# दिल्ली विश्वविद्यालय
# UNIVERSITY OF DELHI

Bachelor of Science (Hons) Biochemistry

(Effective from Academic Year 2019-20)

Revised Syllabus as approved by

Academic Council

Date: No:

Executive Council

Date: No:

Applicable for students registered with Regular Colleges, Non Collegiate Women's Education Board and School of Open Learning

# Syllabus
For
# B.Sc. (Honours) Biochemistry
# (Three Year Full Time Programme)

Under

## Choice Based Credit System (CBCS)
## Learning Outcome Based Curriculum Framework (LOCF)

**1st Meeting of Teachers / Faculties (13th Feb 2019)**
**Course Revision Committee (18th February 2019)**
DRAFT 1 (15th March 2019)
DRAFT 2 (22nd April 2019)
1st COC Meeting: 24th April 2019
Draft 3 : (3rd June 2019)
2nd COC Meeting: 4th June 2019
Faculty Meeting : 11th June 2019
Standing Committee : 11th July 2019

*(Syllabus applicable for students seeking admission in the B.Sc. (Hons) Biochemistry Course from the academic year 2019-20)*

**Department of Biochemistry**
Faculty of Interdisciplinary and Applied Sciences
University of Delhi South Campus
New Delhi-110021

# PREAMBLE

Biochemistry is the branch of science that explores the chemical processes within and related to living organisms. It is a laboratory based science programme that brings together biology and chemistry and focuses on processes happening at the cellular and molecular level. Biochemistry is the study of the components and composition of living things and their assembly and interactions important in sustaining life. By using chemical knowledge and techniques, biochemists attempt to investigate and solve biological problems pertaining to the understanding of physiological processes, their malfunction leading to diseases and subsequent disease diagnostics, prevention, therapy and prognostics. Bachelor's degree in Biochemistry at University of Delhi endeavors to train students in this classical art of life sciences to create a knowledge pool and skilled manpower to take on the challenges that modern biological sciences poses in understanding the emerging dynamics of life processes and the myriads of diseases that threaten mankind.

Education in the 21st century has undergone a paradigm shift, which necessitates frequent updates in any curriculum to reflect the dynamic changes in knowledge outcome, more so for biological sciences where advances are rapid and far-reaching. The revised Choice-Based Credit System (CBCS) curriculum to be introduced in the academic session 2019-2020 conforms to Learning Outcome Based Curriculum Framework (LOCF) and aims at imparting concept based learning with emphasis on skill development and research.

For multi-faceted development of a student, the curriculum includes courses to gain specialization in biochemistry while at the same time obtain sufficient exposure to related and varied subjects and skills. The curriculum emphasizes on several "core" courses (C) that will train students with the basic as well as advanced concepts of the discipline of biochemistry. All students pursuing the Bachelor's degree with Honours shall study fourteen such core papers across the six semesters. Students pursuing the programme shall also study four Discipline-Specific Elective (DSE) courses in the fifth and sixth semesters, which they will select from a list of such courses based on their individual preferences. These DSE courses will include diverse papers in other areas of life sciences (like Microbiology and Plant Biochemistry) or specialized research oriented courses (like Molecular Basis of Infectious Diseases) or advanced courses of Biochemistry (like Advanced Cell Biology and Advanced Methodologies), which will provide students with wholesome knowledge and requisite skills preparing them for higher studies across the globe. The content of each paper (C and DSE papers) is based on the premise that the fundamental principles and ideas must come across in a clear, easy and concise manner. The course seeks to be diverse and yet will present the essence of biochemistry in a very elegant and focused manner that will build competitive edge not only for professional development in a related area but prepare students for academic pursuits like research and teaching.

The Skill Enhancement Courses (SEC), offered in the third and fourth semesters, emphasizes on hands-on-training and supplements the discipline courses in an appropriate manner to impart students the confidence and required skills in practical aspects of biochemistry to help them choose a future path in either industrial or academic setting. The

SEC courses also include a paper on research methodology that will prepare students appropriately for a future in research.

The Generic Elective Courses (GE) offer inter- and trans-disciplinary students an opportunity to obtain a flavour of Biochemistry in simple and concise terms. It will also help them to switch over to this discipline of study in the future, should they choose to do so. Students opting for these courses learn the basic concepts of Biochemistry right from the first semester onwards, with one paper in each of the first, second, third and fourth semester. . Students who join for Honours degree in Biochemistry will opt for Generic Elective courses from other related/unrelated disciplines.

Two value-based courses (Ability Enhancement Compulsory Courses - AECC) in the first and second semester will enable students to improve their knowledge and communication skills.

# B.Sc. (Hons) Biochemistry

## 1. Introduction

**Biochemistry** is the branch of dynamic science that explores the chemical processes within living organisms/ systems. The study of Biochemistry aims to understand how all the molecules that constitute living organisms interact, to maintain and perpetuate life. It deals with the complexity of living organisms, the microscopic and macroscopic structures within organisms that have specific functions and their systems for extracting and transforming energy from the environment. Biochemistry also explains how organisms adapt to their changing environments and gradually evolve.

The teaching of such a dynamic and evolving course is best achieved through **Choice-based Credit System (CBCS)** since it offers opportunities to provide solid foundation in the core discipline, while allowing freedom to students to select discipline specific courses that augment the learning in core courses. This freedom is further reiterated through flexibility in opting courses that enhance specific skills in the discipline as well as selection of courses from other disciplines / departments that widen the scope for higher education and employability. The **Learning Outcome-based Curriculum Framework (LOCF)** built into the CBCS offers focus and purpose to the programme providing a platform for self-evaluation by students and teachers in addition to global assessment by all stakeholders. The combination of LOCF and CBCS also allows for lateral movement of students between institutes of higher learning and offers a level playing field for them across the nation.

### 1a. Nature and Extent of the B.Sc. (Honours) Programme in Biochemistry

Biochemistry is an interdisciplinary science with areas of overlap with Chemistry, Physics and Mathematics. It is a laboratory based science that acts as a bridge between Biology and Chemistry. It also shares boundaries with other interdisciplinary subjects such as Microbiology, Genetics and Biophysics. This course is designed so as to enable the students to gain theoretical knowledge and hands- on-experience in the laboratory. The course content is aimed at encouraging students to cultivate keen observational skills and to develop the ability to analyze and interpret experimental data, making them suitable for future careers in higher education and employment in industry and research institutes.

### 1b. Aims of the Programme

The overall objective of the Bachelors (Honours) Programme in Biochemistry is to enable students to learn and integrate foundational knowledge in Biology and Chemistry that is relevant to Biochemistry and thus prepare them for post-graduate education and /or careers as researchers in academia or related industries.

The program aims to:

- Provide students with scholarly experiences, both theoretical and hands-on, that help instil deep interests in learning the chemistry underlying the working of biological systems while developing broad and balanced knowledge and understanding of key biological concepts, principles and theories. The idea is to equip students with

appropriate tools of analysis so that they can independently tackle issues and problems in the field of biology and chemistry.

- Encourage students to study the structure and function of specific molecules and pathways and their interactions and networking in biological systems with particular emphasis on regulation of chemical reactions in living cells.
- Develop in students an inquisitive learning approach to seek answers regarding the complex workings of various physiological systems, cellular multiplication and differentiation and communication within and between cells and organs, and the chemical bases of inheritance and disease.
- Empower students to apply the knowledge and skills they have acquired to the solution of specific theoretical and applied problems in Biochemistry.
- Build concepts in biochemistry that would enable them to undertake further studies in Biochemistry and related areas or in multidisciplinary areas and help develop a range of generic skills that are relevant to wage employment, self-employment and entrepreneurship.

## 1c. Program Duration, Design and Structure

***Duration of the Program:***

The BSc Biochemistry course is a three-year degree programme divided into six semesters. Each academic year (July - May) will consist of two semesters. Each semester will be of fifteen weeks duration with one week designated for teaching break to promote co-curricular and co-scholastic activities.

***Program Design:***

The program has been designed to offer a variety of discipline specific and interdisciplinary courses disseminated through class-room, laboratory and out-of-classroom modes of teaching, monitored through a repertoire of assessment methods. The teaching-learning process will include theory classes of one hour duration and practical classes of two hour duration for every credit offered. The curriculum will be delivered through various methods including classical chalk and talk, power-point presentations, essay writing and quiz contests, audio and video tools, e-learning and e-content, virtual labs, field trips or educational tours, seminars by external experts, workshops and symposiums and class discussions and debates. The learning outcome will be assessed by direct and indirect methods comprising broadly of Internal Assessment or Continuous Evaluation and End-Semester Examination. The internal assessment will include mid-term written tests, multiple choice questions, home and class assignments, oral presentations (seminars), group tasks, class discussions and debates, essay and report writing. End-semester assessments will include written tests and practical examinations. Each theory paper will carry a maximum of 100 marks, with 25% marks allotted for internal assessment and 75% for end-semester examination. Each practical paper will carry a maximum of 50 marks including experimentation, viva-voce and practical notebook assessment.

***Structure of the Programme:***

The programme is structured into a variety of courses with different credits, some mandatory while others elective. Broadly, the programme comprises of Core Courses (CC) and elective courses. The core courses are all mandatory courses. The elective courses are of three

kinds: Discipline-Specific Elective (DSE), Skill Enhancement Course (SEC) and Generic Elective (GE). The programme also includes two compulsory Ability Enhancement Courses (AEC).

To successfully complete the program, a student must study fourteen Core Courses, four Discipline-Specific Electives, two Skill Enhancement Courses, four Generic Elective Courses and two compulsory Ability Enhancement Courses. The Core Courses, Discipline-Specific Electives and Generic Electives are six-credit courses. The Skill Enhancement Courses are four-credit courses while the Ability Enhancement Courses are two credit-courses. A student has to earn a minimum of 148 credits to get a degree in B.Sc. (H) Biochemistry.

The six-credit courses will include theory classes of four credits each and practicals of two credits each. The four-credit courses will comprise of two-credit theory classes and two-credit practical courses. However, the two-credit courses will include only theory classes. One credit is equivalent to one-hour lecture per week for theory classes and two-hour sessions for practical classes. Each batch of students for practical sessions will be of fifteen members. If the number of students exceed fifteen (by at least ten), they will be divided into two equal batches.

It is mandatory for students to study two Core Courses each in Semesters I and II, three Core Courses each in Semesters III and IV, and two Core Courses each in Semesters V and VI. The Core Courses will be of six credits each (four credits theory and two credits practicals).

Six courses of Discipline-Specific Electives (DSE) are offered in the programme, of which students will opt any two in each of the Semesters V and VI. The DSE courses will be of six credits each (four credits theory and two credits practicals). A particular DSE course will be offered only if the minimum number of students opting for that course is 10.

Generic Elective (GE) courses for the programme will be offered by other departments of the respective college. Students will elect one GE course each in Semesters I, II, III, and IV. The GE courses will be of six credits each (four credits theory and two credits practicals). The Department of Biochemistry will offer seven GE courses for students of other departments in the respective colleges.

From a list of six Skill Enhancement (SE) courses provided, students will undertake two Skill Enhancement (SE) courses of four credits each in Semesters III and IV. The SE courses will be of four credits each (two credits theory and two credits practicals). The two compulsory Ability Enhancement Courses (AEC), AE1 (Environmental Sciences) and AE2 (English / MIL communication), will be of two credits each (theory only). Students will undertake one each in Semesters I and II.

## 2. Learning Outcome-based Approach to Curriculum Planning

The learning outcomes-based curriculum framework (LOCF) for a B.Sc. degree in Biochemistry is intended to provide a broad framework within which the biochemistry programme is designed such that it enables students to acquire a skill set that helps them understand and appreciate the field of biochemistry. The structure or design of this framework shall ensure a high standard of the Honours degree in Biochemistry in the University. It shall subsequently pave the way for periodic updation and review of the programme, all within the boundaries of the set framework. This programme specification, as outline in individual courses, is intended as a reference point for prospective students, current students, examiners

and academic and support staff involved in delivering the programme and enabling student development and achievement.

Program learning outcomes are the central organizing features of student learning. They are developed from the complex interaction of a range of competing and complementary factors. Since program learning outcomes can only be achieved and demonstrated through component courses, course learning outcomes and their assessment are integrally related to program learning outcomes. The expected programme learning outcomes are described below while the course learning outcomes are included along with course contents. The LOCF in Biochemistry aims to achieve this important aspect of a modern teaching programme.

## 3. Characteristic Attributes of a Graduate in Biochemistry

A graduate in the Biochemistry programme is expected to demonstrate the following attributes:

- **Disciplinary knowledge and skills**: Capable of demonstrating (i) comprehensive knowledge and understanding of major concepts, theoretical principles and experimental findings in Biochemistry and other related fields of study, including interdisciplinary subfields such as life science in general, medicine and clinical biology, plant sciences, biotechnology, microbiology, nutrition, forensics, bioinformatics and environmental science; (ii) ability to use modern instrumentation for chemical and physical analysis of biological samples.
- **Critical thinker and problem solver**: Ability to employ critical thinking and efficient problem solving skills in the various areas of biochemistry and related disciplines.
- **Sense of inquiry**: Biochemistry being the foundation for understanding all biological processes, a graduate in this discipline is expected to seek deeper knowledge by asking relevant/appropriate questions relating to issues and problems in the field of Biochemistry and related areas. It is also envisaged that the course will empower them with the ability to plan, execute and report the results of an experiment or investigation.
- **Research skills**: Capable of identifying a scientific problem, preparing/mobilising appropriate resources required for the project, and execute the project through to completion, while observing responsible and ethical scientific conduct; and biosafety and chemical hygiene regulations and practices.
- **Skilled communicator**: Ability to transmit complex technical information relating to biochemistry in a clear and concise manner in both oral and written formats.
- **Team player/worker**: Capable of working effectively in diverse teams in both classroom, laboratory and in industry and field-based situations.
- **Digitally literate**: Capable of using computers for mining scientific information using modern library search tools from various open source platforms or journals and the ability to use technique specific software to conduct experiments and analyze data. The graduates are expected to be proficient in using computational & visualization tools to study bio-molecular structures, graphing and statistical software to analyze statistical significance of data and report data in the form of graphs, tables or figures.
- **Ethical awareness**: The graduates of this programme will be able to avoid unethical behaviour such as fabrication, falsification or misrepresentation of data or committing plagiarism. They will learn to appreciate environmental and sustainability issues and their societal relevance.

and academic and support staff involved in delivering the programme and enabling student development and achievement.

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well-designed posters and slides in talks aimed at scientific audiences as well as the general public.

***PO7***: Students will learn to work collaboratively in a team.

***PO8***: Students will gain knowledge of ethical and good laboratory practices, health and biohazard regulations, plagiarism and intellectual property rights related issues practiced in modern era of scientific investigation.

***PO9***: Graduates will be able to apply the major theories and research procedures to contemporary societal issues.

***P10***: The programme will prepare students to plunge into various fields of higher education or related profession in various disciplines, armed with plethora of knowledge, hands-on-experience and scientific attitude, at national and global levels.

## 6. Teaching-learning processes

The foremost effort of teaching is to impart knowledge to students, factual as well as hypothetical. The manner in which this is communicated to the students determines the success of the teaching process. To be able to see tangible results, it is imperative that the teaching-learning process be bilateral. There are three critical components to the teaching learning process, namely content writing, content delivery and engaging the students to complete the course. A passive flow of information from the teacher to the taught should make way for a vibrant atmosphere of active participation from the students. Teachers participating in the programme would have a well-structured and well-planned lecture ready for the class that should compel the students to concentrate, understand and enjoy the discourse. Students would be encouraged to think independently and ask pertinent questions cultivating out-of-the-box thinking. The link between theory and practical would be made evident, as working with their hands reinforces the concepts first introduced in theory classes.

The traditional chalk and talk method of teaching is simple but very effective. Diagrams or additional material may be shown as slides but with minimum text-rich content. For concepts that are difficult to explain, power point presentations or videos would be used. Some laboratory experiments will be open ended. Students will be divided into small groups to encourage teamwork, healthy competition and to be able to complete the task in stipulated time frames. Students will be taken out of the classroom and into the world of research institutions as well as industries in the form of simple visits or internships or educational tours for maximum benefit. It will help them to correlate what they learn in the classroom with the real world. Additionally, teachers will use MOODLE platform to create lessons and interact with students to create an open and effective two-way communication channel. Digital initiatives such as the Swayam portal, National digital library and open education resources will be used to greatly facilitate blended learning and flipped class rooms encouraging students to be responsible for learning. Group discussions, debates and scientific talks by external experts will be arranged for facile learning. Students will be encouraged to write comprehensive reviews of papers in a particular topic, reports, essays and short projects to augment their writing skills. Students will also be motivated to deliver seminars to strengthen their oratory skills.

## 7. Assessment methods

Assessment methods are the strategies, techniques, tools and instruments for collecting information to determine the extent to which students demonstrate desired learning outcomes.

Student learning outcomes cannot be ascertained by single evaluation criteria. A combination of direct and indirect assessments would thus be used. Direct methods of assessment will be used for students to demonstrate their learning while indirect methods will be used to observe students reflect on their learning. Written tests, essays, quiz, presentations and seminars will be used as direct methods of assessment, and indirect methods will include surveys, discussions, debates, participation in scientific meetings and festivals. Embedded assessments, in other words "classroom-based" or "continuous" assessments will be utilized as both a grading instrument as well as data for assessing student learning outcomes. Some examples of assessment methods that will be used are given below:

| Method | Description | Direct or Indirect Assessment |
|---|---|---|
| Attendance | Regular participation in class activities (Theory and Practicals) | Indirect |
| Observations | Information can be collected while observing "events" such as classes, group work, and study sessions. | Indirect |
| Performance | Students can be evaluated on participation in practicals, events, presentations, projects. Encourages public speaking skills. | Direct |
| Portfolio | Students' work is collected throughout the program which is assessed by faculty using a common scoring guide. Portfolios may contain assignments, reports, class tests, exams, case studies, presentations, practical file record etc. | Direct |
| Viva Voce or External Review | An interview conducted by external faculty to gauge the depth of theoretical knowledge, clarity, visualization and hands on practical skills of the student. Instills self-confidence to face interviews in their future careers. | Indirect |
| Internally developed class tests | These are shorter tests held periodically through the semester to assess how well the students have grasped the concepts and skills. Also encourages regular attendance. | Direct |
| Course Exam | A comprehensive written exam given near the end of every 2 semesters to determine a student's acquisition and application of a particular type of knowledge or skill, as well as the ability to integrate knowledge. | Direct |

# Structure of B.Sc. (Honours) Biochemistry under CBCS

## Core Course

BCH C-1: Molecules of Life
BCH C-2: Cell Biology
BCH C-3: Proteins
BCH C-4: Enzymes
BCH C-5: Metabolism of Carbohydrates and Lipids
BCH C-6: Membrane Biology and Bioenergetics
BCH C-7: Hormone: Biochemistry and Function
BCH C-8: Human Physiology
BCH C-9: Gene Organization, Replication and Repair
BCH C-10: Metabolism of Amino Acids and Nucleotides
BCH C-11: Concepts in Genetics
BCH C-12: Gene Expression and Regulation
BCH C-13: Genetic Engineering and Biotechnology
BCH C-14: Immunology

## Discipline Specific Elective (*Any four*)

BCH DSE-1: Nutritional Biochemistry
BCH DSE-2: Advanced Cell Biology
BCH DSE-3: Microbiology
BCH DSE-4: Molecular Basis of Infectious Diseases
BCH DSE-5: Plant Biochemistry
BCH DSE-6: Advanced Methodologies

## Generic Elective (*Any four*)

BCH GE-1: Biomolecules
BCH GE-2: Techniques in Biochemistry
BCH GE-3: Proteins and Enzymes
BCH GE-4: Biochemical Correlation of Diseases
BCH GE-5: Intermediary Metabolism
BCH GE-6: Biochemical Applications in Forensics
BCH GE-7: Recombinant DNA Technology

## Ability Enhancement Compulsory Course

AECC-1: English / MIL communication
AECC-2: Environmental science

## Skill Enhancement Elective Course (*Any two*)

BCH SEC-1: Biochemical Techniques
BCH SEC-2: Biostatistics
BCH SEC-3: Research Methodology
BCH SEC-4: Bioinformatics
BCH SEC-5: Microbial Techniques

## SEMESTER-WISE COURSE STRUCTURE of B.Sc. (Honours) Biochemistry

| SEMESTER I | | SEMESTER II | |
|---|---|---|---|
| C1 | Molecules of Life | C3 | Proteins |
| C2 | Cell Biology | C4 | Enzymes |
| AECC1 | English/MIL Communication or EVS | AECC2 | English/MIL Communication or EVS |
| GE-I | Generic Elective (*Any one*) | GE-II | Generic Elective (*Any one*) |
| | I. Biomolecules (GE-1) | | I. Proteins and Enzymes (GE-3) |
| | II. Techniques in Biochemistry (GE-2) | | II. Techniques in Biochemistry (GE-2A) |
| | | | III. Biochemical Correlation of Diseases (GE-4) |
| **SEMESTER III** | | **SEMESTER IV** | |
| C5 | Metabolism of Carbohydrates and Lipids | C8 | Human Physiology |
| C6 | Membrane Biology and Bioenergetics | C9 | Gene Organization, Replication and Repair |
| C7 | Hormone: Biochemistry and Function | C10 | Metabolism of Amino Acids and Nucleotides |
| SEC-I | Skill Enhancement Course (*Any one*) | SEC-II | Skill Enhancement Course (*Any one*) |
| | I. Biochemical Techniques (SEC-1) | | I. Bioinformatics (SEC-4) |
| | II. Biostatistics (SEC-2) | | II. Microbial Techniques (SEC-5) |
| | III. Research Methodology (SEC-3) | | III. Research Methodology (SEC-3A) |
| GE-III | Generic Elective (*Any one*) | GE-IV | Generic Elective (*Any one*) |
| | I. Intermediary Metabolism (GE-5) | | I. Biochemical Correlation of Diseases (GE-4A) |
| | II. Proteins and Enzymes (GE-3A) | | II. Recombinant DNA Technology (GE-7) |
| | III. Biochemical Applications in Forensics (GE-6) | | III. Biochemical Applications in Forensics (GE-6A) |
| **SEMESTER V** | | **SEMESTER VI** | |
| C11 | Concepts in Genetics | C13 | Genetic Engineering and Biotechnology |
| C12 | Gene Expression and Regulation | C14 | Immunology |
| DSE-I | Discipline Specific Elective (*Any two*) | DSE-II | Discipline Specific Elective (*Any two*) |
| | I. Nutritional Biochemistry (DSE-1) | | I. Molecular Basis of Infectious Diseases (DSE-4) |
| | II. Advanced Cell Biology (DSE-2) | | II. Plant Biochemistry (DSE-5) |
| | III. Microbiology (DSE-3) | | III. Advanced Methodologies (DSE-6) |

**C**: Core Courses (14); **GE**: Generic Elective (04); **AECC**: Ability Enhancement Compulsory Course (02); **SEC**: Skill Enhancement Courses (02); **DSE**: Discipline Specific Elective (04). **Numbers within bracket indicate the total number of courses offered in each category.**

