard reagent).

Elimination and Nucleophilic substitution reactions
Nucleophilic substitution reaction (S_N1 and S_N2) in alkyl halides (mechanisms with stereochemical aspect), alcohols (with nucleophiles like ammonia, halides, thiols, ambident nucleophiles (cyanide and nitrite ion)), ethers (Williamson ether synthesis), Elimination reaction (E1 & E2), elimination *vs* substitution (*w.r.t.* potassium t-butoxide and KOH); Nucleophilic aromatic substitution in aryl halides-elimination addition reaction *w.r.t.* chlorobenzene, including the effect of nitro group (on the ring) on the reaction. relative reactivity and strength of C-X bond in alkyl, allyl, benzyl, vinyl and aryl halides towards substitution reactions

Electrophilic substitution reactions
Electrophilic Aromatic substitution with mechanism (benzene)- sulphonation, nitration, halogenation, Friedel craft acylation :*o*-, *m*- and *p*- directive influence giving examples of

toluene/nitrobenzene/ phenol/ aniline/ chlorobenzene.

Reactive intermediates and Rearrangement Reactions
Free radicals (Birch Reduction); *Carbocations* (Pinacol-Pinacolone, Wagner-Meerwein, Rearrangement, and Beckmann rearrangement); *Carbanions (*Michael Addition); *Carbenes* (Reimer-Tiemann).

PRACTICALS: Credits: 02

(Laboratory periods: 60)

1. Purification of an organic compound by crystallization (from water and alcohol) and distillation, Criteria of purity: Determination of M.P.
2. Determination of boiling point of liquid compunds. (Boiling point lower than and more than 100 °C by distillation and capillary method)

3. Detection of extra element
4. Preparations: (Mechanism of various reactions involved to be discussed).

   a. Bromination of phenol/aniline.
   b. 2,4-Dinitrophenylhydrazone of aldehydes and ketones
   c. Semicarbazone of aldehydes/ ketones
   d. Aldol condensation reaction using green method.
   e. Bromination of Stilbene.
   f. Acetanilide to p-Bromoacetanilide.

The above derivatives should be prepared using 0.5-1g of the organic compound. The solid samples
must be collected and may be used for recrystallization and melting point.

References:

Theory:

1. Sykes, P.(2003), **A Guide Book to Mechanism in Organic Chemistry,** 6th Edition Pearson Education.
2. Eliel, E. L. (2001), **Stereochemistry of Carbon Compounds**, Tata McGraw Hill.
3. Morrison, R. N.; Boyd, R. N., Bhattacharjee, S.K. (2010), **Organic Chemistry**, 7th Edition, Pearson Education.
4. Bahl, A; Bahl, B. S. (2019), **Advanced Organic Chemistry**, 22nd Edition, S. Chand.

Practical:

1. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. (2012), **Vogel's Textbook of Practical Organic Chemistry**, Pearson.
2. Mann, F.G.; Saunders, B.C. (2009), **Practical Organic Chemistry**, Pearson Education.
3. Dhingra, S; Ahluwalia V.K., (2017), **Advanced Experimental Organic Chemistry**, Manakin Press.
4. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume I**, I K International Publishing House Pvt. Ltd., New Delhi.

Teaching Learning Process:
*   Blend of conventional blackboard teaching, modern teaching learning tools and
*   Computational infrastructure- based instructions and Practical training.
*   Problem solving and quizzes for enhanced understanding of the concepts.
*   Explaining the handling and usage of the hardware and softwares required for solution to the given set of problems.

Assessment Methods:
*   Presentations by individual student/ group of students
*   Class Tests at periodic intervals.
*   Written assignment(s)
*   End semester University theory examination presentations by individual student/ group of students

Keywords: Chirality, Electrophilic addition, Nucleophilic addition, Nucleophilic substitution, Electrophilic substitution.

Course Code: DSC 2: PHYSICS I

Course Title: MECHANICS

Total Credits: 04 (Credits: Theory: 02, Practical: 02)

Total Hours: Theory: 30, Practical: 60

Course 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.

Course 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 to basic problems.
- Particle collision (elastic and in-elastic collisions)
- Motion of simple pendulum
- Postulates of special theory of relativity, inertial and non-inertial frame of reference and 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.

THEORY (Credit: 02; 30 Hours)

Unit 1: Review of vectors and ordinary differential equation   Hours: 4
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   Hours: 7
Dynamics of a system of particles, centre of mass, determination of centre of mass for discrete 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   Hours: 8

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   Hours: 3
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   Hours: 8
Frames of reference, Gallilean 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, 2nd Edn., 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, Pearson Education.
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 (Credit: 02; 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) acceleration due to

gravity (g)
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:
1) Advanced practical physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House.
2) Engineering practical physics, S. Panigrahi and B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
3) Practical physics, G. L. Squires, 2015, 4/e, Cambridge University Press.
4) A text book of practical physics, I. Prakash and Ramakrishna, 11/e, 2011, Kitab Mahal.
5) B. Sc. practical physics, Geeta Sanon, R. Chand and Co., 2016.

Course Code: DSC 3: MATHEMATICS I

Course Title: Topics in Calculus

Total Credits: 04 (Credits: Theory: 03, Tutorial: 01)

Total Hours: Theory: 45, Tutorial: 15

Course 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. Students will be able to understand/create various mathematical models in everyday life.

Course Learning Outcomes: This course will enable the students to:

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

Unit 1: 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 $n$thderivatives, Leibnitz theorem; Partial differentiation, Euler's theorem on
homogeneous functions.

Unit 2: 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: 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 $\int \sin^m x \cos^n xdx$ and their applications.

References:

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

Additional Readings:

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

Teaching Plan (Discipline A-1: Topics in Calculus):

Weeks 1 and 2: Limit of a function, $\varepsilon - \delta$ definition of a limit, Infinite limits, Continuity and
types of discontinuities.
[1] Chapter 2.

Weeks 3 and 4: Differentiability of a function, Successive differentiation: Calculation of the nth
derivatives, Leibnitz theorem.
[1] Chapter 3 (Sections 3.1, and 3.2), and Chapter 5.

Week 5: Partial differentiation, Euler's theorem on homogeneous functions.
[1] Chapter 12 [Section 12.2 (12.21 without proof, exclude 12.22 and 12.23), and Section 12.3].

Weeks 6 and 7: Rolle's theorem, Mean value theorems and applications to monotonic functions and inequalities.
[1] Chapter 7 (Sections 7.4 to 7.6).

Weeks 8 and 9: Taylor's theorem with Lagrange's and Cauchy's form of remainders, Definition and examples of convergent sequences and series, Taylor's, Maclaurin's series expansions of e^x, $\sin x$, $\cos x$, $\log(1+x)$ and $(1+x)^m$.
[1] Chapter 6 (Brief introduction of convergence from the Sections 6.1 and 6.2).
[1] Chapter 7 (Sections 7.7, and 7.8).

Week 10: Indeterminate forms.
[1] Chapter 16.

Week 11: Asymptotes (parallel to axes and oblique).
[1] Chapter 9 (Sections 9.1 to 9.4).

Weeks 12 and 13: Concavity and inflexion points, Singular points (cusp, node and conjugate), Tangents at the origin and nature of singular points, Curve tracing (cartesian and polar equations).
[1] Chapter 10 (Section 10.7).
[1] Chapter 11. Use only statement for nature of double points in the Section 11.4.

Week 14: 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.
[2] Chapter 4 (Sections 4.1, 4.11, 4.12, and 4.13).