***Courses containing "A" in their course code are repeated in different semesters.***

# SCHEME FOR CHOICE BASED CREDIT SYSTEM IN B.Sc. HONOURS BIOCHEMISTRY

| SEMESTER | COURSES OFFERED | COURSE NAME | CREDITS |
|---|---|---|---|
| I | Ability Enhancement Compulsory Course 1 | English / MIL communication / Environmental Science | 4 |
| | Core course 1 Theory (C1) | Molecules of Life | 4 |
| | Core course 1 Practical | Molecules of Life | 2 |
| | Core course 2 Theory (C2) | Cell Biology | 4 |
| | Core course 2 Practical | Cell Biology | 2 |
| | Generic Elective 1 Theory (GE-1) | Biomolecules | 4 |
| | Generic Elective 1 Practical | Biomolecules | 2 |
| | Generic Elective 2 Theory (GE-2) | Techniques in Biochemistry | 4 |
| | Generic Elective 2 Practical | Technique in Biochemistry | 2 |
| II | Ability Enhancement Compulsory Course 2 | English / MIL communication / Environmental Science | 4 |
| | Core course 3 Theory (C3) | Proteins | 4 |
| | Core course 3 Practical | Proteins | 2 |
| | Core course 4 Theory (C4) | Enzymes | 4 |
| | Core course 4 Practical | Enzymes | 2 |
| | Generic Elective 3 Theory (GE-3) | Proteins and Enzymes | 4 |
| | Generic Elective 3 Practical | Proteins and Enzymes | 2 |
| | Generic Elective 4 Theory (GE-4) | Biochemical Correlation of Diseases | 4 |
| | Generic Elective 4 Practical | Biochemical Correlation of Diseases | 2 |
| III | Core course 5 Theory (C5) | Metabolism of Carbohydrates and Lipids | 4 |
| | Core course 5 Practical | Metabolism of Carbohydrates and Lipids | 2 |
| | Core course 6 Theory (C6) | Membrane Biology and Bioenergetics | 4 |
| | Core course 6 Practical | Membrane Biology and Bioenergetics | 2 |

| | | | |
|---|---|---|---|
| | Core course 7 Theory (C7) | Hormone: Biochemistry and Function | 4 |
| | Core course 7 Practical | Hormone: Biochemistry and Function | 2 |
| | Skill Enhancement Course -1 Theory (SEC-1) | Biochemical Techniques | 2 |
| | Skill Enhancement Course -1 Practical | Biochemical Techniques | 2 |
| | Skill Enhancement Course -2 Theory (SEC-2) | Biostatistics | 2 |
| | Skill Enhancement Course -2 Practical | Biostatistics | 2 |
| | Skill Enhancement Course -3 Theory (SEC-3) | Research Methodology | 2 |
| | Skill Enhancement Course -3 Practical | Research Methodology | 2 |
| | Generic Elective – 5 Theory (GE-5) | Intermediary Metabolism | 4 |
| | Generic Elective – 5 Practical | Intermediary Metabolism | 2 |
| | Generic Elective – 6 Theory (GE-6) | Biochemical Applications in Forensics | 4 |
| | Generic Elective – 6 Practical | Biochemical Applications in Forensics | 2 |
| IV | Core course 8 Theory (C8) | Human Physiology | 4 |
| | Core course 8 Practical | Human Physiology | 2 |
| | Core course 9 Theory (C9) | Gene organization, replication and repair | 4 |
| | Core course 9 Practical | Gene organization, replication and repair | 2 |
| | Core course 10 Theory (C10) | Metabolism of Amino Acids and Nucleotides | 4 |
| | Core course 10 Practical | Metabolism of Amino Acids and Nucleotides | 2 |
| | Skill Enhancement Course – 4 Theory (SEC-4) | Bioinformatics | 2 |
| | Skill Enhancement Course – 4 Practical | Bioinformatics | 2 |
| | Skill Enhancement Course – 5 Theory (SEC-5) | Microbial Techniques | 2 |
| | Skill Enhancement Course – 5 Practical | Microbial Techniques | 2 |

| | | | |
|---|---|---|---|
| | Generic Elective – 7 Theory (GE-7) | Recombinant DNA Technology | 4 |
| | Generic Elective - 7 Practical | Recombinant DNA Technology | 2 |
| V | Core course 11 Theory (C11) | Concepts in Genetics | 4 |
| | Core course 11 Practical | Concepts in Genetics | 2 |
| | Core course 12 Theory (C12) | Gene expression and regulation | 4 |
| | Core course 12 Practical | Gene expression and regulation | 2 |
| | Discipline Specific Elective-1 Theory (DSE-1) | Nutritional Biochemistry | 4 |
| | Discipline Specific Elective-1 Practical | Nutritional Biochemistry | 2 |
| | Discipline Specific Elective-2 Theory (DSE-2) | Advanced Cell Biology | 4 |
| | Discipline Specific Elective – 2 Practical | Advanced Cell Biology | 2 |
| | Discipline Specific Elective – 3 Theory (DSE-3) | Microbiology | 4 |
| | Discipline Specific Elective – 3 Practical | Microbiology | 2 |
| VI | Core course 13 Theory (C13) | Genetic Engineering and Biotechnology | 4 |
| | Core course 13 Practical | Genetic Engineering and Biotechnology | 2 |
| | Core course 14 Theory (C14) | Immunology | 4 |
| | Core course 14 Practical | Immunology | 2 |
| | Discipline Specific Elective-4 Theory (DSE-4) | Molecular basis of infectious diseases | 4 |
| | Discipline Specific Elective-4 Practical | Molecular basis of infectious diseases | 2 |
| | Discipline Specific Elective-5 Theory (DSE-5) | Plant Biochemistry | 4 |
| | Discipline Specific Elective-5 Practical | Plant Biochemistry | 2 |
| | Discipline Specific Elective – 6 Theory (DSE-6) | Advanced Methodologies | 4 |
| | Discipline Specific Elective – 6 Practical | Advanced Methodologies | 2 |

**Total : 148 credits**

*Note*: 1 Credit is equivalent to 1 hour of teaching per week for theory courses and 2 hour of teaching for practical courses.

# दिल्ली विश्वविद्यालय
# UNIVERSITY OF DELHI

Bachelor of Science (Hons) Biomedical Science

(Effective from Academic Year 2019-20)

**Revised Syllabus as approved by**

**Academic Council**

Date: No:

**Executive Council**

Date: No:

**Applicable for students registered with Regular Colleges**

# Preamble

The objective of any programme at Higher Education Institute is to prepare their students for the society at large. The University of Delhi envisions all its programmes in the best interest of their students and in this endeavour it offers a new vision to all its Under-Graduate courses. It imbibes a Learning Outcome-based Curriculum Framework (LOCF) for all its Under Graduate programmes.

The LOCF approach is envisioned to provide a focused, outcome-based syllabus at the undergraduate level with an agenda to structure the teaching-learning experiences in a more student-centric manner. The LOCF approach has been adopted to strengthen students' experiences as they engage themselves in the programme of their choice. The Under-Graduate Programmes will prepare the students for both, academia and employability.

Each programme vividly elaborates its nature and promises the outcomes that are to be accomplished by studying the courses. The programmes also state the attributes that it offers to inculcate at the graduation level. The graduate attributes encompass values related to well-being, emotional stability, critical thinking, social justice and also skills for employability. In short, each programme prepares students for sustainability and life-long learning.

The new curriculum of B. Sc. (Hons) Biomedical Science offers a comprehensive skill and the knowledge base for the students keeping in mind the employability of the students. The proposed syllabus has taken advantage of the credit system to gradually make the transition from simple to complex concepts relevant to the interdisciplinary nature of undergraduate program in Biomedical Science.

The University of Delhi hopes the LOCF approach of the B. Sc. (Hons) Biomedical Science programme will help students in making an informed decision regarding the goals that they wish to pursue in further education and life, at large.

# 1. Introduction to B.Sc. (Hons) Biomedical Science Programme

The B.Sc. (Hons) Biomedical Science was started as an interdisciplinary course at University of Delhi in 1999. The course has been very successful in terms of the career options taken up by the students after graduation over the years.

Over the years the course has been structured to reinforce the basic exposure that students get in the higher secondary school and to gradually build on this knowledge-base. The Core courses of the first two semesters are introductory courses in organic chemistry relevant to biology, biology of the cell, the basic building units of an organism, human physiology a glimpse at the orchestrated functioning of organ systems and the basic principles of genetics as seen in nature. In the second year the students would build on what is introduced in the I & II semesters; for instance, building on basic bioorganic chemistry the students will learn more about proteins, the work-horses of the cell running the biochemical factory. At the end of the second year, a student will have basic knowledge of cell biology, genetics, bioorganic chemistry, human physiology, biochemistry, medicinal chemistry, basic molecular and immunobiology. Along with this they will have hands-on training in medical lab techniques, epidemiological data analysis, tools used in forensic science and modern biology under the Skill enhancement courses (SEC). The concepts in pharmacology, toxicology, pathology and biophysics are vital to Biomedical Science and these are introduced in the final year of the course. In the third year, the courses include more complex concepts of mechanisms of achieving regulated functioning of the biological systems, biophysical principles of biological systems, human genetics, genome organization, medical biotechnology and biochemistry and some of the recent excitement in biology and the application of bioinformatics in Biomedical Science as part of Discipline specific elective (DSE) courses along with project work. One or two papers in the final year therefore have a longer list of learning material to be drawn from different sources; however, the actual length of the material for reading/teaching is minimal. This also introduces the students to resources for self-study.

The Generic elective (GE) courses are designed to give the essential exposure to the interdisciplinary nature of Biomedical Science. For example, biological chemistry, bioethics and biosafety, biostatistics, immunology, biotechnology, pharmacology and toxicology are combined into one paper, bioinformatics, IPR, pathophysiology combining human physiology in the context of diseases, tools and model organism in biomedical research are part of GE courses.

# 2. Learning Outcome-Based Approach to Curriculum Planning

## 2.1 Nature and Extent of the B.Sc. (Hons) Biomedical Science Programme

Learning outcomes-based curriculum framework for a B.Sc. degree in Biomedical Science is intended to provide a broad framework that responds to the needs of students and to the evolving nature of biology as a subject. The focus on outcomes creates a clear expectation of what needs to be accomplished by the end of the course. The present framework is intended to allow concept-based learning along with flexibility and innovation that enable transition towards application of the learnt concepts. The programme design and syllabi is abreast with the latest research and developments happening around the world. This helps the students to find a grip on the subject of his/ her choice and make dedicated efforts towards specific field of interest.

Biomedical Science focuses on how cells, organs and systems function in the human body; parameters governing them and attributes of gens and genetics. It is an exciting and dynamic area that is highly relevant to the understanding and treatment of human diseases and diagnostics. This course provides students with an intellectually stimulating education in modern molecular, cellular and systems biology along with Human Genetics, Medical Biotechnology, and a plethora of subjects like Biophysics, Toxicology, Human Pathology, Computational Biology and Drug Design, and Genome Organization and Function distributed over the three years of the course. The course structure essentially has varied components that play important role in an integrated understanding of biomedical science that allows students to subsequently shape their future studies towards the topics that interest them the most. Laboratory work forms an integral part of all the course offered in the programme.

### 2.2 Aims of the B.Sc. (Hons) Biomedical Science Programme

The overall aim(s) of the Bachelor's degree in Biomedical Science are:

(i) To help develop an inherent interest in the field of Biomedical Science. The course aims to enhance understanding of key concepts, theories and principles that will help them to find answers to challenges being faced today in Biomedical Science. The course will help the students develop a broad base understanding of various fields that the bachelor's degree opens up for them, so that they can take up their field of specialization in higher studies.

(ii) To help students to develop thinking and application skills to apply the knowledge thus gained in finding practical solutions to present day challenges.

(iii) To inculcate true scientific temperament in students, such that they apply their knowledge in interdisciplinary fields like Bioinformatics, Biophysics, and Data Science.

## 3. Graduate Attributes in Subject

### Disciplinary knowledge

The course is an amalgamation of various fields of modern life science and provides basic knowledge of functioning of human body. The course also provides insights into mechanisms for normalizing altered functions of the body such as under pathological conditions by use of therapeutic xenobiotics or drugs. In addition, it also inculcates fundamentals of physics and chemistry necessary for development of a deeper understanding of molecular mystery of life.

### Communication Skills

The course structure provides a systematic way of communicating scientific phenomena both oral and written, thereby facilitating expression skills. The precision in communication is instilled through seminars, presentations, viva and discussions.

### Critical Thinking

The course curriculum indoctrinates the ability to critically evaluate the body of knowledge, formulate arguments, asses the present evidence, understand the implicit assumptions and then crystallize a concept or form an opinion.

## Problem Solving

The curriculum would help students to get exposed to scientific skills, such as development of hypothesis and interpreting data. Helping students to acquire these skills would facilitate them to solve complex problems and generate innovative ideas.

## Analytical Reasoning

The multidisciplinary design of the course enables learners to develop rational thinking with reference to the taught phenomena, life-process, etc. from various points of view. The interactive mode of teaching and hands-on sessions further refines their analytical skills.

## Research-Related Skills

The course curriculum exposes students to basic disciplines as well as applied fields which gives a wholesome academic exposure. The inclusion of short-term research projects in the curriculum ensures students develop the capability to inquire, analyze, ask questions and identify cause and effect relationship, outline problem build hypothesis, collect data, infer, interpret and formulate an opinion. This sharpens their research skills and helps develop scientific temperament.

## Cooperation/ Team Work

The course structure and its experimental curriculum ensure coordinated efforts amongst the students as a group. The co-action and synergism within the students for common goals builds a team spirit which nurtures tolerance and understanding.

## Scientific Reasoning

After studying the course, students will be clear that most of the discoveries in the field are using well-structured protocols. Students would become more inquisitive, ready to do experimentation, collect evidences and draw inferences on a routine basis.

## Reflective Thinking

Curriculum would promote emotionality supportive environment for students. Moreover, it would provide an environment that prompts students to explore what they think is important. Students will be able to develop strategies to apply new knowledge for complex situations. Ability of students to review their course work would substantially increase their problem-solving skills.

## Information/ Digital Literacy

In addition to "Face-to-face" education, E-learning skills would help students understand concepts in a better way. These skills would help them with their own presentations and assignments and help them with their timelines. Peer learning using ICT skills would also make them connected with society. Considering the fact that ICT skills are now widespread in all fields, college graduates with these skills would be in great demand by employers in many sectors.

### Self-Directed Learning

Students would be intrinsically motivated towards self-learning. This would help them cultivate their networks to learn effectively and would know how to be self-reliant. Students would readily embrace responsibility for doing good work and ready for growth mindset. Moreover, they would not be easily thwarted when their going gets tough.

### Moral and Ethical Awareness/ Reasoning

The curriculum inculcates different aspects of moral and ethical values in students such as ethics in laboratories and animal- handling, and plagiarism related issues. Such training makes them responsible citizens and good human beings.

### Lifelong Learning

The course curriculum teaches the students to keep themselves abreast with the current developments in different disciplines in order to have a comprehensive scientific knowledge which provides a base for all the future endeavours. The students thus develop a self-directed lifelong learning in conjunction with the contextual environment to remain relevant and progressive.

## 4. Qualification Descriptors for Graduates

Through the academic standards and generic outcomes for the award of B.Sc. (Hons) Biomedical Science, the student should be able to demonstrate:

i) an integrated grasp of the core and discipline specific subjects covered in Biomedical Science through stories of discovery and rigour of experiential learning;
ii) how to access, create and analyze knowledge and data, stitch diverse concepts and apply in the management of human diseases, public health and related areas;
iii) appreciation for interdisciplinary skills as the key theme in thinking, comprehending and solving the local and global issues in the area of biomedical research and development;
iv) extensive laboratory, analytical and problem-solving skills gained through elaborate and meticulously planned experiments;
v) an aptitude for research, academia and industry;
vi) how to do literature search, retrieve information on current research available online or in print, use and include open source tools for learning and in short-term projects relating to essential and advanced areas in Biomedical Science;
vii) experimental skills and their application required for identifying problems and issues relating to the disciplinary area and field of study;
viii) communication skills though making presentations (oral or written), writing reports and expressing their science ideas through a technical note/design or via an art form;
ix) confidence and a curiosity driven quest to work in large teams at national and international platforms and/or execute a research project/task independently and
x) the ability to extrapolate/draw inferences and direct the acquired knowledge and transferable skills to real-life research questions as well in areas such as industry, management, scientific communication etc.

## 5. Programme Learning Outcomes

The expected learning outcomes that an undergraduate student of B.Sc. (Hons) Biomedical Science should be able to demonstrate for the award of the qualification may include the following:

i) Demonstrate fundamental knowledge and understanding of the principles and processes underlying various inter-disciplinary subjects related to Biomedical Science, e.g. physiology, cell biology, biochemistry, biotechnology, computational biology, genetics, molecular biology, medicinal chemistry, toxicology, pharmacology, microbiology, etc.
ii) Apply appropriate methodologies for planning and executing experiments related to different aspects of life sciences. Also analyze and interpret the results of the experiments performed.
iii) Ability to reason scientifically and analytically.
iv) Undertake hands-on lab work and practical activities which develop problem solving abilities, required for careers in research.

## 6. Teaching-Learning Process

The programme of study in Biomedical Science is designed to encourage the acquisition of disciplinary/ subject (core, interdisciplinary) knowledge, understanding experimental research, academic and professional skills required for life sciences, biomedical science and biotechnology-based professions both in industry and academic jobs. Learning experiences both practical based and classroom teaching should be designed and implemented to foster active/ participative learning. Development of practical skills will constitute an important aspect of the teaching-learning process. A variety of approaches to teaching-learning process, including lectures by faculty, eminent scientists, student seminars, tutorials, workshops, peer teaching and learning, practicum and project-based learning, field-based learning, substantial laboratory-based practical component and experiments, open-ended project work, games, quizzes, technology-enabled learning, internship in industry and research establishments etc. will need to be adopted to achieve this. Problem-solving skills and higher-order skills of reasoning and analysis will be encouraged through teaching strategies.

## 7. Assessment Methods

Different assessment methods that are appropriate to Biomedical Science course will be used to assess progress towards the course/ programme learning outcomes. Progress towards achievement of learning outcomes will be assessed using the following:

Semester end examinations as conducted by the University; problem-based assignments; closed-book and open-book tests; observation of practical skills; laboratory records; project reports; case-study reports; oral presentations, including seminar presentation; viva-voce interviews; computerized adaptive testing; peer and self-assessment etc. and any other pedagogic approaches.

# 8. Structure of B.Sc. (Hons) Biomedical Science

## 8.1. Credit Distribution

The B.Sc. (Hons) in Biomedical Science programme is a three-year course divided into six-semesters. A student is required to complete 148 credits for the completion of course and the award of degree.

Course Credit Scheme

| Semester | Core Course (CC) (6 Credits/ Paper) | | | Skill-Enhancement Elective Course (SEC) (4 Credits/ Paper) | | | Discipline Specific Elective (DSE) Course (6 Credits/ Paper) | | | Generic Elective (GE) Course (6 Credits/ Paper) | | | Total credit/ Semester |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. of Papers | Credits (L+P) | Total Credits | No. of Papers | Credits (L+P) | Total Credits | No. of Papers | Credits (L+P) | Total Credits | No. of Papers | Credits (L+P) | Total Credits | |
| I* | 2 | 8+4 | 12 | 0 | - | - | 0 | - | - | 1 | 4+2 | 6 | 22* |
| II* | 2 | 8+4 | 12 | 0 | - | - | 0 | - | - | 1 | 4+2 | 6 | 22* |
| III | 3 | 12+6 | 18 | 1 | 2+2 | 4 | 0 | - | - | 1 | 4+2 | 6 | 28 |
| IV | 3 | 12+6 | 18 | 1 | 2+2 | 4 | 0 | - | - | 1 | 4+2 | 6 | 28 |
| V | 2 | 8+4 | 12 | 0 | - | - | 2 | 8+4 | 12 | 0 | - | - | 24 |
| VI | 2 | 8+4 | 12 | 0 | - | - | 2 | 8+4 | 12 | 0 | - | - | 24 |
| **Total** | 14 | 56+28 | 84 | 2 | 4+4 | 8 | 4 | 16+8 | 24 | 4 | 16+8 | 24 | 148* |

*Students will have two papers of 4 credits each of Ability Enhancement Compulsory Course (AECC- English/ MIL and EVS) one in each semester.

For Theory (L): 1 Credit = 1hour lecture and there will be 4 lectures/ week. For Practical (P): 1 Credit = 2 hours and there will be 4 hour-session/ week.

## 8.2 Semester-wise Distribution of Courses

| SEMESTER I | | SEMESTER II | |
|---|---|---|---|
| C1 | Bioorganic Chemistry | C3 | Principles of Genetics |
| C2 | Cell and Radiation Biology | C4 | Human Physiology and Anatomy I |
| AECC1 | English/MIL Communication or EVS | AECC2 | EVS or English/MIL Communication |
| GE1 | Generic Elective | GE2 | Generic Elective |

| SEMESTER III | | SEMESTER IV | |
|---|---|---|---|
| C5 | Biochemistry | C8 | Immunobiology |
| C6 | Human Physiology and Anatomy II | C9 | Molecular Biology |
| C7 | Medical Microbiology | C10 | Medicinal Chemistry |
| SEC1 | Skill-Enhancement Elective Course | SEC2 | Skill-Enhancement Elective Course |
| GE3 | Generic Elective | GE4 | Generic Elective |

| SEMESTER V | | SEMESTER VI | |
|---|---|---|---|
| C11 | Biophysics | C13 | Human Pathology |
| C12 | Pharmacology | C14 | Toxicology |
| DSE1 | Discipline Specific Elective | DSE3 | Discipline Specific Elective |
| DSE2 | Discipline Specific Elective | DSE4 | Discipline Specific Elective |

C: Core Courses; AECC: Ability Enhancement Compulsory Course; SEC: Skill-Enhancement Elective Courses; DSE: Discipline Specific Elective; GE: Generic Elective

**SEC 1-2: Skill-Enhancement Elective Courses (any one per semester in semesters 3-4)**

1. Methods in Epidemiological Data Analysis (EDA)
2. Medical Laboratory Diagnostics (MLD)
3. Techniques for Forensic Science
4. Tools in Modern Biology

**DSE 1-4: Discipline Specific Elective (any two per semester in semesters 5-6)**

1. Computational Biology and Drug Design
2. Genome Organization and Function
3. Human Genetics
4. Medical Biochemistry
5. Medical Biotechnology
6. Project Work (can be chosen only in semester 6)

**GE 1-4: Generic Electives (any one per semester in semesters 1-4)**

1. Basics of Immunology
2. Biological Chemistry
3. Biosafety and Bioethics
4. Biostatistics
5. Bridging Information Technology and Biotechnology
6. Concepts in Biotechnology
7. Concepts in Medicinal Chemistry and Drug Development
8. Intellectual Property Rights (IPR) for Biologists
9. Pathological Basis of Diseases
10. Pharmacology and Toxicology
11. Tools and Model Organisms in Biomedical Research

## 9. Courses for Programme

### Core Courses (CC) (Theory + Practical)

**Semester I**
Bioorganic Chemistry
Cell and Radiation Biology

**Semester II**
Principles of Genetics
Human Physiology and Anatomy I

**Semester III**
Biochemistry
Human Physiology and Anatomy II
Medical Microbiology

**Semester IV**
Immunobiology
Molecular Biology
Medicinal Chemistry

**Semester V**
Biophysics
Pharmacology

**Semester VI**
Human Pathology
Toxicology

# दिल्ली विश्वविद्यालय
# UNIVERSITY OF DELHI

Bachelor of Science (Hons) Chemistry

(Effective from Academic Year 2019-20)

**Revised Syllabus as approved by**

**Academic Council**

Date: 15 & 16 July 2019 No:

**Executive Council**

Date: 20 & 21 July 2019 No:

**Applicable for students registered with Regular Colleges, Non Collegiate Women's Education Board and School of Open Learning**

## Preamble

The objective of anyprogramme at Higher Education Institute is to prepare their students for the society at large. The University of Delhi envisions all its programmes in the best interest of their students and in this endeavour, it offers a new vision to all its Under-Graduate courses. It imbibes a Learning Outcome-based Curriculum Framework (LOCF) for all its Under Graduate programmes.

The LOCF approach is envisioned to provide a focused, outcome-based syllabus at the undergraduate level with an agenda to structure the teaching-learning experiences in a more student-centric manner. The LOCF approach has been adopted to strengthen students' experiences as they engage themselves in the programme of their choice. The Under-Graduate Programmes will prepare the students for both, academia and employability.

Each programme vividly elaborates its nature and promises the outcomes that are to be accomplished by studying the courses. The programmes also state the attributes that it offers to inculcate at the graduation level. The graduate attributes encompass values related to well-being, emotional stability, critical thinking, social justice and also skills for employability. In short, each programme prepares students for sustainability and life-long learning.

The new curriculum of BSc (Hons) Chemistry offer courses in the areas of inorganic, organic, physical, materials and analytical. All the courses are having defined objectives and Learning Outcomes, which will help prospective students in choosing the elective courses to broaden their skills in the field of chemistry and interdisciplinary areas. The courses will train students with sound theoretical and experimental knowledge that suits the need of academics and industry. The courses also offers ample skills to pursue research as career in the filed of chemistry and allied areas. As usual, B.Sc. (Hons.) Chemistry programme offered by one of the largest and oldest Departments in the country will continue to produce best minds to meet the demands of society.

The University of Delhi hopes the LOCF approach of the programme BSc (Hons) Chemistry will help students in making an informed decision regarding the goals that they wish to pursue in further education and life, at large.

## 1. Introduction to B.Sc. (Hons.) Chemistry

The Choice Based Credit System (CBCS) provides an opportunity to a student to choose courses from the syllabus comprising Core, Elective and Skill based courses. It offers a flexibility of programme structure while ensuring that the student gets a strong foundation in the subject and gains in-depth knowledge. The learning outcome based curriculum framework (LOCF) will provide students with a clear purpose to focus their learning efforts and enable them to make a well judged choice regarding the course they wish to study. This will suit the present day needs of students in terms of securing their paths towards higher studies or employment.

**Programme Duration and Design**

The B.Sc. (Hons.) Chemistry course is a six semester course spread over three academic years. The teaching – learning process involves theory and practical classes and will be student centered. Apart from the conventional chalk and talk method, power point presentations, audio – video tools, class discussions, simulations and virtual labs (wherever possible) will be used. Students will be encouraged to carry out short term projects and participate in industrial and institutional visits, seminars and workshops. Assessment will be based on continuous evaluation (class test, presentation, group discussion, quiz, assignment etc.) and end of semester examination. Each theory paper will be of 100 marks out of which 25% marks are for internal assessment while a practical paper will be of 50 marks comprising 50% internal assessment.

## 2. Learning Outcome-based Curriculum Framework in BSc (Hons.) Chemistry

The Learning Outcomes-based Curriculum Framework (LOCF) for the B.Sc. (Hons.) degree in Chemistry provides a broad structural framework that can accommodate the current curricular needs as well as gives sufficient flexibility to include changes in content that assume importance as the frontiers of science grow. The inherent flexibility in framework allows design of course basket in tune with individual preferences. The basic uniformity in core course design ensures smooth movement across universities in the country.

### 2.1 Nature and Extent of B.Sc. (Hons.) Chemistry

The B.Sc. (Hons.) Chemistry programme covers a wide range of basic and applied courses as well as courses of interdisciplinary nature.

### 2.2 Aims of the Bachelors Degree Programme in B.Sc. (Hons.) Chemistry

The core courses offered in the programme aim to build a strong conceptual chemical knowledge base in the student,the contents of electives and skill enhancement courses help them explore their fitness and suitability to pursue studies in these areas.

## 3. Graduate Attributes inB.Sc. (Hons.) Chemistry

Though a student pursuing an undergraduate degree in a science discipline is inherently curiosity driven and has the ability to observe and integrate rationally, here are the additional attributes that distinguish a student graduating with an honours degree in chemistry:

(i) Disciplinary Knowledge:

The student has acquired in-depth knowledge of the various concepts and theoretical principles and is aware of their manifestations. An understanding of the centrality of chemistry is usually evident from familiarity with interfacial disciplines.A graduate in chemistry is expected to be thoroughly conversant with all basic analytical, qualitative and quantitative laboratory techniques and demonstrate meticulousness in operation. She/he is aware of the importance of working with safety and consciousness in laboratory and actively seeks information about health and environmental safety of chemicals that are used in the laboratories and follows protocols for their safe disposal.

(ii) Communication skills:

Effective communication is a much desirable attribute across courses. However, a chemistry honours student is expected to assimilate technical information about chemistry from various sources and convey it to intended audience, both orally and in writing in an intelligible manner.

(iii) Critical thinking:

Critical thinking as an attribute enables a student to analyze a problem, assess it, reconstruct it and solve it.

(iv) Problem solving:

An integral part of chemistry curriculum is problem solving. The student will be equipped to solve problems of numerical, synthetic and analytical nature that are best approached with critical thinking.

(v) Analytical reasoning:

The student will be able to draw logical conclusions based on a group of observations, facts and rules.

(vi) Research related skills:

The student is inquisitive about processes and phenomena happening during experiments in laboratories and seeks answers through the research path.

(vii) Cooperation/Team work:

Teams may comprise of peers in classroom, laboratory or any other team of members from diverse fields. The student is capable of contributing meaningfully to team ethos and goals.

(viii) Scientific reasoning:

Students learn to investigate, experiment, relate information and draw logical conclusions based on scientific reasoning.

(ix) Reflective thinking:

Reflective thinking focuses on the process of making judgments about what has happened. The students learn to review their experience and make a plan for future actions in a similar situation with a view to improve.

(x) Information/digital literacy:

Increasing use of instruments having interface with computers and use of computers in laboratory work creates this attribute. A student with degree in chemistry is able to employ knowledge and skill in computers in a variety of situations- data analysis, computing as well as information retrieval and library use.

(xi) Self-directed learning:

Studentsare encouraged to explore the many sources of information available to them. Various activities require the students to find relevant information and educate themselves.

(xii) Multicultural competence:

The student recognizes that all persons are unique in their own way and appreciates the differences in cultural background, religious beliefs, and socio-economic status.

(xiii) Moral and ethical awareness/reasoning:

The student is aware of what constitutes unethical behaviour-- plagiarism, fabrication and misrepresentation or manipulation of data.

(xiv) Leadership readiness/qualities:

Leadership is essential in making teamwork into a reality. Working in teams promotes both teamwork and leadership qualities in the student.

(xv) Lifelong learning:

Having a strong conceptual framework in the subject along with the skills of teamwork, analytical reasoning, problem solving, critical thinking etc. make the students lifelong learners.

## 4. Qualification Descriptors for Graduates in B.Sc. (Hons.) Chemistry

The qualification description for B.Sc. (Hons.) programme in Chemistry includes

- Demonstration of a comprehensive knowledge basedon concepts, principles and theories relating to chemistry that spans the traditional sub-disciplines (inorganic chemistry, organic chemistry, physical chemistry, analytical chemistry and biochemistry) as well as advanced and emerging topics.
- Demonstration of an ability to apply underlying concepts and principles outside the context in which they were first studied and in interdisciplinary scenarios.
- Acquisition of competence in the use of routine materials, techniques and practices of chemistry.
- Exhibition of skills required for conducting the documented laboratory procedures as well as well-developed skills for the gathering, evaluation, analysis and presentation of information, ideas, concepts and quantitative and/or qualitative data.
- Acquisition of skills in the operation of standard chemical instrumentation.
- Demonstration of skills in the use of safety data sheets, safe-handling of chemical materials, considering their physical and chemical properties including any specific hazards associated with their use.
- Development of literature searching and information management skills.

- Acquisition of the ability for responsible treatment of data, proper citation of others' work, and the standards related to plagiarism.
- Development of awareness of the role of chemistry in contemporary societal and global issues, including areas such as sustainability and green chemistry.
- Development of the appreciation of the uses of chemistry in daily life.
- Development of competence in intellectual, practical and transferable skills (Communication skills, IT skills, Interpersonal skills) necessary for employment as a professional chemist

## 5. Programme Learning Outcomes in B.Sc. (Hons.) Chemistry

The B.Sc.(Hons) programme in Chemistry is designed to develop in students in depth knowledge of the core concepts and principles that are central to the understanding of this core science discipline. Undergraduates pursuing this programme of study go through laboratory work that specifically develops their quantitative and qualitative skills, provides opportunities for critical thinking and team work, and exposes them to techniques useful for applied areas of scientific study.

- **Knowledge: Width and depth:** Students acquire theoretical knowledge and understanding of the fundamental concepts, principles and processes in main branches of chemistry, namely, organic chemistry, inorganic chemistry, physical chemistry, analytical chemistry and biochemistry. In depth understanding is the outcome of transactional effectiveness and treatment of specialized course contents. Width results from the choice of electives that students are offered.
- **Laboratory Skills: Quantitative, analytical and instrument based:** A much valued learning outcome of this programme is the laboratory skills that students develop during the course. Quantitative techniques gained through hands on methods opens choice of joining the industrial laboratory work force early on. The programme also provides ample training in handling basic chemical laboratory instruments and their use in analytical and biochemical determinations. Undergraduates on completion of this programme can cross branches to join analytical, pharmaceutical, material testing and biochemical labs besides standard chemical laboratories.
- **Communication:** Communication is a highly desirable attribute to possess. Opportunities to enhance students' ability to write methodical, logical and precise reports are inherent to the structure of the programme. Techniques that effectively communicate scientific chemical content to large audiences are acquired through oral and poster presentations and regular laboratory report writing.
- **Capacity Enhancement:** Modern day scientific environment requires students to possess ability to think independently as well as be able to work productively in groups. This requires some degree of balancing. The chemistry honours programme course is designed to take care of this important aspect of student development through effective teaching learning process.
- **Portable Skills:** Besides communication skills, the programme develops a range of portable or transferable skills in students that they can carry with them to their new work environment after completion of chemistry honours programme. These are problem solving, numeracy and mathematical skills- error analysis, units and conversions, information retrieval skills, IT skills and organizational skills. These are valued across work environments.

## 6. Structure of the Programme in B.Sc. (Hons.) Chemistry

The programme includes Core Courses and Elective Courses. The Core Courses are all compulsory courses.There are three types of Elective Courses – Discipline Specific Elective (DSE), Generic Elective (GE), Skill Enhancement Courses (SEC). In addition there are two compulsory Ability Enhancement Courses (AEC). The Core, DSE and GE Courses are six credit courses; the SEC, AEC are four credit courses.

**To acquire a B.Sc. (Hons) Chemistry degree, the student will study fourteen Core Courses,two Ability Enhancement compulsory courses, two Skill Enhancement Courses, fourDiscipline Specific Elective Courses and four Generic Elective Courses.**

The student will study two Core Courses each, in Semesters I and II, three Core Courses each in Semesters III and IV and two Core Courses each in Semesters V and VI. The programme offers several Discipline-Specific Electives, of which the student will study two in each of the Semesters V and VI.

Different Generic Elective courses are offered to students of B.Sc. (Hons) Chemistry Programme by other Departments of the Collegeand the student will have the option to choose one GE course each in Semesters I, II, III, and IV. **At least two papers of Mathematics are compulsory for admission to M.Sc. Chemistry in University of Delhi, thus students are advised to opt for the same.** The Department of Chemistry offers eight GE courses to students of other disciplines (refer to * on page 13).

Students will study one Skill Enhancement Course each in Semesters III and IV. The two compulsory Ability Enhancement Courses are Environmental Sciences and English Communication and the student will study one each in Semesters I and II.

Structure of the B.Sc. (Hons) Chemistry Programme under Choice Based Credit System

| Semester | CORE COURSE (14)* | Ability Enhancement Compulsory Course (AECC) (2)* | Skill Enhancement Course (SEC) (2)* | Elective: Discipline Specific DSE (4)* | Elective: Generic (GE) (4)* |
|---|---|---|---|---|---|
| I | C-1<br>C-2 | AECC-1 | | | GE-1 |
| II | C-3<br>C-4 | AECC-2 | | | GE-2 |
| III | C-5<br>C-6<br>C-7 | | SEC-1 | | GE-3 |
| IV | C-8<br>C-9<br>C-10 | | SEC-2 | | GE-4 |
| V | C-11<br>C-12 | | | DSE-1, DSE-2 | |
| VI | C-13<br>C-14 | | | DSE-3, DSE-4 | |

* Number of courses student has to study

## 6.1 Semester-wise Distribution of Courses for B.Sc. (Hons) Chemistry Programme under CBCS and Credit Distribution

| CORE COURSES –14 (six credits each) – Each course has 4 Periods/week for Theory, 4 Periods/week for Practical | | | |
|---|---|---|---|
| **SEMESTER** | **COURSE CODE** | **NAME OF THE COURSE** | **CREDITS T- Theory Credits P- Practical Credits** |
| I | CHEMISTRY – C I | Inorganic Chemistry I:Atomic Structure & Chemical Bonding | T=4 P=2 |
| I | CHEMISTRY – C II | Physical Chemistry I:States of Matter & Ionic Equilibrium | T=4 P=2 |
| II | CHEMISTRY – C III | Organic Chemistry I:Basics and Hydrocarbons | T=4 P=2 |
| II | CHEMISTRY – C IV | Physical Chemistry II:Chemical Thermodynamics and its Applications | T=4 P=2 |
| III | CHEMISTRY – C V | Inorganic Chemistry II:s- and p-Block Elements | T=4 P=2 |
| III | CHEMISTRY – C VI | Organic Chemistry II:Halogenated Hydrocarbons and Oxygen Containing Functional Groups | T=4 P=2 |
| III | CHEMISTRY – C VII | Physical Chemistry III:Phase Equilibria and Electrochemical Cells | T=4 P=2 |
| IV | CHEMISTRY – C VIII | Inorganic Chemistry III:Coordination Chemistry | T=4 P=2 |
| IV | CHEMISTRY – C IX | Organic Chemistry III:Nitrogen containing functional groups, Polynuclear Hydrocarbons, Heterocyclic Chemistry, Alkaloids and Terpenes | T=4 P=2 |
| IV | CHEMISTRY – C X | Physical Chemistry IV: Conductance & Chemical Kinetics | T=4 P=2 |
| V | CHEMISTRY – C XI | Organic Chemistry IV: Biomolecules | T=4 P=2 |
| V | CHEMISTRY – C XII | Physical Chemistry V: Quantum Chemistry & Spectroscopy | T=4 P=2 |
| VI | CHEMISTRY – C XIII | Inorganic Chemistry IV: Organometallic Chemistry & Bioinorganic Chemistry | T=4 P=2 |
| VI | CHEMISTRY – C XIV | Organic Chemistry V: Spectroscopy & Applied Organic Chemistry | T=4 P=2 |
| Credits: 14×6 = 84 | | | |

| ABILITY ENHANCEMENT COMPULSORY COURSES (AECC) – 2 (4 credits each) | | | |
|---|---|---|---|
| **SEMESTER** | **COURSE CODE** | **NAME OF THE COURSE** | **CREDITS T- Theory Credits P- Practical Credits** |
| | AEC-I | Environmental Science | T = 4 |
| | AEC-II | English Communication | T = 4 |
| | | | **Credits: 2 × 4 = 08** |

| SKILL ENHANCEMENT ELECTIVE COURSES (SEC) – 2 (four credits each, refer to *** on page 14) | | | |
|---|---|---|---|
| **SEMESTER** | **COURSE CODE** | **NAME OF THE COURSE** | **CREDITS**<br>**T=Theory Credits**<br>**P=Practical Credits** |
| | CHEMISTRY-SEC-1 | IT Skills for Chemists | T=2 P=2 |
| | CHEMISTRY-SEC-2 | Basic Analytical Chemistry | T=2 P=2 |
| | CHEMISTRY-SEC-3 | Chemical Technology & Society | T=4 |
| | CHEMISTRY-SEC-4 | Cheminformatics | T=2 P=2 |
| | CHEMISTRY-SEC-5 | Business Skills for Chemists | T=4 |
| | CHEMISTRY-SEC-6 | Intellectual Property Rights | T=4 |
| | CHEMISTRY-SEC-7 | Analytical Clinical Biochemistry | T=2 P=2 |
| | CHEMISTRY-SEC-8 | Green Methods in Chemistry | T=2 P=2 |
| | CHEMISTRY-SEC-9 | Pharmaceutical Chemistry | T=2 P=2 |
| | CHEMISTRY-SEC-10 | Chemistry of Cosmetics & Perfumes | T=2 P=2 |
| | CHEMISTRY-SEC-11 | Pesticide Chemistry | T=2 P=2 |
| | CHEMISTRY-SEC-12 | Fuel Chemistry | T=2 P=2 |
| | | | **Credits: 2 × 4 = 08** |

| DISCIPLINE SPECIFIC ELECTIVE COURSES (DSE) – 4 (six credits each, refer to ** on page 14)<br>Each course has 4 Periods/week for Theory, 4 Periods/week for Practical | | | |
|---|---|---|---|
| **SEMESTER** | **COURSE CODE** | **NAME OF THE COURSE** | **CREDITS**<br>**T=Theory Credits**<br>**P=Practical Credits** |
| | CHEMISTRY-DSE-1 | Novel Inorganic Solids | T=4<br>P=2 |
| | CHEMISTRY-DSE-2 | Inorganic Materials of Industrial Importance | T=4<br>P=2 |
| | CHEMISTRY-DSE-3 | Applications of Computers in Chemistry | T=4<br>P=2 |
| | CHEMISTRY-DSE-4 | Analytical Methods in Chemistry | T=4<br>P=2 |
| | CHEMISTRY-DSE-5 | Molecular Modelling & Drug Design | T=4<br>P=2 |
| | CHEMISTRY-DSE-6 | Polymer Chemistry | T=4<br>P=2 |
| | CHEMISTRY-DSE-7 | Research Methodology for Chemistry | T=5<br>P=1 |
| | CHEMISTRY-DSE-8 | Green Chemistry | T=4<br>P=2 |
| | CHEMISTRY-DSE-9 | Industrial Chemicals & Environment | T=4<br>P=2 |
| | CHEMISTRY-DSE-10 | Instrumental Methods of Chemical Analysis | T=4<br>P=2 |
| | CHEMISTRY-DSE-11 | Nanoscale Materials and their Applications | T=4<br>P=2 |
| | CHEMISTRY-DSE-12 | Dissertation | 6 |
| Credits: 4 × 6 = 24 | | | |

| GENERIC ELECTIVES COURSES (GE)– 4(six credits each) –Offered by other Departments. Please refer to the syllabus of other departments (Mathematics, Physics, Economics and computer science). | | | |
|---|---|---|---|
| SEMESTER | COURSE CODE | NAME OF THE COURSE | CREDITS<br>T=Theory Credits<br>P=Practical Credits or Tutorial Credits |
| I | | GE 1 | 6 |
| II | | GE 2 | 6 |
| III | | GE 3 | 6 |
| IV | | GE 4 | 6 |
| Credits: 4 × 6 = 24 | | | |

**TOTAL CREDITS = 148**

**Note: Wherever there is a practical there will be no tutorial and vice-versa. The size of the group for practical papers is recommended to be maximum of 12 to 15 students.**

***Generic Elective Papers (GE) for other Departments/Disciplines: (Credit: 06 each – 4T + 2P)**

1. Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons
2. Chemical Energetics, Equilibria & Functional Group Organic Chemistry-I
3. Solutions, Phase Equilibrium, Conductance, Electrochemistry & Functional Group Organic Chemistry-II
4. Chemistry of s- and p-block elements, States of matter and Chemical Kinetics
5. Chemistry of d-block elements, Quantum Chemistry and Spectroscopy
6. Organometallics, Bioinorganic chemistry, Polynuclear hydrocarbons and UV, IR Spectroscopy
7. Molecules of life
8. Green Chemistry: Designing Chemistry for human health and environment

****Discipline Specific Elective Courses: (Credit: 06 each) (4 courses to be selected)-DSE 1-4**

**DSE 1: Choose any one of the following**

1. Novel Inorganic Solids
2. Inorganic Materials of Industrial Importance

**DSE 2: Choose any one of the following**

1. Applications of Computers in Chemistry
2. Analytical Methods in Chemistry
3. Green Chemistry
4. Industrial Chemicals & Environment
5. Dissertation

**DSE 3 and 4: Choose any one option each from Group A and Group B**

**Group A**

1. Analytical Methods in Chemistry
2. Polymer Chemistry
3. Nanoscale Materials and their Applications
4. Instrumental Methods of Chemical Analysis

**Group B**

1. Applications of Computers in Chemistry
2. Molecular Modelling & Drug Design
3. Research Methodology for Chemistry
4. Green Chemistry
5. Dissertation

**All colleges will float more than one DSE course for DSE 2, DSE3 and DSE 4 to enable students to have a choice.**Students may opt for a dissertation as a DSE course in Semester VI. It will be a six credit course. The number of students who will be allowed to opt for this will vary from college to college depending upon the infrastructural facilities and may vary each year. The college may announce the number of seats for Dissertation/project work well in advance and choose students for the same. It will involve experimental work under the supervision of a faculty member. Internal and external examiners will evaluate the project and the report should be sent to examiners in advance (prior to the day of examination).

*****Skill Enhancement Courses** - Inthe following **papers students should submit a project or case studies.**

- Chemical Technology & Society
- Business Skills for Chemists
- Intellectual Property Rights

## 7. Teaching – learning process:

B.Sc. (Hons) Chemistry programme is a three-year degree programme designed to provide students with a sound theoretical background and practical training in all aspects of chemistry and helps them develop an appreciation of the importance of chemistry in different contexts. The programme includes foundational as well as in-depth courses that span the traditional sub-disciplines of chemistry. Along with the above Core Courses there are Discipline Specific Elective Courses, Generic Elective Courses and Ability Enhancement Courses which address the need of the hour.

These courses are delivered through classroom, laboratory work, projects, case studies and field work in a challenging, engaging, and inclusive manner that accommodates a variety of learning styles and tools (PowerPoint presentations, audio visual resources, e-resources, seminars, workshops, models, softwares).

The laboratory training complements the theoretical principles learned in the classroom and includes synthesis of molecules, measurement of chemical properties and phenomenon, hands-on experience with modern instruments, computational data analysis, modelling and laboratory safety procedures.

Different pedagogies such as problem-based learning, peer-led instruction, and technology-aided instruction (blended learning) are adopted wherever suitable. These promote independent thinking, critical thinking and reasoning and a perspective of chemistry as a scientific process of discovery. Students are encouraged to work together in groups which leads to development of interpersonal skills like communication and team work.

The student will participate in industrial visits that will lay strong foundation for a successful career as a professional chemist by providing him/her useful information related to the practical aspects of the course and giving an insight to future areas of employment.

## 8. Assessment methods:

Assessment methods have two major objectives:

- The primary one is to assess the learning outcomes of the course in tune with the broad outcomes of strengthening core theoretical knowledge base and practical laboratory skills. This is assessed by comprehensive summative end-semester examinations conducted for both theory and practical courses. Also In-courseassessmentsare given in every course in order to assess the students mastery of various learning outcomes. These assessments include individual assignments, group assignments, laboratory notebooks, written reports, quizzes, class tests and periodical tests.
- Another objective is to improve the students' learning and teachers' teaching. Results of assessments and their critical analysis are used to improve the process further by focusing on the areas that need conceptual strengthening, laboratory exposure or design of new experiments.

# दिल्ली विश्वविद्यालय

# UNIVERSITY OF DELHI

Bachelor of Science (Hons.) Computer Science

(Effective from Academic Year 2019-20)

Revised Syllabus as approved by

Academic Council

Date: No:

Executive Council

Date: No:

**Applicable for students registered with Regular Colleges, Non Collegiate Women's Education Board and School of Open Learning**

## Preamble

The objective of any programme at Higher Education Institute is to prepare their students for the society at large. The University of Delhi envisions all its programmes in the best interest of their students and in this endeavour it offers a new vision to all its Under-Graduate courses. It imbibes a Learning Outcome-based Curriculum Framework (LOCF) for all its Under Graduate programmes.

The LOCF approach is envisioned to provide a focused, outcome-based syllabus at the undergraduate level with an agenda to structure the teaching-learning experiences in a more student-centric manner. The LOCF approach has been adopted to strengthen students' experiences as they engage themselves in the programme of their choice. The Under-Graduate Programmes will prepare the students for both, academia and employability.
Each programme vividly elaborates its nature and promises the outcomes that are to be accomplished by studying the courses. The programmes also state the attributes that it offers to inculcate at the graduation level. The graduate attributes encompass values related to well-being, emotional stability, critical thinking, social justice and also skills for employability. In short, each programme prepares students for sustainability and life-long learning.

The new curriculum of B.Sc. (H) Computer Science offers to develop theoretical foundations in computer science to build computational thinking, analytical, and problem solving skills. The programme builds a base for entry level jobs in information technology and prepares the students for higher studies in the area of Computer Science/Applications. The course aims to produce skilled graduates with a creative mind-set who can recognize a computational problem either in IT industry or society, and develop effective solutions. Understanding the needs of society and societal obligations are instilled in courses related to AI and Information security.

The students develop expertise in programming skills using contemporary programming languages used by software industry. It covers core computer science topics like computer systems architecture, data structures, computer networks, operating systems, computer graphics, algorithms, software engineering, database management, theory of computation, artificial intelligence, and information security. The mode of learning shall be a blend of the formal and the inquiry based methods, with special focus on practical and projects.

The University of Delhi hopes the LOCF approach of the programme B.Sc. (H) Computer Science will help students in making an informed decision regarding the goals that they wish to pursue in further education and life, at large.

## 1. Introduction to Programme B.Sc. (H) Computer Science

The B.Sc. (H) Computer Science programme is designed to develop analytical & computational thinking, and problem solving skills. It covers the core computer science topics like computer systems architecture, data structures, computer networks, operating systems, computer graphics, algorithms, software engineering, database management, theory of computation, artificial intelligence, and information security. The programme builds a base for entry level jobs in information technology and prepares the students for higher studies in the area of Computer Science/Applications.

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## 2. Learning Outcome-based Curriculum Framework for B.Sc. (H) Computer Science programme

### 2.1 Aims of Bachelor Degree Programme in B.Sc. (H) Computer Science

i. Develop theoretical foundations in computer science.
ii. Develop expertise in programming skills using high level programming languages.
iii. Develop skills to design, implement and document the solutions for computational problems.
iv. Develop soft skills to work effectively in a team to solve a problem.
v. Develop the ability to use state of the art technologies.
vi. Inculcating the understanding of the needs of society and the importance of societal obligations.

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## 3. Graduate Attributes in B.Sc. (H) Computer Science

**Disciplinary knowledge**

Ability to build (either independently or by joining higher academic program) on of the core computer science concepts learnt in the course.

Ability to apply the core computer science concepts to solve the problems in the IT industry.

**Problem solving**

Graduates are equipped with skills to solve the computational problems at their workplace and for the society.

**Cooperation/Team work**

Graduates demonstrate competence to use communication skills to participate or lead a team for a new initiative or for solving an existing problem.

**Communication Skills**

Graduates demonstrate effective communication and presentation skills while interacting with professional peers and in the society.

**Scientific reasoning**

Given a problem, the graduates will be able to analyse it, suggest solutions, and critically evaluate the solutions proposed by others.

**Professional Ethics**: Graduates follow ethical principles and commitment to professional ethics, accountability and responsibilities.

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## 4. Qualification Descriptors for Graduates B.Sc. (H) Computer Science

i. Demonstrate coherent knowledge and understanding of the logical organization of a digital computer, its components and working. Understanding of the time and space complexities of algorithms designed to solve computational problems.

ii. Demonstrate programming skills in high level language and an ability to learn a new programming language without substantial effort.

iii. Apply knowledge of logical skills to identify and analyse problems and issues, and seek solutions to real-life problems. For example, creating mobile applications, database applications, and educative computer games.

iv. Enhanced communication and leadership abilities and ability to work and learn in team environment.

v. Understand the needs of society and sensitivity to societal obligations

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## 5. Programme Learning Outcomes for B.Sc. (H) Computer Science

i. Ability to analyze a problem, and identify and define the computing requirements appropriate to its solution.

ii. Ability to design, implement, and evaluate a computer-based system, process, component, or program to solve the given problem.

iii. Ability to communicate effectively through oral and written means.

iv. Ability to work in a team to achieve a common goal

---

## 6. Structure of B.Sc. (H) Computer Science

### 6.1 Credit Distribution for B.Sc. (H) Computer Science

| Course | *Credits | |
|---|---|---|
| | Theory + Practical | Theory+ Tutorial |
| **I. Core Course** | | |
| **(14 Papers)** | 14 X 4 = 56 | 14 X 5 = 70 |
| **Core Course Practical/ Tutorial*** | | |
| **(14 Papers)** | 14 X 2 = 28 | 14 X 1 = 14 |
| **II. Elective Course** | | |
| **(8 Papers)** | | |
| A.1. Discipline Specific Elective | 4 X 4 = 16 | 4 X 5 = 20 |
| **(4 Papers)** | | |
| A.2. Discipline Specific Elective | | |
| Practical/ Tutorial* | 4 X 2 = 8 | 4 X 1 =4 |
| **(4 Papers)** | | |
| B.1. Generic | | |
| Elective/Interdisciplinary | 4 X 4 = 16 | 4 X 5 =20 |
| **(4 Papers)** | | |
| B.2. Generic Elective Practical/ | | |
| Tutorial* | 4 X 2 =8 | 4 X 1=4 |
| **(4 Papers)** | | |

*** Optional Dissertation or project work in place of one Discipline Specific Elective paper (6 credits) in 6th Semester**

**III. Ability Enhancement Courses**

**1. Ability Enhancement Compulsory**

ii. Ability to design, implement, and evaluate a computer-based system, process, component, or program to solve the given problem.

iii. Ability to communicate effectively through oral and written means.

iv. Ability to work in a team to achieve a common goal

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## 6. Structure of B.Sc. (H) Computer Science

### 6.1 Credit Distribution for B.Sc. (H) Computer Science

| Course | *Credits | |
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| | Theory + Practical | Theory+ Tutorial |
| **I. Core Course** | | |
| **(14 Papers)** | 14 X 4 = 56 | 14 X 5 = 70 |
| **Core Course Practical/ Tutorial*** | | |
| **(14 Papers)** | 14 X 2 = 28 | 14 X 1 = 14 |
| **II. Elective Course** | | |
| **(8 Papers)** | | |
| A.1. Discipline Specific Elective | 4 X 4 = 16 | 4 X 5 = 20 |
| **(4 Papers)** | | |
| A.2. Discipline Specific Elective | | |
| Practical/ Tutorial* | 4 X 2 = 8 | 4 X 1 =4 |
| **(4 Papers)** | | |
| B.1. Generic | | |
| Elective/Interdisciplinary | 4 X 4 = 16 | 4 X 5 =20 |
| **(4 Papers)** | | |
| B.2. Generic Elective Practical/ | | |
| Tutorial* | 4 X 2 =8 | 4 X 1=4 |
| **(4 Papers)** | | |

*** Optional Dissertation or project work in place of one Discipline Specific Elective paper (6 credits) in 6th Semester**

**III. Ability Enhancement Courses**

**1. Ability Enhancement Compulsory**

| | | |
|---|---|---|
| **(2 papers of 4 credit each)** | 4 X 2 = 8 | 4 X 2 =4 |
| Environmental Science | | |
| English/MIL Communication | | |
| **2. Skill Enhancement Elective** | 4 X 2 = 8 | 4 X 2 = 8 |
| **(2 papers of 4 credit each)** | | |
| **Total Credit** | **140** | **140** |

*** wherever there is a practical there will be no tutorial and vice-versa**

**6.2 Semester-wise Distribution of Courses.**

| SEMESTER | DISCIPLINE SPECIFIC CORE COURSE (DSC) (14) | Ability Enhancement Compulsory Course (AECC) (2) | Skill Enhancement Course (SEC) (2) | Elective: Discipline Specific (DSE) (4) | Elective: Generic (GE) (6) |
|---|---|---|---|---|---|
| I | Programming Fundamentals using C++ | | | | GE-1 |
| | Computer System Architecture | | | | |
| II | Programming in JAVA | | | | GE-2 |
| | Discrete Structure | | | | |
| III | Data Structures | | SEC-1 | | GE-3 |
| | Operating System | | | | |
| | Computer Networks | | | | |
| IV | Design and Analysis of Algorithms | | SEC-2 | | GE-4 |
| | Software Engineering | | | | |
| | Database Management Systems | | | | |
| V | Internet Technologies | | | DSE-1 | |
| | Theory of Computation | | | DSE-2 | |
| VI | Artificial Intelligence | | | DSE-3 | |
| | Computer Graphics | | | DSE-4 | |

| Semester | COURSE OPTED | COURSE NAME | CREDITS |
|---|---|---|---|
| I | | | |
| | Core Course-I | Programming Fundamentals using C++ | 4 |
| | Core Course-I Practical/Tutorial | Programming Fundamentals using C++ Lab | 2 |
| | Core Course-II | Computer System Architecture | 4 |
| | Core Course –II Practical/Tutorial | Computer System Architecture Lab | 2 |
| | Generic Elective-I | GE – 1 | 4/5 |
| | Generic Elective-I Practical/Tutorial | | 2/1 |
| II | | | |
| | Core Course-III | Programming in Java | 4 |
| | Core Course –III Practical/Tutorial | Programming in Java Lab | 2 |
| | Core Course-IV | Discrete Structure | 4 |
| | Core Course –IV Practical/Tutorial | Discrete Structure Tutorial | 2 |
| | Generic Elective- 2 | GE – 2 | 4/5 |
| | Generic Elective- 2 Practical/Tutorial | | 2/1 |
| III | | | |
| | Core Course – V | Data Structures | 4 |
| | Core Course –V Practical/Tutorial | Data Structures Lab | 2 |
| | Core Course - VI | Operating System | 4 |
| | Core Course –VI Practical/Tutorial | Operating System Lab | 2 |
| | Core Course - VII | Computer Networks | 4 |
| | Core Course –VII Practical/Tutorial | Computer Networks Lab | 2 |
| | Skill Enhancement Course-1 | SEC – 1 | 4 |
| | Generic Elective – 3 | GE- 3 | 4/5 |
| | Generic Elective - 3 Practical/Tutorial | | 2/1 |
| IV | | | |
| | Core Course – VIII | Design and Analysis of Algorithms | 4 |
| | Core Course –VIII Practical/Tutorial | Design and Analysis of Algorithms Lab | 2 |
| | Core Course-IX | Software Engineering | 4 |
| | Core Course –IX Practical/Tutorial | Software Engineering Lab | 2 |

| | | | |
|---|---|---|---|
| | Core Course-X | Database Management Systems | 4 |
| | Core Course –X Practical/Tutorial | Database Management Systems Lab | 2 |
| | Skill Enhancement Course-2 | SEC – 2 | 4 |
| | Generic Elective – 4 | | 4/5 |
| | Generic Electives - 4 Practical/Tutorial | | 2/1 |
| V | Core Course-XI | Internet Technologies | 4 |
| | Core Course –XI Practical/Tutorial | Internet Technologies Lab | 2 |
| | Core Course-XII | Theory of Computation | 5 |
| | Core Course –XII Practical/Tutorial | Theory of Computation Tutorial | 1 |
| | Discipline Specific Elective-1 | DSE-1 | 4 |
| | Discipline Specific Elective-1 Practical/Tutorial | DSE-1 Lab | 2 |
| | Discipline Specific Elective-2 | DSE-2 | 4 |
| | Discipline Specific Elective-2 Practical/Tutorial | DSE- 2 Lab | 2 |
| VI | | | |
| | Core Course-XIII | Artificial Intelligence | 4 |
| | Core Course –XIII Practical/Tutorial | Artificial Intelligence Lab | 2 |
| | Core Course-XIV | Computer Graphics | 4 |
| | Core Course –XIV Practical/Tutorial | Computer Graphics Lab | 2 |
| | Discipline Specific Elective-3 | DSE-3 | 4 |
| | Discipline Specific Elective-3 Practical/Tutorial | DSE-3 Lab | 2 |
| | Discipline Specific Elective-4 | DSE-4 | 4 |
| | Discipline Specific Elective-4 Practical/Tutorial | DSE-4 Lab | 2 |
| Total Credits | | | 140 |

**Discipline Specific Core Papers (DSC): (Credit: 06 each)**
(1 period/ week for tutorials or 4 periods/week of practical)

1. BHCS01 Programming Fundamentals using C++
2. BHCS02 Computer System Architecture
3. BHCS03 Programming in JAVA
4. BHCS04 Discrete Structure
5. BHCS05 Data Structures
6. BHCS06 Operating System
7. BHCS07 Computer Networks
8. BHCS08 Design and Analysis of Algorithms
9. BHCS09 Software Engineering

10. BHCS10 Database Management Systems
11. BHCS11 Internet Technologies
12. BHCS12 Theory of Computation
13. BHCS13 Artificial Intelligence
14. BHCS14 Computer Graphics

**Discipline Specific Elective Papers: (Credit: 06 each)**
**(DSE-1, DSE-2, DSE-3, DSE-4)**

**DSE-1 (Choose any one)**

a) BHCS15A Data Analysis and Visualization
b) BHCS15B System Programming
c) BHCS15C Combinatorial Optimization

**DSE – 2 (Choose any one)**

a) BHCS16A Digital Image Processing
b) BHCS16B Microprocessors

**DSE – 3 (Choose any one)**

a) BHCS17A Information Security
b) BHCS17B Data Mining
c) BHCS17C Advanced Algorithms

**DSE – 4 (Choose any one)**

a) BHCS18A Machine Learning
b) BHCS18B Deep Learning
c) BHCS18C Unix Network Programming
d) BHCS18D Project Work/ Dissertation

**Other Discipline (Four papers of any one discipline) – GE 1 to GE 4**

**Skill Enhancement Courses (Credit: 04 each)**
**(SEC – 1, SEC – 2)**

**SEC -1(Choose any one)**
a) BHCS19A Web Design and Development
b) BHCS19B Programming in Python

**SEC – 2(Choose any one)**
a) BHCS20A Android Programming
b) BHCS20B Introduction to R Programming

**Note:**

1. There will be one batch of 10-15 students for practical classes. The size of tutorial group for papers without practical is recommended to be 8-10 students.

2. Each practical will carry 50 marks including 25 marks for continuous evaluation and 5 marks for the oral viva.

3. Colleges are advised and encouraged to conduct the practical using Free and Open Source Software (FOSS)

4. At least two questions have to be compulsorily attempted in the final practical examination.

5. Softcopy of all the practical must be maintained by each student for each practical paper.

6. Discipline specific core and elective courses (DSC and DSE) are to be taught as 4 Hrs theory and 4 Hrs practical per week. In case the course has tutorials, it is to be taught as 5 Hrs theory and 1 Hr. tutorial per week

7. Skill enhancement courses (SEC) are to be taught as 2 Hrs theory and 4 Hrs practical per week.

8. Practical given for the courses are only indicative, and by no means exhaustive. Instructor may add more complex problems in laboratory depending on the ability of the students.

# UNIVERSITY OF DELHI

Bachelor of Science (Hons) Electronic Science

(Effective from Academic Year 2019-20)

**Revised Syllabus as approved by**

**Academic Council**

**Date:** **No:**

**Executive Council**

**Date:** **No:**

**Applicable for students registered with Regular Colleges, Non Collegiate Women's Education Board and School of Open Learning**

# Choice based Credit System (CBCS)
# with
# Learning Outcomes based Curriculum Framework (LOCF)
# for
# B.Sc. (Hons) Electronic Science
# Undergraduate Programme
# (Effective from Academic Year 2019-20)


## DEPARTMENT OF ELECTRONIC SCIENCE
FACULTY OF INTERDISCIPLINARY AND APPLIED SCIENCES
UNIVERSITY OF DELHI SOUTH CAMPUS
NEW DELHI – 110021

# Preamble

The objective of any programme at Higher Education Institute is to prepare their students for the society at large. The University of Delhi envisions all its programmes in the best interest of their students and in this endeavour it offers a new vision to all its Under-Graduate courses. It imbibes a Learning Outcome-based Curriculum Framework (LOCF) for all its Under Graduate programmes.

The LOCF approach is envisioned to provide a focused, outcome-based syllabus at the undergraduate level with an agenda to structure the teaching-learning experiences in a more student-centric manner. The LOCF approach has been adopted to strengthen students' experiences as they engage themselves in the programme of their choice. The Under-Graduate Programmes will prepare the students for both, academia and employability.

Each programme vividly elaborates its nature and promises the outcomes that are to be accomplished by studying the courses. The programmes also state the attributes that it offers to inculcate at the graduation level. The graduate attributes encompass values related to well-being, emotional stability, critical thinking, social justice and also skills for employability. In short, each programme prepares students for sustainability and life-long learning.

The new curriculum of B.Sc. (Hons) Electronic Science offer the undergraduates a complete package to have an in-depth understanding of basic to advance electronics. They can equip themselves to the fundamentals of electronics to a complete skill set compatible to industry 4.0 standards. The exhaustive curriculum will prepare them to pursue higher education as well compete in the job market.

The University of Delhi hopes the LOCF approach of the programme B.Sc. (Hons) Electronic Science will help students in making an informed decision regarding the goals that they wish to pursue in further education and life, at large.

# 1. Introduction to Programme

The learning outcomes based curriculum framework (LOCF) for B.Sc. (Hons) Electronic Science is intended to prepare a curriculum which enables the graduates to respond to the current needs of the industry and equip them with skills relevant for national and global standards. The framework will assist in maintaining international standards to ensure global competitiveness and facilitate student/graduate mobility after completion of B.Sc. (Hons) Electronic Science programme. The framework intends to allow for greater flexibility and innovation in curriculum design and syllabus development, teaching learning process, assessment of student learning levels.

The LOCF for B.Sc. (Hons) Electronic Science is prepared on the contours and curricular structure of CBCS provided by the UGC, and may be modified without sacrificing the spirit of CBCS and LOCF.

## Programme Duration:

The B.Sc. (Hons) Electronic Science programme will be of three years duration. Each year will be called an academic year and will be divided into two semesters. Thus there will be a total of six semesters. Each semester will consist of sixteen weeks.

## Design of Programme:

The teaching-learning will involve theory classes (Lectures) of one hour duration, tutorials and practical classes. The curriculum will be delivered through various methods including chalk and talk, powerpoint presentations, audio, video tools, E-learning/E-content, lab sessions, virtual labs, simulations, optional experiments, field trips/Industry visits, seminars (talks by experts), workshops, projects, models, class discussions and other listed suggestive ways. The assessment broadly will comprise of Internal Assessment (Continuous Evaluation) and End Semester Examination. Each theory paper will be of 100 marks with 25% marks for Internal Assessment and 75% for End Semester examination. The internal Assessment will be through MCQ, quizzes, test, assignment, oral presentation, worksheets, short project and other suggested methods. Each practical paper will be of 50 marks.

## Programme Structure:

The programme will consist of six-credit courses and four-credit courses. All six credit courses with practicals will comprise of theory classes (four credits) and practicals (two credits) whereas those without practicals will have theory classes (five credits) and tutorials (one credit). Four credit courses with practicals will comprise of theory classes (two credits) and practicals (two credits). Four credit courses without practicals will comprise of theory classes only (four credits). For theory or tutorial classes, one credit indicates a one hour lecture per week while for practicals one credit indicates a two-hour session per week. Each practical or tutorial batch will be of 12-15 students.

The programme includes Core Courses (CC) and elective courses. The core courses are all compulsory courses. There are three kinds of elective courses: Discipline-Specific Elective

(DSE), Generic Elective (GE) and Skill Enhancement Course (SEC). In addition there are two compulsory Ability Enhancement Courses (AEC). The outline of the Course is as under:

**1. Core Course:** A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

**2. Elective Course:** Generally a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill is called an Elective Course.

**2.1 Discipline Specific Elective (DSE) Course**: Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).

**2.2 Dissertation/Project Work**: An elective course designed to acquire special/advanced knowledge, such as supplement study/support study/ solving / analyzing /exploring a real life situation / difficult problem into a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project work. A Dissertation/Project Work may be given in lieu of a discipline specific elective paper.

**2.3 Generic Elective (GE) Course**: An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.

**Note: A core course offered in a discipline/subject may be treated as an elective by other discipline/subject and vice versa and such electives may also be referred to as Generic Elective. Therefore, the department is free to offer any of its Core Courses as Generic Electives to other discipline/subject.**

**3. Ability Enhancement Courses (AEC)/Competency Improvement Courses/Skill Development Courses/Foundation Course:** The Ability Enhancement (AE) Courses may be of two kinds: AE Compulsory Course (AECC) and AE Elective Course (AEEC). "AECC" courses are the courses based upon the content that leads to Knowledge enhancement. They ((i) Environmental Science, (ii) English/MIL Communication) are mandatory for all disciplines. AEEC courses are value-based and/or skill-based and are aimed at providing hands-on-training, competencies, skills, etc.

**3.1 AE Compulsory Course (AECC)**: Environmental Science, English Communication/MIL Communication.

**3.2 AE Elective Course (AEEC)**: These courses may be chosen from a pool of courses designed to provide value-based and/or skill-based instruction.

To acquire a Honours degree in Electronic Science, a student must study fourteen Core Courses, four Discipline- Specific Electives, four Generic Electives, two Skill Enhancement Courses and two compulsory Ability Enhancement Courses. The Core Courses, Discipline-Specific Electives and Generic Electives are six-credit courses. The Skill Enhancement Courses and Ability

Enhancement Courses are four credit-courses. A student has to earn a minimum of 148 credits to get a degree in B.Sc. (Hons) Electronic Science.

There will be fourteen Core Courses which are to be compulsorily studied to complete the requirements for an Honours degree in B.Sc. Electronic Science. The students will study two Core Courses each in Semesters I and II, three Core Courses each in Semesters III and IV, and two Core Courses each in Semesters V and VI. The Core Courses will be of six credits each (four credits theory and two credits practicals).

The programme offers fourteen Discipline-Specific Electives (DSEs), of which the student must choose any two in each of the Semesters V and VI. The DSEs will be of six credits each (four credits theory and two credits practicals). A particular option of DSE course shall be offered in Semesters V and VI only if the minimum number of students opting for that course is 15. The DSE course that is project work will also carry six credits. The number of students who will be allowed to opt for project work will vary from college to college depending upon the infrastructural facilities and may vary each year. The college shall announce the number of seats for project work well in advance and may select the students for the same based on merit. Project work will involve investigative work and the student will have to do this in the time after their regular theory and practical classes. The final evaluation of the project work will be done through a committee involving internal and external examiners. In this regard guidelines provided by University of Delhi for executing and evaluation of project work will be final. Students will be asked their choice for Project work at the end of IV semester and all formalities of topic and mentor selection will be completed by this time.

Different Generic Elective (GE) courses will be offered to the students of the B.Sc. (Hons) Electronic Science programme by other departments of the college and the student will have the option to choose one GE course each in Semesters I, II, III, and IV. The GEs will be of six credits each (four credits theory and two credits practicals or five credits theory and one credit tutorial). The Department of Electronic Science will offer thirteen GE courses for students of other departments. A core course offered in a discipline/subject may be treated as a Generic Elective by other discipline/subject and vice versa. Therefore, the department of Electronic Science is free to offer any of its Core Courses as Generic Electives to other discipline/subject.

The students will undertake two Skill Enhancement (SEC) courses of four credits each in Semesters III and IV which they can choose from the list of SEC courses offered by their college. The SEC courses will be of four credits each (two credits theory and two credits practicals). The Department of Electronic Science is offering eleven such courses.

The two compulsory Ability Enhancement Courses (AECs): AECC1 (Environmental Sciences) and AECC2 (English communication) will be of four credits each (theory only). The student will take one each in Semesters I and II.

## 2. Learning Outcome-based Curriculum Framework in B.Sc.(Hons) Electronic Science

The learning outcomes based approach implies that when an academic programme is planned, desirable learning outcomes are identified and considered in formulation of the plans. Course contents, learning activities and assessment types are designed to be consistent with the achievement of desired learning outcomes. The learning outcomes are in terms of knowledge,

Professional attitude, work ethics, critical thinking, self managed learning, adaptability, problem solving skills, communication skills, interpersonal skills and group works. At the end of a particular course/program, assessment is carried out to determine whether the desired outcomes are being achieved. This outcome assessment provides feedback to ensure that element in the teaching and learning environment are acting in concert to facilitate the nurturing of the desired outcomes. The expected learning outcomes are used as reference points that would help formulate graduate attributes, qualification descriptors, programme learning outcomes and course learning outcomes which in turn help not only in curriculum planning and development, but also in delivery and review of academic programmes.

The overall objectives of the learning outcomes based curriculum framework are:

- Help formulate graduate attributes, qualification descriptors, program learning outcomes and course learning outcomes that are expected to be demonstrated by the holders of qualification.
- Enable prospective students, parents, employers and others to understand the nature and level of learning outcomes or attributes a graduate of a programme should be capable of demonstrating on successful completion of the programme of study.
- Maintain national standards and international comparability of learning outcomes and academic standards to ensure global competitiveness, and to facilitate student/graduate mobility.
- Provide higher education institutions an important point of reference for designing teaching-learning strategies, assessing student learning level, and periodic review of programme and academic research.

## 2.1 Nature and extent of the Programme in B.Sc. (Hons) Electronic Science

B.Sc. (Hons) Electronic Science is a professional program which needs to develop a specialized skill set among the graduates to cater the need of industries. In recent years, Electronic Science has made unprecedented growth in terms of new technologies, new ideas and principles. The research organizations and industries that work in this frontier area are in need of highly skilled and scientifically oriented manpower. This manpower can be available only with flexible, adaptive and progressive training programs and a cohesive interaction among the research organizations, academicians and industries. The key areas of study within subject area of Electronic Science comprise: Semiconductor Devices, analog and digital circuit design, Microprocessors & Microcontroller systems, Communication techniques, IoT and computation techniques for Electronics, computer coding/programming in high level languages etc.

B.Sc. (Hons) Electronic Science covers topics that overlap with areas outlined above and with applied fields such as embedded system, advanced computer and data communication, robotics, control systems, VLSI Design and Fabrication, Nanoelectronics, Artificial Intelligence, Internet of Things etc.

The present learning outcomes based model curriculum of B.Sc. (Hons) Electronic Science, is designed to provide better learning experience to the graduates. Besides, imparting disciplinary knowledge, curriculum is aimed to equip the graduates with competencies like problem solving, analytical reasoning and leadership which provide them high professional competence.

## 2.2 Aims of Bachelor Degree Programme in B.Sc. (Hons) Electronic Science

The overall aims of the B.Sc. (Hons) Electronic Science are:

- Provide students with learning experiences that develop broad knowledge and understanding of key concepts of electronic science and equip students with advanced scientific/technological capabilities for analyzing and tackling the issues and problems in the field of electronics.
- Develop ability in student's to apply knowledge and skills they have acquired to the solution of specific theoretical and applied problems in electronics.
- Develop abilities in students to design and develop innovative solutions for benefits of society, by diligence, leadership, team work and lifelong learning.
- Provide students with skills that enable them to get employment in industries or pursue higher studies or research assignments or turn as entrepreneurs.

# 3. Graduates Attributes in B.Sc. (Hons) Electronic Science

**Graduates Attributes** (GAs) form a set of individually assessable outcomes that are the components indicative of the graduate's potential to acquire competence to practice at the appropriate level. The Graduate Attributes of B.Sc. (Hons) Electronic Science are listed below:

**GA1. Scholarship of Knowledge:** Acquire in-depth knowledge of specific discipline or professional area, including wider and global perspective, with an ability to discriminate, evaluate, analyze and synthesize existing and new knowledge, and integration of the same for enhancement of knowledge.

**GA2. Critical Thinking:** Analyze complex scientific/technological problems critically; apply independent judgment for synthesizing information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.

**GA3. Problem Solving:** Think laterally and originally, conceptualize and solve scientific/technological problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors in the core areas of expertise.

**GA4. Usage of modern tools:** Create, select, learn and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex scientific/technological activities with an understanding of the limitations.

**GA5. Collaborative and Multidisciplinary work:** Possess knowledge and understanding of group dynamics, recognize opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis in order to achieve common goals and further the learning of themselves as well as others.

**GA6. Communication:** Communicate with the scientific/technological community, and with

society at large, regarding complex scientific/technological activities confidently and effectively, such as, being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.

**GA7. Life-long Learning**: Recognize the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.

**GA8. Ethical Practices and Social Responsibility**: Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.

# 4. Qualification Descriptors for Graduates in B.Sc. (Hons) Electronic Science

A qualification descriptor indicates the generic outcomes and attributes expected for the award of a particular type of qualification. The learning experiences and assessment procedures are expected to be designed to provide every student with the opportunity to achieve the intended programme learning outcomes. The qualification descriptors reflect followings:

1. Disciplinary knowledge and understanding
2. Skills & Ability
3. Global competencies that all students in different academic fields of study should acquire/attain and demonstrate.

*4.1 Qualification descriptors for B.Sc. (Hons) Electronic Science programme:* Some of the expected learning outcomes that a student should be able to demonstrate on completion of a B.Sc. (Hons) Electronic Science programme may include the following:

**Knowledge & Understanding**

- Demonstrate extensive knowledge of the disciplinary foundation in the various areas of Electronics, as well as insight into contemporary research and development.
- Demonstrate specialized methodological knowledge in the specialized areas of Electronics about professional literature, statistical principles and reviewing scientific work.

**Skills & Ability**

- Demonstrate ability to apply electronics knowledge & experimental skills critically and systematically for assessment and solution of complex electronics problems and issues related to communication systems, embedded systems, computers networks, robotics, VLSI Design and fabrication and other specialized areas of electronics.
- Demonstrate ability to model, simulate and evaluate the phenomenon and systems in the advanced areas of electronics.

- Demonstrate ability to apply one's electronics knowledge, experimental skills, scientific methods & advanced design, simulation and validation tools to identify and analyze complex real life problems and frame technological solutions for them.
- Demonstrate ability to design and develop industrial products, processes and electronics systems while taking into account the circumstances and needs of individuals, organizations and society with focus on economical, social and environmental aspects.

**Competence**

- Communicate his or her conclusions, knowledge & arguments effectively and professionally both in writing and by means of presentation to different audiences in both national and international context.
- Ability to work in collaborative manner with others in a team, contributions to the management, planning and implementations.
- Ability to independently propose research/developmental projects, plan its implementation, undertake its development, evaluate its outcomes and report its results in proper manner.
- Ability to identify the personal need for further knowledge relating to the current and emerging areas of study by engaging in lifelong learning in practices.

## 5. Program Learning Outcomes for B.Sc. (Hons) Electronic Science

**The following program outcomes have been identified for B.Sc. (Hons) Electronic Science**

| | |
|---|---|
| **PLO1** | Ability to apply knowledge of mathematics & science in solving electronics related problems |
| **PLO2** | Ability to design and conduct electronics experiments, as well as to analyze and interpret data |
| **PLO3** | Ability to design and manage electronic systems or processes that conforms to a given specification within ethical and economic constraints |
| **PLO4** | Ability to identify, formulate, solve and analyze the problems in various disciplines of electronics |
| **PLO5** | Ability to function as a member of a multidisciplinary team with sense of ethics, integrity and social responsibility |
| **PLO6** | Ability to communicate effectively in term of oral and written communication skills |
| **PLO7** | Recognize the need for, and be able to engage in lifelong learning |
| **PLO8** | Ability to use techniques, skills and modern technological/scientific/engineering software/tools for professional practices |

# Structure of B.Sc. (Hons) Electronic Science

## 6.1 Credit Distribution for B.Sc. (Hons) Electronic Science

148 credits (as per University norms) will be required by a student to be eligible to get the degree of B.Sc. (Hons) Electronic Science. The credit distribution is as under:

| | | Credit Details | | |
|---|---|---|---|---|
| | | (Theory + Practical) | or | (Theory +Tutorial) |
| **I. Core Course (14 Papers)** | | | | |
| Core Courses (Theory) | | 14X4=56 | | |
| Core Course (Practical) | | 14X2=28 | | |
| **II. Elective Course (8 Courses = 4 DSE + 4 GE)** | | | | |
| A.1. Discipline Specific Elective (DSE) (Theory) (4 in number) | | 4x4 =16 | | |
| A.2. Discipline Specific Elective (Practical) (4 in number) | | 4x2=8 | | |
| B.1. Generic Elective/Interdisciplinary (GE) (4 in number) | | 4X4=16 | or | 4X5=20 |
| B.2. Generic Elective(Practical/ Tutorial*) (4 in number) | | 4x2 =8 | or | 4 X1=4 |
| **III. Ability Enhancement Courses** | | | | |
| 1. **Ability Enhancement Compulsory Courses (AECC)** (2 Papers of 4 credit each) | | | | |
| Environmental Science/ English/MIL Communication | | 2 X 4=8 | | |
| 2. **Skill Enhancement Courses (SEC) **** (2 Papers of 4 credit each) | | 2 X 4=8** | | |
| **Total** | | **148** | | |

* wherever there is a practical there will be no tutorial and vice-versa

** As per University notification ( No. Aca.I/Choice Based Credit System/2016/1173 dated 04.10.2016)

## 6.2 Semester-wise Distribution of Courses

| Semester I | | | | |
|---|---|---|---|---|
| | Course Type | Course Name | Hours/week | Credit |
| 1 | Core | Core I: *Basic Circuit Theory and Network Analysis* | 4 | 4 |
| 2 | | Core II: *Mathematics Foundation for Electronics* | 4 | 4 |
| 3 | | Core Lab I: *Basic Circuit Theory and Network Analysis Lab* | 4 | 2 |
| 4 | | Core Lab II: *Mathematics Foundation for Electronics Lab* | 4 | 2 |
| 5 | GE | GE-1 | 4/5 | 4/5* |
| 6 | | GE-1 *Practical/Tutorial** | 4/1 | 2/1* |
| 7 | AECC | *AECC-I English/MIL communications/Environmental Science* | 4 | 4 |
| | | | **Total Credits** | 22 |

| Semester II | | | | |
|---|---|---|---|---|
| | Course Type | Course Name | Hours/week | Credit |
| 1 | Core | Core III: *Semiconductor Devices* | 4 | 4 |
| 2 | | Core IV: *Applied Physics* | 4 | 4 |
| 3 | | Core Lab1II: *Semiconductor Devices Lab* | 4 | 2 |
| 4 | | Core Lab IV: *Applied Physics Lab* | 4 | 2 |
| 5 | GE | GE-2: | 4/5 | 4/5* |
| 6 | | GE-2: *Practical/Tutorial** | 4/1 | 2/1* |
| 7 | AECC | AECC-II: *English/MIL communications/Environmental Science* | 4 | 4 |
| | | | **Total Credits** | 22 |

| Semester III | | | | |
|---|---|---|---|---|
| | Course Type | Course Name | Hours/week | Credit |
| 1 | Core | Core V: *Electronic Circuits* | 4 | 4 |
| 2 | | Core VI: *Digital Electronics and Verilog/VHDL* | 4 | 4 |
| 3 | | Core VII : *C Programming and Data Structures* | 4 | 4 |
| 4 | | Core Lab V: *Electronic Circuits Lab* | 4 | 2 |
| 5 | | Core Lab VI: *Digital Electronics and Verilog/VHDL Lab* | 4 | 2 |
| 6 | | Core Lab VII: *C Programming and Data Structures Lab* | 4 | 2 |
| 7 | GE | GE-3 | 4/5 | 4/5* |
| 8 | | GE-3: *Practical/Tutorial** | 4/1 | 2/1* |
| | SEC | SEC-1: | 2 | 2 |
| 9 | | SEC-1: *Practical* | 4 | 2 |
| | | | **Total Credits** | 28 |

| Semester IV | | | | |
|---|---|---|---|---|
| | Course Type | Course Name | Hours/week | Credit |
| 1 | Core | Core VIII: *Operational Amplifiers and Applications* | 4 | 4 |
| 2 | | Core IX: *Signals and Systems* | 4 | 4 |
| 3 | | Core X : *Electronic Instrumentation* | 4 | 4 |
| 4 | | Core Lab VIII: *Operational Amplifiers and Applications Lab* | 4 | 2 |
| 5 | | Core Lab IX: *Signals and Systems Lab* | 4 | 2 |
| 6 | | Core Lab X: *Electronic Instrumentation Lab* | 4 | 2 |
| 7 | GE | GE-4: | 4/5 | 4/5* |
| 8 | | GE-4: *Practical/Tutorial** | 4/1 | 2/1* |
| | SEC | SEC-2: | 2 | 2 |
| 9 | | SEC-2: *Practical* | 4 | 2 |
| | | Total Credits: | | 28 |

| Semester V | | | | |
|---|---|---|---|---|
| | Course Type | Course Name | Hours/week | Credit |
| 1 | Core | Core XI: *Microprocessors and Microcontrollers* | 4 | 4 |
| 2 | | Core XII: *Electromagnetics* | 4 | 4 |
| 3 | | Core Lab XI: *Microprocessors and Microcontrollers Lab* | 4 | 2 |
| 4 | | Core Lab XII: *Electromagnetics Lab* | 4 | 2 |
| 5 | DSE | DSE-1: | 4 | 4 |
| 6 | | DSE-2: | 4 | 4 |
| 7 | | DSE-1: *Practical* | 4 | 2 |
| 8 | | DSE-2: *Practical* | 4 | 2 |
| | | Total Credits: | | 24 |

| Semester VI | | | | |
|---|---|---|---|---|
| | Course Type | Course Name | Hours/week | Credit |
| 1 | Core | Core XI: *Communication Electronics* | 4 | 4 |
| 2 | | Core XII: *Photonics* | 4 | 4 |
| 3 | | Core Lab XI: *Communication Electronics Lab* | 4 | 2 |
| 4 | | Core Lab XII: *Photonics Lab* | 4 | 2 |
| 5 | DSE | DSE-3: | 4 | 4 |
| 6 | | DSE-4: | 4 | 4 |
| 7 | | DSE-3: *Practical* | 4 | 2 |
| 8 | | DSE-4: *Practical* | 4 | 2 |
| | | Total Credits: | | 24 |

## A. CORE COURSE(CC):

**Credit: 06 each (Theory: 04 + Lab: 02)**

1. Basic Circuit Theory and Network Analysis (4+4)
2. Mathematics Foundation for Electronics (4+4)
3. Semiconductor Devices (4+4)
4. Applied Physics (4+4)
5. Electronic Circuits (4+4)
6. Digital Electronics and Verilog/VHDL (4+4)
7. C Programming and Data Structures (4+4)
8. Operational Amplifiers and Applications (4+4)
9. Signals and Systems (4+4)
10. Electronic Instrumentation (4+4)
11. Microprocessors and Microcontrollers (4+4)
12. Electromagnetics (4+4)
13. Communication Electronics (4+4)
14. Photonics (4+4)

## B. Discipline Specific Electives (DSE):

**(4 papers to be selected) - DSE 1-4**

**Credit: 06 each (Theory: 04 + Lab: 02)**

**Group 1 (V Semester) (DSE 1, 2)**

1. Power Electronics (4+4)
2. Numerical Analysis (4+4)
3. Digital Signal Processing (4+4)
4. Basic VLSI Design (4+4)
5. Computer Networks (4+4)
6. Semiconductor Fabrication and Characterization (4+4)
7. Biomedical Instrumentation (4+4)

**Group 2 (VI Semester) (DSE-3, 4)**

1. Electrical Machines (4+4)
2. Modern Communication Systems (4+4)
3. Control Systems (4+4)
4. Transmission Lines, Antenna and Wave Propagation (4+4)
5. Nanoelectronics (4+4)
6. Embedded Systems (4+4)
7. Dissertation/ Project work

## C. Skill Enhancement Course (SEC) (02 papers) - SEC1 to SEC2
## Credit: 04 each (Theory: 02 + Lab: 02)

1 Design and Fabrication of Printed Circuit Boards (2+4)
2 Robotics (2+4)
3 Mobile Applications Development (2+4)
4 Internet and Java Programming (2+4)
5 Programming with LabVIEW (2+4)
6 Artificial Intelligence (2+4)
7 Internet of Things (2+4)
8 Data Sciences (2+4)
9 Cyber Security (2+4)
10 3D Printing and Design (2+4)
11 Virtual Reality (2+4)

## D. Generic Elective Papers (GE) for other Departments/Disciplines: (Credit: 06 each)***

1. Electronic Circuits and PCB Designing (4+4)
2. Digital System Design (4+4)
3. Instrumentation (4+4)
4. Practical Electronics (4+4)
5. Communication Systems (4+4)
6. Microprocessor and Microcontroller Systems (4+4)
7. Consumer Electronics (4+4)
8. Computational Mathematics (5+1)
9. Applied Mathematics-I (5+1)
10. Applied Mathematics-II (5+1)
11. Artificial Intelligence (4+4)
12. Internet of Things (4+4)
13. Data Science (4+4)

**Any of the Core Courses in Category A can be offered as Generic Electives to other discipline/subject.**

*** *Finally, a word on the Generic Electives to be chosen by Electronic Science students. They are, of course, free to exercise their choice in a way they deem fit. However, it is recommended that they shall avoid opting for a Generic Elective of another program that has majority overlapping to their core course.*

**Important:**
1. The size of the practical/tutorial group for practical/tutorial based papers is recommended to be 12-15 students.

**Note:**

1. Universities/Institutions/Departments may wish to add more courses against categories marked B, C and D, depending on the availability of specialists and other required resources.

2. Any major deviation in the category A (core courses) is likely to impact the very philosophy of LOCF in Electronic Science.

3. Departments/Board of Studies/ Universities should have freedom to arrange courses in the order they deem fit with justification.

4. Whenever stakeholders seek to introduce modifications or alterations in the LOCF or CBCS guidelines, they are (a) expected to have adequate and transparent justifications to do so and (b) to notify the UGC regarding the changes and the justifications thereof.

## Mapping of Course with Program Outcomes (PLOs)

| | Core Course Name | PLO1. Apply subject knowledge & scientific/technical skills. | PLO2. Design and conduct electronics experiments, as well as to analyze and interpret data | PLO3. Design and manage electronic systems | PLO4. Identify, formulate, solve and analyse the problems in Electronics. | PLO5. Function as a member of a multidisciplinary team | PLO6. Communicate effectively | PLO7. Lifelong learning and Professional Development | PLO8. Use techniques, skills and modern technological/scientific/engineering |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Basic Circuit Theory and Network Analysis | √ | | √ | √ | | | | |
| 2 | Basic Circuit Theory and Network Analysis Lab | | √ | √ | | √ | √ | | |
| 3 | Mathematics Foundation for Electronics | √ | | √ | √ | | | | |
| 4 | Mathematics Foundation for Electronics Lab | | √ | | | √ | √ | | √ |
| 5 | Semiconductor Devices | √ | | √ | | | | | |
| 6 | Semiconductor Devices Lab | | √ | √ | | √ | √ | | |
| 7 | Applied Physics | √ | | | √ | √ | | | |
| 8 | Applied Physics Lab | | √ | | | √ | √ | | |
| 9 | Electronic Circuits | √ | | √ | √ | | | | |
| 10 | Electronic Circuits Lab | | √ | | | √ | √ | | √ |
| 11 | Digital Electronics and Verilog/VHDL | √ | | √ | √ | | | | |
| 12 | Digital Electronics and Verilog/VHDL Lab | | √ | | | √ | √ | | √ |
| 13 | C Programming and Data Structures | √ | √ | | | | | | √ |
| 14 | C Programming and Data Structures Lab | | √ | | | √ | √ | | √ |
| 15 | Operational Amplifiers and Applications | √ | | √ | √ | | | | |
| 16 | Operational Amplifiers and Applications Lab | | √ | | | √ | √ | | |
| 17 | Signals and Systems | √ | | √ | √ | | | | |
| 18 | Signals and Systems Lab | | √ | | | √ | √ | | |
| 19 | Electromagnetics | √ | | | | | | | |
| 20 | Electromagnetics Lab | | | | | √ | | | |
| 21 | Microprocessors and Microcontrollers | | | √ | √ | | | | |
| 22 | Microprocessors and Microcontrollers Lab | | √ | | | √ | √ | | |
| 23 | Communication Electronics | √ | | | √ | | | | |
| 24 | Communication Electronics lab | | √ | | | √ | √ | | |
| 25 | Electronic Instrumentation | √ | | √ | √ | | | | |
| 26 | Electronic Instrumentation Lab | | √ | | | √ | √ | | |
| 27 | Photonics | √ | | √ | √ | | | | |
| 28 | Photonics lab | | √ | | | √ | √ | | |
| 29 | Dissertation/Project work | √ | √ | √ | √ | √ | √ | √ | √ |

# UNIVERSITY OF DELHI

Bachelor of Business Administration (Financial Investment Analysis) BBA(FIA)

(Effective from Academic Year 2019-20)

**Revised Syllabus as approved by**

**Academic Council**

Date: No:

**Executive Council**

Date: No:

## Preamble

The objective of any programme at Higher Education Institute is to prepare their students for the society at large. The University of Delhi envisions all its programmes in the best interest of their students and in this endeavour it offers a new vision to all its Under-Graduate courses. It imbibes a Learning Outcome-based Curriculum Framework (LOCF) for all its Under Graduate programmes.

The LOCF approach is envisioned to provide a focused, outcome-based syllabus at the undergraduate level with an agenda to structure the teaching-learning experiences in a more student-centric manner. The LOCF approach has been adopted to strengthen students' experiences as they engage themselves in the programme of their choice. The Under-Graduate Programmes will prepare the students for both, academia and employability.

Each programme vividly elaborates its nature and promises the outcomes that are to be accomplished by studying the courses. The programmes also state the attributes that it offers to inculcate at the graduation level. The graduate attributes encompass values related to well-being, emotional stability, critical thinking, social justice and also skills for employability. In short, each programme prepares students for sustainability and life-long learning.

The new curriculum of BBA (FIA) offer in depth knowledge of ever changing field of finance with focus on latest development through policy intervention, global integration and technological disruption. After pursuing this course students will get expertise in the field of corporate finance in general with specialization in the specific fields of Banking and financial services; Investment and fund management; Corporate financial management and Financial Risk Management, International Finance.

The University of Delhi hopes the LOCF approach of the programme BBA (FIA) will help students in making an informed decision at the time of working with Corporates or engaged in any financial services.

## 1. Introduction to Programme

**This is a three years honors program designed to develop analytical skills in the field of finance since 1999.** The program is focused to create financial expertise to contribute in emerging India in the following specific fields of Banking and financial services; Investment and fund management; Corporate financial management and Financial Risk Management. The students are exposed to various statistical, quantitative, econometric tools & techniques used for financial analysis with the help of Software like SPSS, Eviews, R, Metlab etc. They are prepared to work on various financial research projects and making Presentation of their works and findings. This program is a true value addition in professional education in the field of finance at earliest stage of under graduation.

## 2. Learning Outcome based approach to Curriculum Planning:

### 2.1. Nature and Extent of the Programme

The entire curriculum of BBA (FIA) is planned to have following learning outcomes:

a. Students should orient towards fundamentals of Accounts, Statistics, Economics and Financial Management, Financial Markets along with Quantitative techniques to handle the financial problems in first two years of their three year program.
b. They will also learn communication skill of English in their first year itself.
c. During first year of their program they will get sensitized towards environment through EVS course.
d. They will also learn to use software for financial data extractions and operating on those data through statistical and econometric tools under SEC papers during the second year of the program.
e. Along with two specialized core papers of finance they will learn two additional papers of finance under Discipline Specific Electives in their fifth and sixth semester each.
f. The progression of the program is such that every next semester will use the learning of previous semester(s) and from understanding of the subjects to concept building followed by critical evaluation and application in the real world.
g. Students are also motivated to go for summer internship to gain the practical insight from industry which makes their specialized papers understanding more meaningful.

### 2.2. Aims of Bachelor Degree Programme

At the end of the Programme students are expected to analyze any financial statement, value any organization or develop financial and risk models for their application. They will be ready to take the emerging challenges at their job in the field of finance and will be able to handle it strategically.

3. **Graduate Attributes**

a. **Academic excellence**: Sound knowledge of the subjects studied.

b. **Professional Efficiency**: Ability to use the knowledge for quality services in financial market in an efficient manner.

c. **Social Engagement**: Through their subject knowledge and co-curricular activities serve the society especially to those at bottom of the pyramid.

d. **Environmental Sensitivity**: Environmental care has taken prime position because of the threat caused. These students get sensitized through the EVS paper in their first year of study and keep on getting alerts through various other academic and extra-curricular activities. They are also expected to sensitize the society at large on this account.

e. **Critical Thinking**: The design of the program itself make the critical thinking as an integral part. Subjects like Financial Accounting and analysis or Corporate Analysis and valuation or Strategic Corporate finance compel the students to think critically.

f. **Analytical bent of mind**: Critical thinking leads to analysis of the subject i.e. understanding beyond the verbal meaning and establishing cause effect relation.

g. **Creativity and originality**: Regular compulsion of critical thinking and analysing the subjects make the students as original thinker and able to create their own view on the subject.

h. **Intellectual curiosity**: During the process of developing their own view on the subjects they tempt to read and learn as much as possible and they become in-quisitive on the topic.

i. **Strong presentation and communication skills**: Students are asked to present on the topic assigned to them for the purpose under every paper either individual or in group. This makes their presentation skill strong and they become effective presenter as well as communicator of their innovative ideas/views.

j. **Leadership and team spirit**: Working on various assignments both academic and extra-curricular help them in becoming team worker. Since they engage with society at large on different projects which help them to germinate their leadership quality and nurture that into full leadership.

4. **Qualification Descriptors for Graduates**

a. Demonstrate

(i) A coherent understanding of how a financial institution operates and is managed,

(ii) Managerial and analytical skills required in an industry,

(iii) Analytical skills for financial and Investment analysis as well as fund management.

b. Use knowledge, understanding and skills required for identifying problems and issues, collection of relevant quantitative and/or qualitative data drawing on a wide range of sources, and their application.
c. Meet one's own needs for start-ups or any entrepreneurial venture
d. Demonstrate subject-related and transferable skills that are relevant for entry level management positions in diverse industries;
e. Create a sound foundation for students to pursue higher level studies and research in areas of management.

5. **Program learning outcomes**
   a. Provide students with a sound theoretical base and exposure to current business challenges
   b. Prepare students with capabilities and skills in areas of finance to take up roles in financial services for management and analyst's position across diverse industries.
   c. The program is focused to create financial expertise to contribute in emerging India in the following specific fields
      Banking and financial services
      Investment and fund management
      Corporate financial management
      Financial Risk Management
   d. To encourage creativity and innovative thinking leading to unique solution for complex problems.
   e. Enhance the ability of students to meet global challenges through sensitivity towards organizational, economic and cultural diversity.
   f. To make them capable of handling all kinds of financial risks.

6. Structure of BBA (FIA).

### 6.1. Credit Distribution for BBA (FIA)

**CBCS Course Structure for BBA (FIA) Honors**

| Courses | Credits | |
|---|---|---|
| | Theory + Practical | Theory + Tutorial |
| **I. Core Courses** | | |
| (14 Papers of 6 credits each) | 14x4 = 56 | 14x5 = 70 |
| Core Course Practical/Tutorial | | |
| (14 Practical/Tutorial*) | 14x2 = 28 | 14x1 = 14 |
| **II. Elective Courses** | | |
| (9 Papers of 6 credits each) | | |
| A.1. Discipline Specific Elective (4 Papers of 6 credits each) | 4x4 = 16 | 4x5 = 20 |
| A.2. Discipline Specific Elective (5 Practical/Tutorial*) | 4x2 = 8 | 4x1 = 4 |
| B.1. Generic Elective/Interdisciplinary (4 Papers of 6 credits each) | 4x4 = 16 | 4x5 = 20 |
| B.2. Generic Elective/Interdisciplinary (4 Practical/Tutorial*) | 4x2 = 8 | 4x1 = 4 |
| **III. Ability Enhancement Courses** | | |
| 1. Ability Enhancement Compulsory Courses (2 Papers of 4 Credits each) | 2x4 = 8 | 2x4 = 8 |
| 2. Ability Enhancement Elective (Skill Based) (2 Papers of 4 credits each) | 2x4 = 8 | 2x4 = 8 |
| **Total credits:** | **148**** | **148**** |

*** Wherever there is practical there will be no tutorial and vice-versa**
**** Extra 6 Credit may be earned by taking Research Project as an additional paper. It will also be evaluated at the end of sixth semester.**

**Types of Courses**

**BBA (FIA)** is aligned with Choice Based Credit System (CBCS) adopted by the University of Delhi. Following types of courses are offered under CBCS:

1. **Core Course (CC)**: These courses are to be compulsorily studied by a student.
2. **Elective Course (EC)**: An elective course is a course that can be chosen from a pool of courses.

An elective may be of following types:

1. **Discipline Specific Elective (DSE)**: It is an elective course that adds proficiency to the students in the discipline or leads to an interdisciplinary approach to learning. BBA (FIA) offer 8 papers under this category four each in semesters V and VI. An additional paper in Research project mode (Semester-long Research Project) may be offered at semester VI as extra credit paper under discipline specific electives. Students can choose one Research project as extra paper under the guidance of a teacher.
2. **Generic Elective (GE)**: It is an elective course offered by different academic disciplines. Under this category total 4 papers will be studied one paper each in first four semesters.
3. **Ability Enhancement Compulsory Course (AECC)**: Two AECC papers are offered, one in semester I (English equivalent to MIL) and one in semester II (Environmental Science).
4. **Skill Enhancement Course (SEC)**: 2 Skill Enhancement Courses out of a pool of 4 are offered one each in semester III and IV.

6.2. Semester-wise Distribution of Courses.

## PROPOSED COURSE STRUCTURE UNDER CHOICE BASED CREDIT SYSTEM

### Bachelor of Business Administration (Financial Investment Analysis) [BBA (FIA)]

| Paper Code | | |
|---|---|---|
| | **Semester I** | |
| FC101 | Environmental Science | Ability Enhancement – Compulsory |
| FC102 | Financial Accounting& Analysis | Core Discipline |
| FC103 | Managerial Economics | Core Discipline |
| | Any **One** from the List of **Generic Elective / Interdisciplinary Courses** | Elective Course – Generic /Interdisciplinary |
| | | |
| | **Semester II** | |
| FC 201 | Business Communication (Language : English / MIL) | Ability Enhancement - Compulsory |
| FC 202 | Statistics for Business Decisions | Core Discipline |
| FC 203 | Cost & Management Accounting | Core Discipline |
| | Any **One** from the List of **Generic Elective / Interdisciplinary Courses** | Elective Course – Generic /Interdisciplinary |
| | | |
| | **Semester III** | |
| FC 301 | Income Tax | Core Discipline |
| FC 302 | Corporate Finance | Core Discipline |
| FC 303 | Financial Markets& Institutions | Core Discipline |
| | Any **One** from the List of **Generic Elective / Interdisciplinary Courses** | Elective Course – Generic /Interdisciplinary |
| | Any **ONE** from list of **SKILL ENHANCEMENT COURSE (SEC)** | Skill Enhancement Course |
| | | |
| | **Semester IV** | |
| FC 401 | Macro Economics | Core Discipline |
| FC 402 | Quantitative Techniques | Core Discipline |
| FC 403 | Financial Econometrics | Core Discipline |
| | Any **One** from the List of **Generic Elective / Interdisciplinary Courses** | Elective Course – Generic / Interdisciplinary |
| | Any **ONE** from the list of **SKILL ENHANCEMENT COURSE (SEC)** | Skill Enhancement Course |
| | | |
| | **Semester V** | |
| FC 501 | Investment Analysis & Portfolio Management | Core Discipline |
| FC 502 | Financial Derivatives | Core Discipline |
| | Elective – I | Discipline Specific Elective |
| | Elective – II | Discipline Specific Elective |
| | | |
| | **Semester VI** | |
| FC 601 | Corporate Restructuring | Core Discipline |
| FC 602 | International Finance | Core Discipline |

| | | |
|---|---|---|
| | Elective – III | Discipline Specific Elective |
| | Elective – IV | Discipline Specific Elective |

**Discipline Specific Elective:-**

| | |
|---|---|
| FD 501 | Investment Banking & Financial Services |
| FD 502 | Corporate Analysis & Valuation |
| FD 503 | Business Tax Planning |
| FD 504 | Advanced Financial Econometrics |
| FD 601 | Strategic Corporate Finance |
| FD 602 | Behavioral Finance |
| FD 603 | Management of Financial Institutions |
| FD 604 | International Financial Architecture |
| FD 605 | **Research Projects (additional course for extra credit)** |

**Skill Enhancement Course:-**

| | |
|---|---|
| FS 301 | IT Tools for Business |
| FS 302 | Financial Database and Analysis Software |
| FS 401 | Financial Analytics |
| FS 402 | Advanced Spreadsheets Tools For Financial Analysis |
| | Summer Internship (6-8 weeks) |

**Generic Elective / Interdisciplinary Course:-**

| | |
|---|---|
| FG 101 | Business Ethics & Corporate Governance |
| FG 102 | Fundamentals of Financial Management |
| FG 201 | Operations Management |
| FG 202 | Fundamentals of Econometrics |
| FG 203 | Entrepreneurship Theory and Practices |

# दिल्ली विश्वविद्यालय

# UNIVERSITY OF DELHI

## Bachelor of Science (Hons) Food Technology

## (Effective from Academic Year 2019-20)

# SYLLABUS AND SCHEME OF EXAMINATION FOR B.SC. (HONS) FOOD TECHNOLOGY

## Three Year Full Time Programme

## (Choice Based Credit System)

**Syllabus applicable for students seeking admission in 2019 onwards**


DEPARTMENT OF HOME SCIENCE

FACULTY OF SCIENCE

UNIVERSITY OF DELHI



Approved in AC Meeting 15.07.2019

## Preamble

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The LOCF approach is envisioned to provide a focused, outcome-based syllabus at the undergraduate level with an agenda to structure the teaching-learning experiences in a more student-centric manner. The LOCF approach has been adopted to strengthen students' experiences as they engage themselves in the programme of their choice. The Under-Graduate Programmes will prepare the students for both, academia and employability.

Each programme vividly elaborates its nature and promises the outcomes that are to be accomplished by studying the courses. The programmes also state the attributes that it offers to inculcate at the graduation level. The graduate attributes encompass values related to well-being, emotional stability, critical thinking, social justice and also skills for employability. In short, each programme prepares students for sustainability and life-long learning.

The new curriculum of B.Sc. (Hons) Food Technology offers the students to gain the requisite knowledge, skills and aptitude for the field of food technology. The efforts are made to measure cognitive as well as applied learning. Students are not only trained on the core components but also in areas which are need based, innovative and relevant keeping in pace with the fast growing food industry. The course is internationally competitive.

The University of Delhi hopes the LOCF approach of the programme B.Sc. (Hons) Food Technology will help students in making an informed decision regarding the goals that they wish to pursue in further education and life, at large.

# 1. Introduction to B.Sc. (Hons) Food Technology

The Food Technology course at the Bachelors level is being run in the University of Delhi since the last 25 years and was introduced by the Faculty of Science from the academic year 1989-1990. The new course has been prepared keeping in view, the unique requirements of B.Sc. (H) Food Technology students. The Food Technology course in Choice Based Credit System is of 3-year duration which comprises of 6 semesters, divided into 14 Core papers, 4 Discipline Specific Elective courses (DSE), 2 Skill Enhancement Elective Courses (SEC) and 4 Generic Elective (GE) Courses. Each year consists of 2 semesters. This course has been prepared keeping in view, the unique requirements of B.Sc. Hons Food Technology students.

The objectives of the course are:

- To impart knowledge in areas related to Food Science and Technology.
- To enable the students to understand the food composition along with its physico- chemical, nutritional, microbiological and sensory aspects.
- To acquaint the students with the technologies of food processing and preservation of plant and animal foods; cereals, pulses, oilseeds, fruits vegetables, spices, meat, fish, poultry, sea food, milk and dairy products.
- To stress on the importance of food safety and quality management, national and international food laws and regulations as well as importance of food engineering and packaging in food industry.

The course contents have been so designed that it can keep pace with the rapidly growing food industry. Since, Food Technology is an interdisciplinary science it is recommended that subjects like Biochemistry, Biology, Chemistry, Maths, Statistics, Biostatistics, Physics etc be preferably chosen as the Generic elective(GE) by the students as they are synergistic to the curriculum. However, students are free to pick up any of the Generic Elective Courses offered by other departments.

# 2. Learning Outcome Based Curriculum Framework

## 2.1 Nature and Extent of the Programme in B.Sc. (Hons) Food Technology

The learning outcomes-based curriculum framework is based on the premise that every student and graduate is unique. Each student or graduate has his/her own characteristics in terms of previous learning levels and experiences, life experiences, learning styles and approaches to future career-

related actions. The quality, depth and breadth of the learning experiences made available to the students while at the higher education institutions help develop their characteristic attributes.

## 2.2 Aims of Bachelor Degree Programme in B.Sc. (Hons) Food Technology

The key objectives that underpin curriculum planning and development at the undergraduate level include Programme Learning Outcomes, and Course Learning Outcomes. For the B.Sc. (H) Food Technology course it includes:

- To demonstrate comprehensive knowledge and understanding of the food technology curriculum.
- To apply the principles of food science to preserve, process and package to assure the quality and safety of food products.
- To understand that the real-world problems in the food industry requires continuous acquisition of knowledge and its application to improve the safety and quality of a given food or process.
- To analyse, interpret and draw conclusions from quantitative/qualitative data; and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective.
- To acquire knowledge and skills, including "learning how to learn", that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, and adapting to changing trades and demands of work place through knowledge/skill development/reskilling.
- To use ICT in a variety of learning situations, demonstrate ability to access, evaluate, and use a variety of relevant information sources.
- To acquire professional competency and entrepreneurial skills for economic empowerment.
- To demonstrate the ability to acquire, analyze, interpret and appropriately present laboratory data.

## 3. Graduate Attributes in B.Sc. (Hons) Food Technology

**Disciplinary knowledge**

Students are able to demonstrate comprehensive knowledge and understanding of one or more disciplines such as chemistry, bio-chemistry, mathematics, statistics, microbiology, engineering, management; regulations with support of different allied subjects of Life Science; Physical Science.

**Communication Skills**

Development of students' communication skills is planned through an AECC paper (English) which is compulsory for each student. Besides that the students do various assignments that enable them to develop skills in public speaking writing and effective's interpersonal skills. Presentations in each paper enhances their confidence, ability to express themselves; presentation skills.

**Research-related skills**

Students develop a scientific temper and a sense of enquiry through various food technology papers. They have capabilities in asking relevant questions relating to current issues and themes and state hypothesis and rationale for inquiry. Students are capable of using appropriate research methodology especially for understanding safety issues in Food Technology and reporting the results in different formats.

**Cooperation/Team work**

Students are capable of effective working in diverse contexts and teams in class rooms laboratories, student societies, industry and the community. They have basic management skills for independently organizing events, resource mobilization and leading community based projects, initiatives; cultural shows.

**Self-directed learning**

Students are capable of working independently and are able to apply the concepts of Food Technology in an original; creative manner to solve and manage real life issues for the customers and industry. Students develop customized products as per the requirements of customers eg. Sugar free jams; sweets for diabetics, gluten free products for celiacs etc.

**Multicultural competence**

Students are confident of working in diverse socio-cultural contexts. They are able to effectively engage with multicultural groups and teams. They have sensitivities of cross cultural and ethnic diversity which they can apply to different settings. College through a student and faculty exchange program with foreign university helps them to acquire multicultural competency. They are competent to seek higher education in foreign universities.

**Moral and ethical awareness/reasoning**

Student has awareness of ethical conduct in different situations (academic and personal). They have skills in understanding and avoiding unethical behavior such as misrepresentation, plagiarism and environmental misuse and violence. They are formally taught ethics of research and human interventions.

**Leadership readiness/qualities**

Students have leadership qualities in organizing teams and their mobilization for effective problem solving in different Food Technology aspects. Students apply creative leadership for realization of various goals. As a leader, they are trained to have greater customer sensitivity and connect. They can organize food courts and design business plans.

**Lifelong learning**

Students acquire ability to gain knowledge and skills which are necessary in life for the holistic development for meeting their professional and personal needs in varying environment and changing contexts.

## 4. Qualification Descriptors for B.Sc. (Hons) Food Technology

The following descriptors indicate the expectations from B.Sc. Hons Food Technology:

- The students will have a sound knowledge of Food Science and Technology.
- They will understand the technologies of food processing and preservations of all food groups.
- They will understand food composition, nutritional, microbiological and sensory aspects.
- They will understand food safety and standards, both nationally and internationally.

- They will be versant with key principles of food engineering and packaging.

## 5. Programme Learning Outcome in B.Sc. (Hons) Food Technology

The learning outcome of the course are-

- Knowledge of various areas related to Food science and technology,
- Understanding of the food composition and its physico- chemical, nutritional, microbiological and sensory aspects,
- Know how of processing and preservation techniques of pulses, oilseeds, spices, fruits and vegetables, meat, fish, poultry, milk & milk products,
- Relevance and significance of food safety, food quality ,food plant sanitation, food laws and regulations, food engineering and packaging in food industry.

## 6. Structure of B.Sc. (Hons) Food Technology

The B.Sc. (Hons) Food Technology programme will be of three years duration. Each year will be called an academic year and will be divided into two semesters, thus there will be a total of six semesters. Each semester will consist of sixteen weeks.

The programme will consist of core papers, general electives and discipline electives of 6 credits, 4 credits theory and 2 credits practical courses. Skill enhancement courses are 4 credits courses which comprise of practicals or theory 2 credits and Practicals 2 credits. For theory classes 1 credit indicates a one hr lecture per week while for Practicals 1 credit indicates a two hour session per week.

The programme includes Core Courses (CC) and elective courses. The core courses are all compulsory courses. There are three kinds of elective courses: Discipline-Specific Elective (DSE), Generic Elective (GE) and Skill Enhancement Course (SEC). In addition there are two compulsory Ability Enhancement Courses (AEC).

To acquire a degree in Food Technology a student must study fourteen Core Courses, four Discipline-Specific Electives, four Generic Electives, two Skill Enhancement Courses and two compulsory Ability Enhancement Courses. The Core Courses, Discipline-Specific Electives and Generic Electives are six-credit courses. The Skill Enhancement Courses are four-credit courses while the Ability Enhancement

Courses are two credit-courses. A student has to earn a minimum of 148 credits to get a degree in B.Sc. (Hons) Food Technology.

There will be fourteen Core Courses which are to be compulsorily studied to complete the requirements for an Honours degree in B.Sc. Home Science. The students will study two Core Courses each in Semesters I and II, three Core Courses each in Semesters III and IV, and two Core Courses each in Semesters V and VI. The Core Courses will be of six credits each (four credits theory and two credits Practicals).

The programme offers 6 Discipline-Specific Electives (DSEs), of which the student must choose any two in each of the Semesters V and VI. The DSEs will be of six credits each (four credits theory and two credits Practicals). A particular option of DSE course will be offered in Semesters V and VI semesters only if the minimum number of students opting for that course is 10.

Six Generic Elective (GE) courses will be offered to the students of the B.Sc. Hons Food Technology programme by other departments and the student will have the option to choose one GE course each in Semesters I, II, III, and IV. The GEs will be of six credits each (four credits theory and two credits Practicals).

The students will undertake two Skill Enhancement (SE) courses of four credits each in Semesters III and IV, which they can choose from the list of SE courses offered by their college. The SE courses will be of four credits each (two credits theory and two credits Practicals). The Department of Food Technology is offering five such courses.

The two compulsory Ability Enhancement Courses (AECs): AE1 (Environmental Sciences) and AE2 (English communication) will be of four credits each (theory only). The student will take one each in Semesters I and II.

The teaching learning will involve theory classes of one hour duration and practical classes. The curriculum will be delivered through various methods including chalk and talk, powerpoint presentation, audio, video tools, e-learning/e-content, field trips/ industry visits, seminars, workshops, projects and class discussions. The assessment broadly will comprise of internal assessment (25%) and End Semester examination (75%). The internal assessment will be through MCQs, test, assignment, oral presentation, quizzes and worksheets. Each practical paper will be of 50 marks.

## 6.1. Credit Distribution in B.Sc. (Hons.) Food Technology

| CORE courses | | | |
|---|---|---|---|
| **Semester** | **Course Code** | **Course Name** | **Credits (Th.+Pr.)** |
| I | CC FT101 | Fundamentals of Food Technology | 4+2 |
| | CC FT102 | Principles of Food Science | 4+2 |
| II | CC FT 201 | Technology of Food Preservation | 4+2 |
| | CC FT 202 | Food Processing Technology | 4+2 |
| III | CC FT 301 | Food and Nutrition | 4+2 |
| | CC FT 302 | Technology of Fruits, Vegetables and Plantation Crops | 4+2 |
| | CC FT 303 | Technology of Dairy and Sea Food | 4+2 |
| IV | CC FT 401 | Technology of Cereals, Pulses and Oilseeds | 4+2 |
| | CC FT 402 | Food Microbiology | 4+2 |
| | CC FT 403 | Technology of Meat, Poultry and Egg | 4+2 |
| V | CC FT 501 | Food Engineering | 4+2 |
| | CC FT 502 | Food Chemistry-I | 4+2 |
| VI | CC FT 601 | Food Chemistry-II | 4+2 |
| | CC FT 602 | Food Quality And Sensory Evaluation | 4+2 |

| DISCIPLINE SPECIFIC ELECTIVE COURSES | | | |
|---|---|---|---|
| **Semester** | **Course Code** | **Course Name** | **Credits (Theory+Pr)** |
| V and VI | **DSE FT 01** | Food Safety | 4+2 |
| DSE I | **DSE FT 02** | Food Quality Management | |
| (Any One) | **DSE FT 03** | Bakery Technology | |
| | **DSE FT 04** | Food Packaging | |
| | **DSE FT 05** | Nutraceutical and Functional foods | |
| | **DSE FT 06** | Food Plant Sanitation | |
| | **DSE FT 01** | Food Safety | 4+2 |
| DSE II | **DSE FT 02** | Food Quality Management | |
| (Any One) | **DSE FT 03** | Bakery Technology | |
| | **DSE FT 04** | Food Packaging | |
| | **DSE FT 05** | Nutraceutical and Functional foods | |
| | **DSE FT 06** | DSE FT06 Food Plant Sanitation | |

| SKILL ENHANCEMENT ELECTIVE COURSES | | | |
|---|---|---|---|
| **Semester** | **Course Code** | **Course Name** | **Credits (Theory+Pr)** |
| III & IV | SEC FT 01 | Entrepreneurship Development | 4 |
| | SEC FT 02 | Food Product Development | |
| | SEC FT 03 | Food Fermentation Technology | |
| | SEC FT 04 | Confectionary Technology | |
| | SEC FT 05 | Project and Technical Report | |

| GENERIC ELECTIVE COURSES | | | |
|---|---|---|---|
| **Semester** | **Course Code** | **Course Name** | **Credits (Theory+Pr)** |
| I, II, III and IV | GE FT 01 | Food Processing and Preservation | 4+2 |
| | GE FT 02 | Chemistry of Food | |
| | GE FT 03 | Sensory Evaluation of Food | |
| | GE FT 04 | Food Microbiology and Food Safety | |
| | GE FT 05 | Food Engineering and Packaging | |
| | GE FT 06 | Technology of Plant and Animal Foods | |

## 6.2. Semester-wise Distribution of Courses

| Semester | Course Opted | Course Name | Credits |
|---|---|---|---|
| I | Ability Enhancement Compulsory Course - I | English Communications/ Environmental Science | 4 |
| | CC FT 101 Theory | Fundamentals of Food Technology | 4 |
| | CC FT 101 Practical | Fundamentals of Food Technology Practical | 2 |
| | CC FT 102 Theory | Principles of Food Science | 4 |
| | CC FT 102 Practical | Principles of Food Science Practical | 2 |
| | GE FT -1 Theory | GE -1 | 4 |
| | GE FT -1 Practical | GE -1 Practical | 2 |
| II | Ability Enhancement Compulsory Course - II | English Communications/ Environmental Science | 4 |
| | CC FT 201 Theory | Technology of Food Preservation | 4 |
| | CC FT 201 Practical | Technology of Food Preservation Practical | 2 |
| | CC FT 202 Theory | Food Processing Technology | 4 |
| | CC FT 202 Practical | Food Processing Technology PRACTICAL | 2 |
| | GE FT -2 Theory | GE -2 Theory | 4 |
| | GE FT -2 Practical | GE – 2 Practical | 2 |
| III | CC FT 301 Theory | Food and Nutrition | 4 |
| | CC FT 301 Practical | Food and Nutrition Practical | 2 |
| | CC FT 302 Theory | Technology of Fruits, Vegetables and Plantation Crops | 4 |
| | CC FT 302 Practical | Technology of Fruits, Vegetables and Plantation Crops Practical | 2 |
| | CC FT 303 Theory | Technology of Dairy and Sea Food | 4 |
| | CC FT 303 Practical | Technology of Dairy and Sea Food Practical | 2 |
| | SEC FT 1 | SEC-1 | 4 |
| | GE FT -3 Theory | GE -3 Theory | 4 |
| | GE FT -3 Practical | GE – 3 Practical | 2 |
| IV | CC FT 401 Theory | Technology of Cereals, Pulses and Oilseeds | 4 |
| | CC FT 401 Practical | Technology Of Cereals, Pulses And Oilseeds | 2 |

| | | | |
|---|---|---|---|
| | | Practical | |
| | CC FT 402 Theory | Food Microbiology | 4 |
| | CC FT 402 Practical | Food Microbiology Practical | 2 |
| | CC FT 403 Theory | Technology of Meat, Poultry and Egg | 4 |
| | CC FT 403 Practical | Technology of Meat, Poultry and Egg Practical | 2 |
| | SEC FT -2 | SEC- 2 | 4 |
| | GE FT -4 Theory | GE - 4 Theory | 4 |
| | GE FT – 4 Practical | GE - 4 Practical | 2 |
| V | CC FT 501 Theory | Food Engineering | 4 |
| | CC FT 501 Practical | Food Engineering Practical | 2 |
| | CC FT 502 Theory | Food Chemistry-I | 4 |
| | CC FT 502 Practical | Food Chemistry-I Practical | 2 |
| | DSE 1 Theory | DSE -1 Theory | 4 |
| | DSE 1 Practical | DSE -1 Practical | 2 |
| | DSE 2 Theory | DSE -2 Theory | 4 |
| | DSE 2 Practical | DSE -2 Practical | 2 |
| VI | CC FT 601 Theory | Food Chemistry-II | 4 |
| | CC FT 601 Practical | Food Chemistry-II Practical | 2 |
| | CC FT 602 Theory | Food Quality and Sensory Evaluation | 4 |
| | CC FT 602 Practical | Food Quality and Sensory Evaluation practical | 2 |
| | DSE 3 Theory | DSE -3 Theory | 4 |
| | DSE 3 Practical | DSE -3 Practical | 2 |
| | DSE 4 Theory | DSE -4 Theory | 4 |
| | DSE 4 Practical | DSE -4 Practical | 2 |
| | | Total | 148Credits |

**Total Credits: 84 CC + 24 DSE + 8 SEC + 8 AECC + 24 GE = 148 Credits**

## 7. Courses for Programme for B.Sc. (Hons) Food Technology

### Core Course (14 Courses) Total Credits 84

**Credits – 6 Each (4 Credits Theory + 2 Credits Practical = 6)**

**CC FT 101–Fundamentals of Food Technology**: 4 Credits Theory + 2 Credits Practical
**CC FT 102-Principles of Food Science**: 4 Credits Theory + 2 Credits Practical
**CC FT 201- Technology of Food Preservation**: 4 Credits Theory + 2 Credits Practical
**CC FT 202- Food Processing Technology**: 4 Credits Theory + 2 Credits Practical
**CC FT 301-Food and Nutrition**: 4 Credits Theory + 2 Credits Practical
**CC FT 302- Technology of Fruits, Vegetables and Plantation Crops**: 4 Credits Theory + 2 Credits Practical
**CC FT 303-Technology of Dairy and Sea Food**: 4 Credits Theory + 2 Credits Practical
**CC FT 401- Technology of Cereals, Pulses and Oilseeds**: 4 Credits Theory + 2 Credits Practical
**CC FT 402- Food Microbiology**: 4 Credits Theory + 2 Credits Practical
**CC FT 403- Technology of Meat, Poultry and Egg**: 4 Credits Theory + 2 Credits Practical
**CC FT 501-Food Engineering**: 4 Credits Theory + 2 Credits Practical
**CC FT 502-Food Chemistry-I**: 4 Credits Theory + 2 Credits Practical
**CC FT 601-Food Chemistry-II**: 4 Credits Theory + 2 Credits Practical
**CC FT 602-Food Quality and Sensory Evaluation**: 4 Credits Theory + 2 Credits Practical

### Discipline Specific Elective (Any Four) (4 X 6 = 24 Credits)

**Credits – 6 Each (4 Credits Theory + 2 Credits Practical = 6)**

**DSE FT 01 Food Safety**: 4 Credits Theory + 2 Credits Practical
**DSE FT 02 Food Quality Management**: 4 Credits Theory + 2 Credits Practical
**DSE FT 03 Bakery Technology**: 4 Credits Theory + 2 Credits Practical
**DSE FT 04 Food Packaging**: 4 Credits Theory + 2 Credits Practical
**DSE FT 05 Nutraceutical and Functional Foods**: 4 Credits Theory + 2 Credits Practical
**DSE FT 06 Food Plant Sanitation**: 4 Credits Theory + 2 Credits Practical

### Skill Enhancement Elective Course (Any Two) (4+4 = 8)

**Credits – 4 Each**

**SEC FT 01 Entrepreneurship Development**: 2 Credits Theory + 2 Credits Practical
**SEC FT 02 Food Product Development**: 2 Credits Theory + 2 Credits Practical
**SEC FT 03 Food Fermentation Technology**: 2 Credits Theory + 2 Credits Practical
**SEC FT 04 Confectionary Technology**: 2 Credits Theory + 2 Credits Practical
**SEC FT 05 Project and Technical Report**: 4 Credits Practical

**Generic Elective (Any Four) (4 X 6 = 24)**

**Credits – 6 Each (4 Credits Theory + 2 Credits Practical = 6)**

**GE FT 01. Food Processing and Preservation**: 4 Credits Theory + 2 Credits Practical

**GE FT 02. Chemistry of Food**: 4 Credits Theory + 2 Credits Practical

**GE FT 03. Sensory Evaluation of Food**: 4 Credits Theory + 2 Credits Practical

**GE FT 04. Food Microbiology and Food Safety**: 4 Credits Theory + 2 Credits Practical

**GE FT 05. Food Engineering and Packaging**: 4 Credits Theory + 2 Credits Practical

**GE FT 06. Technology of Plant and Animal Foods**: 4 Credits Theory + 2 Credits Practical

**Total Credits: 84 CC + 24 DSE + 8 SEC + 8 AECC + 24 GE = 148 Credits**

# दिल्लीविश्वविद्यालय
# UNIVERSITY OF DELHI

Bachelor of Science (Hons) Instrumentation

(Effective from Academic Year 2019-20)

Revised Syllabus as approved by

Academic Council

Date: No:

Executive Council

Date: No:

**Applicable for students registered with Regular Colleges, Non Collegiate Women's Education Board and School of Open Learning**

# Choice based Credit System (CBCS)
# with
# Learning Outcomes based Curriculum Framework (LOCF)
# for
# B.Sc. (Hons)Instrumentation
# Undergraduate Programme
# (Effective from Academic Year 2019-20)


**DEPARTMENT OF ELECTRONIC SCIENCE**
**FACULTY OF INTERDISCIPLINARY AND APPLIED SCIENCES**
**UNIVERSITY OF DELHI SOUTH CAMPUS**
**NEW DELHI – 110021**

## Preamble

The objective of any programme at Higher Education Institute is to prepare their students for the society at large. The University of Delhi envisions all its programmes in the best interest of their students and in this endeavour it offers a new vision to all its Under-Graduate courses. It imbibes a Learning Outcome-based Curriculum Framework (LOCF) for all its Under Graduate programmes.

The LOCF approach is envisioned to provide a focused, outcome-based syllabus at the undergraduate level with an agenda to structure the teaching-learning experiences in a more student-centric manner. The LOCF approach has been adopted to strengthen students' experiences as they engage themselves in the programme of their choice. The Under-Graduate Programmes will prepare the students for both, academia and employability.

Each programme vividly elaborates its nature and promises the outcomes that are to be accomplished by studying the courses. The programmes also state the attributes that it offers to inculcate at the graduation level. The graduate attributes encompass values related to well-being, emotional stability, critical thinking, social justice and also skills for employability. In short, each programme prepares students for sustainability and life-long learning.

The new curriculum of B.Sc. (Hons) Instrumentation is designed in such a way that the learners should be able to comprehend and analyze the subject. Students will be able to equip themselves to the basic and advanced theories of Instrumentation to a complete skill set compatible to industry standards. The exhaustive curriculum will prepare them to pursue higher education as well compete in the job market.

The University of Delhi hopes the LOCF approach of the programme B.Sc. (Hons) Instrumentation will help students in making an informed decision regarding the goals that they wish to pursue in further education and life, at large.

# 1 Introduction to Programme

The learning outcomesbased curriculum framework (LOCF) for B.Sc. (Hons) Instrumentation is intended to prepare a curriculum which empowers the graduates to design, construct and maintainthe entire instrumentation system of any industrial undertaking of national and global standards. The framework will help in maintaining international standards to ensure global competitiveness and facilitate student/graduate mobility after completion of B.Sc. (Honours) Instrumentation program. The framework intends to allow for greater flexibility and innovation in curriculum design and syllabus development, teaching learning process, assessment of student learning Levels.

The LOCF for B.Sc. (Honours) Instrumentation is prepared by taking CBCS curricular structure of B.Sc. (H) Instrumentation provided by the UGC as reference. It may be modified without losing the essence of CBCS and LOCF.

## Program Duration:

The B.Sc. (Hons) Instrumentaionprogramme will be of three years duration. Each year will be called an academic year and will be divided into two semesters.Thus there will be a total of six semesters. Each semester will consist of sixteen weeks.

## Design of Program:

The teaching-learning will involve theory classes (Lectures) of onehour duration, tutorials and practical classes. The curriculum will be delivered through various methods including chalk and talk, powerpoint presentations, audio, video tools, E-learning/E-content, virtual labs, simulations, field trips/Industry visits, seminars (talks by experts), workshops, projects, models , class discussions and other listed suggestive ways. The assessment broadly will comprise of Internal Assessment (Continuous Evaluation) and End Semester Examination. Each theory paper will be of 100 marks with 25% marks for Internal Assessment and 75% for End Semester examination. The internal Assessment will be through MCQ, test, assignment, oral presentation, worksheets, short project and other suggested methods. Each practical paper will be of 50 marks.

## Programme Structure:

The programme will consist of six-credit courses, four-credit courses and two credit courses. All six credit courses with practicals will comprise of theory classes (four credits) and practicals (two credits) whereas those without practicals will have theory classes (five credits) and tutorials (one credit). Four credit courses will comprise of theory classes (two credits) and practicals (two credits). Two credit courses will comprise of theory classes only (two credits). For theory or tutorial classes, one credit indicates a one hour lecture per week while for practicals one credit indicates a two-hour session per week. Each practical or tutorial batch will be of 12-15 students.

The programme includes Core Courses (CC) and elective courses. The core courses are all compulsory courses. There are three kinds of elective courses: Discipline-Specific Elective (DSE), Generic Elective (GE) and Skill Enhancement Course (SEC). In addition there are two compulsory Ability Enhancement Courses (AEC). The outline of the Course is as under:

**1. Core Course:** A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

**2. Elective Course:** Generally a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill is called an Elective Course.

**2.1 Discipline Specific Elective (DSE) Course:** Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).

**2.2 Dissertation/Project Work:** An elective course designed to acquire special/advanced knowledge, such as supplement study/support study/ solving / analyzing /exploring a real life situation / difficult problem into a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project work. A Dissertation/ Project work would be of 6 credits. A Dissertation/Project Work may be given in lieu of a discipline specific elective paper.

**2.3 Generic Elective (GE) Course:** An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.

**P.S.: A core course offered in a discipline/subject may be treated as an elective by other discipline/subject and vice versa and such electives may also be referred to as Generic Elective. Therefore, the department is free to offer any of its Core Courses as Generic Electives to other discipline/subject.**

**3. Ability Enhancement Courses (AEC)/Competency Improvement Courses/Skill Development Courses/Foundation Course:** The Ability Enhancement (AE) Courses may be of two kinds: AE Compulsory Course (AECC) and AE Elective Course (AEEC). "AECC" courses are the courses based upon the content that leads to Knowledge enhancement. They ((i) Environmental Science, (ii) English/MIL Communication) are mandatory for all disciplines. AEEC courses are value-based and/or skill-based and are aimed at providing hands-on-training, competencies, skills, etc.

**3.1 AE Compulsory Course (AECC):** Environmental Science, English Communication/MIL Communication.

**3.2 AE Elective Course (AEEC):** These courses may be chosen from a pool of courses designed to provide value-based and/or skill-based instruction.

To acquire a degree in Instrumentation, a student must study fourteen Core Courses, four Discipline- Specific Electives, four Generic Electives, two Skill Enhancement Courses and two compulsory Ability Enhancement Courses. The Core Courses, Discipline-Specific Electives and Generic Electives are six-credit courses. The Skill Enhancement Courses are four-credit courses while the Ability Enhancement Courses are two credit-courses. A student has to earn a minimum of 148 credits to get a degree in B.Sc. (Hons) Instrumentation.

There will be fourteen Core Courses which are to be compulsorily studied to complete the requirements for an Honours degree in B.Sc. Instrumentation. The students will study two Core Courses each in Semesters I and II, three Core Courses each in Semesters III and IV, and two Core Courses each in Semesters V and VI. The Core Courses will be of six credits each (four credits theory and two credits practicals).

The programme offers nine Discipline-Specific Electives (DSEs), of which the student must choose any two in each of the Semesters V and VI. The DSEs will be of six credits each (four credits theory and two credits practicals). A particular option of DSE course shall be offered in Semesters V and VI semesters only if the minimum number of students opting for that course is 15. The DSE course that is project work will also carry six credits. The number of students who will be allowed to opt for project work will vary from college to college depending upon the infrastructural facilities and may vary each year. The college shall announce the number of seats for project work well in advance and may select the students for the same based on merit. Project work will involve investigative work and the student will have to do this in the time after their regular theory and practical classes. The final evaluation of the project work will be through a committee involving internal and external examiners. In this regard guidelines provided by University of Delhi for executing and evaluation of project work will be final. Students will be asked their choice for Project work at the end of IV semester and all formalities of topic and mentor selection will be completed by this time.

Different Generic Elective (GE) courses will be offered to the students of the B.Sc. (Hons) Instrumentationprogramme by other departments of the college and the student will have the option to choose one GE course each in Semesters I, II, III, and IV. The GEs will be of six credits each (four credits theory and two credits practicals or five credits theory and one credit tutorial). The Department of Instrumentation will offer nine GE courses for students of other departments. A core course offered in a discipline/subject may be treated as an elective by other discipline/subject and vice versa and such electives may also be referred to as Generic Elective. Therefore, the Department of Instrumentation is free to offer any of its Core Courses as Generic Electives to other discipline/subject.

The students will undertake two Skill Enhancement (SEC) courses of four credits each in Semesters III and IV which they can choose from the list of SEC courses offered by their college. The SEC courses will be of four credits each (two credits theory and two credits practicals). The Department of Instrumentation is offering six such courses.

The two compulsory Ability Enhancement Courses (AECs): AECC1 (Environmental Sciences) and AECC2 (English communication) will be of four credits each (theory only). The student will take one each in Semesters I and II.

## 2. Learning Outcome-based Curriculum Framework in B.Sc.(Hons) Instrumentation

The learning outcomes based approach implies that when an academic programme is planned, desirable learning outcomes are identified and considered in formulation of the plans. Course contents, learning activities and assessment types are designed to be consistent with the achievement of desired learning outcomes. The learning outcomes are in terms of knowledge, Professional attitude, work ethics, critical thinking, self managed learning, adaptability, problem solving skills, communication skills, interpersonal skills and group works. At the end of a

particular course/program, assessment is carried out to determine whether the desired outcomes are being achieved. This outcome assessment provides feedback to ensure that element in the teaching and learning environment are acting in concert to facilitate the nurturing of the desired outcomes. The expected learning outcomes are used as reference points that would help formulate graduate attributes, qualification descriptors, programme learning outcomes and course learning outcomes which in turn help not only in curriculum planning and development, but also in delivery and review of academic programmes.

The overall objectives of the learning outcomes based curriculum framework are to

- Help formulate graduate attributes, qualification descriptors, program learning outcomes and course learning outcomes that are expected to be demonstrated by the holders of qualification;
- Enable prospective students, parents, employers and other to understand the nature and level of learning outcomes or attributes a graduate of a programme should be capable of demonstrating on successful completion of the programme of study.
- Maintain national standards and international comparability of learning outcomes and academic standards to ensure global competitiveness, and to facilitate student/graduate mobility.
- Provide higher education institutions an important point of reference for designing teaching-learning strategies, assessing student learning level, and periodic review of programme and academic research.

## 2.1 Nature and Extent of the Programme in B.Sc.(H) Instrumentation

B.Sc. (Hons)Instrumentation is a specialized branch of physical sciences which caters to study of measurement in physical, chemical, biological sciences along with medical and engineering sciences. B.Sc. (Honours) Instrumentation is a professional course which is designed to develop skills which imparts knowledge in science and technology of measurement and control; to prepare skilled manpower that can objectively contribute towards design, development, use and maintenance of various instruments and machine learning environment.

At a time when automation and artificial intelligence are being considered instrumental in defining the onset of the fourth industrial revolution, an outcome-oriented course in Instrumentation has potential to produce trained professionals ready to take up the challenges in research, industrial and commercial organizations. The programmein Instrumentation is designed to develop academic and practical skills. The course includes many specialized papers like Transducers and Sensors, Machine Intelligence, Control Systems, Electronic Instrumentation, Measurement Technology, Analytical Instrumentation, Biomedical Instrumentation and Standardization and Quality Control, with the aim to produce graduates capable of adapting to technological changes.

The present learning outcomes based model curriculum of B.Sc. (Hons) Instrumentation, is designed to provide better learning experience to the graduates. Besides, imparting disciplinary knowledge, curriculum is aimed to equip the graduates with competencies like problem solving, analytical reasoning and leadership which provide them high professional competence.

## 2.2 Aims of Bachelor Degree Programme in B.Sc. (Hons) Instrumentation

The overall aims of the B.Sc. (Hons) Instrumentation are to:

- Provide students with learning experiences that develop broad knowledge and understanding of key concepts of Instrumentation and equip students with advanced scientific/technological capabilities for analyzing and tackling the issues and problems in the automation and control industries.
- Develop ability in student's to apply knowledge and skills they have acquired to the solution of specific theoretical and applied problems in Instrumentation.
- Develop abilities in students to design and develop innovative solutions for benefits of society, by diligence, leadership, team work and lifelong learning.
- Provide students with skills that enable them to get employment in industries or pursue higher studies or research assignments or turn as entrepreneurs.

# 3.Graduates Attributes in B.Sc. (Hons) Instrumentation

**Graduates Attributes** (GAs) form a set of individually assessable outcomes that are the components indicative of the graduate's potential to acquire competence to practice at the appropriate level. The Graduate Attributes of B.Sc. (Hons) Instrumentationare listed below:

**GA1. Scholarship of Knowledge:** Acquire in-depth knowledge of specific discipline or professional area, including wider and global perspective, with an ability to discriminate, evaluate, analyze and synthesize existing and new knowledge, and integration of the same for enhancement of knowledge.

**GA2. Critical Thinking:** Analyze complex scientific/technological problems critically; apply independent judgment for synthesizing information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.

**GA3. Problem Solving:** Think laterally and originally, conceptualize and solve scientific/technological problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors in the core areas of expertise.

**GA4. Usage of modern tools:** Create, select, learn and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex scientific/technological activities with an understanding of the limitations.

**GA5. Collaborative and Multidisciplinary work:** Possess knowledge and understanding of group dynamics, recognize opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis in order to achieve common goals and further the learning of themselves as well as others.

**GA6. Communication:** Communicate with the scientific/technological community, and with society at large, regarding complex scientific/technological activities confidently and effectively, such as, being able to comprehend and write effective reports and design documentation by

adhering to appropriate standards, make effective presentations, and give and receive clear instructions.

**GA7. Life-long Learning**: Recognize the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.

**GA8. Ethical Practices and Social Responsibility**: Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.

## 4. Qualification Descriptors for Graduates in B.Sc.(Hons) Instrumentation

A qualification descriptor indicates the generic outcomes and attributes expected for the award of a particular type of qualification. The learning experiences and assessment procedures are expected to be designed to provide every student with the opportunity to achieve the intended programme learning outcomes. The qualification descriptors reflect followings:

1. Disciplinary knowledge and understanding
2. Skills & Ability
3. Global competencies that all students in different academic fields of study should acquire/attain and demonstrate.

*4.1 Qualification descriptors for B.Sc. (Honours) Instrumentation Programme:* Some of the expected learning outcomes that a student should be able to demonstrate on completion of a B.Sc. (Hons) Instrumentation programme may include the following:

**Knowledge & Understanding**

- Demonstrate extensive knowledge of the disciplinary foundation in the various areas of Instrumentation, as well as insight into contemporary research and development.
- Demonstrate specialized methodological knowledge in the specialized areas of Instrumentation about professional literature, statistical principles and reviewing scientific work.

**Skills & Ability**

- Demonstrate ability to apply Instrumentation knowledge & experimental skills critically and systematically for assessment and solution of complex Instrumentation problems and issues related to Analytical systems, Biomedical systems, computers networks, robotics, VLSI Design and fabrication and other specialized areas of Instrumentation.
- Demonstrate ability to model, simulate and evaluate the phenomenon and systems in the advanced areas of Instrumentation.
- Demonstrate ability to apply one's instrumentation knowledge, experimental skills, scientific methods & advanced design, simulation and validation tools to identify and analyze complex real life problems and frame technological solutions for them.

- Demonstrate ability to design and develop industrial products, processes and Instrumentation systems while taking into account the circumstances and needs of individuals, organizations and society with focus on economical, social and environmental aspects

**Competence**

- Communicate his or her conclusions, knowledge & arguments effectively and professionally both in writing and by means of presentation to different audiences in both national and international context.
- Ability to work in collaborative manner with others in a team, contributions to the management, planning and implementations.
- Ability to independently propose research/developmental projects, plan its implementation, undertake its development, evaluate its outcomes and report its results in proper manner.
- Ability to identify the personal need for further knowledge relating to the current and emerging areas of study by engaging in lifelong learning in practices.

## 5. Program learning outcomes for B.Sc. (Honours) Instrumentation

The following program outcomes have been identified for **B.Sc. (Honours) Instrumentation**

| | |
|---|---|
| **PLO1** | Ability to apply knowledge of mathematics & science in solving instrumentation related problems |
| **PLO2** | Ability to design and conduct instrumentation experiments, as well as to analyze and interpret data |
| **PLO3** | Ability to design and manage instrumentation systems or processes that conforms to a given specification within ethical and economic constraints |
| **PLO4** | Ability to identify, formulate, solve and analyze the problems in various disciplines of instrumentation. |
| **PLO5** | Ability to function as a member of a multidisciplinary team with sense of ethics, integrity and social responsibility |
| **PLO6** | Ability to communicate effectively in term of oral and written communication skills |
| **PLO7** | Recognize the need for, and be able to engage in lifelong learning. |
| **PLO8** | Ability to use techniques, skills and modern technological/scientific/engineering software/tools for professional practices |

# Structure of B.Sc. (Hons) Instrumentation

## 6.1 Credit Distribution for B.Sc. (Hons) Instrumentation

A 148 credits (as per University norms) will be required for a student to be eligible to get degree of B.Sc. (Hons) Instrumentation. The credit distribution is as under:

| | Credit Details |
|---|---|
| | (Theory + Practical) or (Theory + Tutorial) |
| **I. Core Course (14 Papers)** | |
| Core Courses (Theory) | 14×4=56 |
| Core Courses (Practical) | 14×2=28 |
| **II. Elective Course (8 Courses = 4DSE + 4GE)** | |
| A.1. Discipline Specific Elective (DSE) Theory (4 in number) | 4 × 4 =16 |
| A.2. Discipline Specific Elective (DSE) Practical (4 in number) | 4 × 2 = 8 |
| B.1. Generic Elective/Interdisciplinary (GE) Theory (4 in number) | 4 × 4 =16 or4 × 5 = 20 |
| B.2. Generic Elective (GE) Practical/Tutorial*(4 in number) | 4 × 2 = 8 or4 × 1 = 4 |
| **III. Ability Enhancement Courses** | |
| **1. Ability Enhancement Compulsory Courses (AECC)** (2 papers of 4 credits each) | |
| Environmental Science/ English/ MIL Communication | 2 × 4 = 8 |
| **2. Skill Enhancement Courses (SEC)**** (2 papers of 4 credits each) | 2 ×4 = 8** |
| **Total** | **148** |

* Wherever there is a practical there will be no tutorial and vice-versa.

** As per University notification ( No. Aca.I/Choice Based Credit System/2016/1173 dated 04.10.2016)

## 6.2 Semester-wise Distribution of Courses

| Semester I | | | | | |
|---|---|---|---|---|---|
| | Course Type | Course Name | | Hours/ Week | Credit |
| 1 | Core | Core I: | *Basic Circuit Theory and Network Analysis* | 4 | 4 |
| 2 | | Core II: | *Applied Physics* | 4 | 4 |
| 3 | | Core Lab I: | *Basic Circuit Theory and Network Analysis Lab* | 4 | 2 |
| 4 | | Core Lab II: | *Applied Physics Lab* | 4 | 2 |
| 5 | GE | GE-1: | | 4/3 | 4/3* |
| 6 | | GE-1: | *Practical/Tutorial* | 4/1 | 2/1* |
| 7 | AECC | AECC-I: | *(English/ MIL Communication)/ Environmental Science* | 4 | 4 |
| | | | **Total Credits** | | 22 |

| Semester II | | | | | |
|---|---|---|---|---|---|
| | Course Type | Course Name | | Hours/ Week | Credit |
| 1 | Core | Core III: | *Analog Devices and Circuits* | 4 | 4 |
| 2 | | Core IV: | *Transducers and Sensors* | 4 | 4 |
| 3 | | Core Lab III: | *Analog Devices and Circuits Lab* | 4 | 2 |
| 4 | | Core Lab IV: | *Transducers and Sensors Lab* | 4 | 2 |
| 5 | GE | GE-2: | | 4/3 | 4/3* |
| 6 | | GE-2: | *Practical/Tutorial* | 4/1 | 2/1* |
| 7 | AECC | AECC-II: | *(English/ MIL Communication)/ Environmental Science* | 4 | 4 |
| | | | **Total Credits** | | 22 |

| Semester III | | | | | |
|---|---|---|---|---|---|
| | Course Type | Course Name | | Hours/ Week | Credit |
| 1 | Core | Core V: | *Biomedical Instrumentation* | 4 | 4 |
| 2 | | Core VI: | *Digital Electronics and VHDL* | 4 | 4 |
| 3 | | Core VII: | *Engineering Mathematics* | 4 | 4 |
| 4 | | Core Lab V: | *Biomedical Instrumentation Lab* | 4 | 2 |
| 5 | | Core Lab VI: | *Digital Electronics and VHDL Lab* | 4 | 2 |
| 6 | | Core Lab VII: | *Engineering Mathematics Lab* | 4 | 2 |
| 7 | GE | GE-3: | | 4/3 | 4/3* |
| 8 | | GE-3: | *Practical/Tutorial* | 4/1 | 2/1* |
| 9 | SEC | SEC-1: | | 4 | 4 |
| | | | **Total Credits** | | 28 |

| | | Semester IV | | | |
|---|---|---|---|---|---|
| | Course Type | Course Name | | Hours/ Week | Credit |
| 1 | Core | Core VIII: | *Operational Amplifiers and Applications* | 4 | 4 |
| 2 | | Core IX: | *Analytical Instrumentation* | 4 | 4 |
| 3 | | Core X: | *Electronic Instrumentation* | 4 | 4 |
| 4 | | Core Lab VIII: | *Operational Amplifiers and ApplicationsLab* | 4 | 2 |
| 5 | | Core Lab IX: | *Analytical Instrumentation Lab* | 4 | 2 |
| 6 | | Core Lab X: | *Electronic Instrumentation Lab* | 4 | 2 |
| 7 | GE | GE-4: | | 4/5 | 4/5* |
| 8 | | GE-4: | *Practical/Tutorial* | 4/1 | 2/1* |
| 9 | SEC | SEC-2: | | 4 | 4 |
| | | | | Total Credits: | 28 |

| | | Semester V | | | |
|---|---|---|---|---|---|
| | Course Type | Course Name | | Hours/ Week | Credit |
| 1 | Core | Core XI: | *Measurement Technology* | 4 | 4 |
| 2 | | Core XII: | *Microprocessor* | 4 | 4 |
| 3 | | Core Lab XI: | *Measurement Technology Lab* | 4 | 2 |
| 4 | | Core Lab XII: | *MicroprocessorLab* | 4 | 2 |
| 5 | DSE | DSE-1: | | 4 | 4 |
| 6 | | DSE-2: | | 4 | 4 |
| 7 | | DSE-1 Lab: | *Practical* | 4 | 2 |
| 8 | | DSE-2 Lab: | *Practical* | 4 | 2 |
| | | | | Total Credits: | 24 |

| | | Semester VI | | | |
|---|---|---|---|---|---|
| | Course Type | Course Name | | Hours/ Week | Credit |
| 1 | Core | Core XIII: | *Power Electronics* | 4 | 4 |
| 2 | | Core XIV: | *Control Systems* | 4 | 4 |
| 3 | | Core Lab XIII: | *Power Electronics Lab* | 4 | 2 |
| 4 | | Core Lab XIV: | *Control SystemsLab* | 4 | 2 |
| 5 | DSE | DSE-3: | | 4 | 4 |
| 6 | | DSE-4: | | 4 | 4 |
| 7 | | DSE-3 Lab: | *Practical* | 4 | 2 |
| 8 | | DSE-4 Lab: | *Practical* | 4 | 2 |
| | | | | Total Credits: | 24 |

**A. CORE COURSE (CC):**

**Credit: 06 each (Theory: 04 + Lab: 02)**

1. Basic Circuit Theory and Network Analysis (4+4)
2. Applied Physics (4+4)
3. Analog Devices and Circuits (4+4)
4. Transducers and Sensors (4+4)
5. Biomedical Instrumentation (4+4)
6. Digital Electronics and VHDL (4+4)
7. Engineering Mathematics (4+4)
8. Operational Amplifiers and Applications (4+4)
9. Analytical Instrumentation (4+4)
10. Electronic Instrumentation (4+4)
11. Measurement Technology (4+4)
12. Microprocessors (4+4)
13. Power Electronics (4+4)
14. Control Systems (4+4)

**B. Discipline Specific Electives (DSE):**

**(4 papers to be selected) - DSE 1-4**

**Credit: 06 each (Theory: 04 + Lab: 02)**

1. Signals and Systems (4+4)
2. Advanced Analytical Instrumentation (4+4)
3. Communication System (4+4)
4. Advanced Biomedical Instrumentation (4+4)
5. Embedded System and Robotics (4+4)
6. Process Control Dynamics (4+4)
7. Reliability and Quality Control Techniques (4+4)
8. Artificial Intelligence (4+4)
9. Dissertation (4+4)

**C. Skill Enhancement Course (SEC) (02 papers) SEC1 to SEC2**

**Credit: 04 each (Theory: 02 + Lab: 02)**

1. Programming in C (2+4)
2. VLSI Design and Verification (2+4)
3. Testing and Calibration (2+4)
4. PLC and SCADA (2+4)
5. Virtual Instrumentation (2+4)
6. Programming using MATLAB (2+4)

**D. Generic Elective Papers (GE) for other Departments/Disciplines: (Credit: 06 each)*****

1. Sensors and its Applications (4+4)
2. Instrumentation & Control (4+4)
3. Analytical Instrumentation (4+4)
4. Nuclear & Biomedical Instrumentation (4+4)
5. Machine Intelligence (4+4)
6. Standardization and Quality Control (4+4)
7. MATLAB and its Applications (4+4)
8. General Instrumentation (4+4)
9. Applied Mathematics (4+4)

**Any of the Core Courses in Category A can be offered as Generic Electives to other discipline/subject.**

*** *Finally, a word on the Generic Electives to be chosen by Instrumentation students. They are, of course, free to exercise their choice in a way they deem fit. However, it is recommended that they shall avoid opting for a Generic Elective of another program that has majority overlapping to their core course.*

**Important:**
The size of the practical group for practical papers is recommended to be 12-15 students.

**Note:**

1. Universities/Institutions/Departments may wish to add more courses against categories marked B, C and D, depending on the availability of specialists and other required resources.

2. Any major deviation in the category A (core courses) is likely to impact the very philosophy of LOCF in Instrumentation.

3. Departments/Board of Studies/ Universities should have freedom to arrange courses in the order they deem fit with justification.

4. Whenever stakeholders seek to introduce modifications or alterations in the LOCF or CBCS guidelines, they are (a) expected to have adequate and transparent justifications to do so and (b) to notify the UGC regarding the changes and the justifications thereof.

## Mapping of Course with program outcomes: (PLOs)

| | Core Course Name | PLO1: Ability to apply knowledge of mathematics & science in solving instrumentation related problems. | PLO2: Ability to design and conduct instrumentation experiments, as well as to analyze and interpret data. | PLO3: Ability to design and manage instrumentation systems or processes that conforms to a given specification within ethical and economic constraints. | PLO4:Ability to identify, formulate, solve and analyze the problems in various disciplines of instrumentation. | PLO5: Ability to function as a member of a multidisciplinary team with sense of ethics, integrity and professionalism. | PLO6: Ability to communicate effectively in terms of oral and written communication skills | PLO7: Recognize the need for, and be able to engage in lifelong learning. | PLO8: Ability to use techniques, skills and modern technological tools/software/engineering software/tools for professional practices |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Basic Circuit theory and Networks Analysis | √ | | √ | | | | | |
| 2 | Basic Circuit theory and Networks Analysis Lab | | | | √ | √ | | | √ |
| 3 | Applied Physics | √ | | √ | | | | | |
| 4 | Applied Physics Lab | | | | √ | √ | | | √ |
| 5 | Analog Devices and Circuits | √ | | √ | | | | | |
| 6 | Analog Devices and Circuits Lab | | | | √ | √ | | | |
| 7 | Transducers and Sensors | √ | √ | | | | √ | | |
| 8 | Transducers and Sensors Lab | | | | √ | √ | √ | | |
| 9 | Biomedical Instrumentation | √ | | √ | | | | | √ |
| 10 | Biomedical Instrumentation Lab | | | | √ | √ | | | |
| 11 | Digital Electronics and VHDL | √ | √ | | | | | √ | |
| 12 | Digital Electronics and VHDL Lab | | | | √ | √ | | √ | |
| 13 | Engineering Mathematics | √ | | √ | | | | | |
| 14 | Engineering Mathematics Lab | | | | √ | √ | | | |
| 15 | Operational Amplifiers and Applications | √ | √ | | | | | √ | |
| 16 | Operational Amplifiers and Applications Lab | | | | √ | √ | | √ | √ |
| 17 | Analytical Instrumentation | √ | √ | | | | | √ | |
| 18 | Analytical Instrumentation Lab | | | | √ | √ | √ | √ | |
| 19 | Electronic Instrumentation | √ | | √ | | | √ | √ | √ |
| 20 | Electronic Instrumentation Lab | | | | √ | √ | √ | √ | |
| 21 | Measurement Technology | √ | √ | | | | | | |
| 22 | Measurement Technology Lab | | | | √ | √ | √ | | √ |
| 23 | Microprocessors | √ | √ | √ | | | √ | √ | |
| 24 | Microprocessors Lab | | | | √ | √ | √ | √ | |
| 25 | Power Electronics | √ | | √ | | | | | |
| 26 | Power Electronics Lab | | | | √ | √ | | | |
| 27 | Control Systems | √ | √ | √ | | | √ | | |
| 28 | Control Systems Lab | | | | √ | √ | √ | | √ |
| 29 | Dissertation/Project work | √ | √ | √ | √ | √ | √ | √ | √ |

# UNIVERSITY OF DELHI

Bachelor of Management Studies

(Effective from Academic Year 2019-20)

**Revised Syllabus as approved by**

**Academic Council**

Date: No:

**Executive Council**

Date: No:

**Applicable for students registered with Regular Colleges**

## Preamble

The objective of any programme at Higher Education Institute is to prepare their students for the society at large. The University of Delhi envisions all its programmes in the best interest of their students and in this endeavour it offers a new vision to all its Under-Graduate courses. It imbibes a Learning Outcome-based Curriculum Framework (LOCF) for all its Under Graduate programmes.

The LOCF approach is envisioned to provide a focused, outcome-based syllabus at the undergraduate level with an agenda to structure the teaching-learning experiences in a more student-centric manner. The LOCF approach has been adopted to strengthen students' experiences as they engage themselves in the programme of their choice. The Under-Graduate Programmes will prepare the students for both, academia and employability.

Each programme vividly elaborates its nature and promises the outcomes that are to be accomplished by studying the courses. The programmes also state the attributes that it offers to inculcate at the graduation level. The graduate attributes encompass values related to well-being, emotional stability, critical thinking, social justice and also skills for employability. In short, each programme prepares students for sustainability and life-long learning.

The new curriculum of Bachelor of Management Studies offer students' core papers that help build their foundation in the area of management. The choice of generic electives and skill enhancement courses enable students to pursue an area of their interest in the field of management. The contents of each course have been carefully designed to prepare students with knowledge and skill sets that will not only make them industry ready but also foster entrepreneurial and innovative thinking.

The University of Delhi hopes the LOCF approach of the programme Bachelor of Management Studies will help students in making an informed decision regarding the goals that they wish to pursue in further education and life, at large.

## Introduction to Bachelor of Management Studies Program

Bachelor of Management Studies or BMS is an undergraduate program for management studies. The course allows students to obtain the knowledge and skills needed to assume management positions in a wide range of organizations. Management Studies program provides students with a solid foundation in the field of management and strategy designing. The electives allow students to develop deeper knowledge in specific areas of interest – finance, marketing, human resource management and management of global business. In addition to business management course, it will equip students to understand how organizations work, how they are managed, and sensitize students towards national and international environments. Students cantered learning focuses on skills and practices that enable lifelong learning and independent problem-solving.

**Learning Outcome-based Curriculum Framework in Programme**
**Bachelor of Management Studies**

The LOCF program in BMS provides an opportunity for the students to choose courses from the prescribed courses comprising core, discipline specific elective, generic elective and skill enhancement courses. The courses will be evaluated following the grading system, which is considered to be better than the conventional marks system. This will benefit the students to move across institutions within India to begin with and across countries. The uniform grading system will also enable potential employers in assessing the performance of the candidates. In order to bring uniformity in evaluation system and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations, the UGC guidelines will be followed.

## 2.1 Nature and Extent of the Programme in Bachelor of Management Studies

Outline of Learning Based Curriculum Framework:

1. **Core Course**: A course, which should compulsorily be studied by a candidate as a core requirement in pursuit of a bachelor degree in management.

2. **Elective Course**: A course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the courses/program in management or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill is called an Elective Course.

**2.1 Discipline Specific Elective (DSE) Course**: Elective courses offered by the main discipline/subject of study of management is referred to as Discipline Specific Elective. A choice from among four DSE – Finance; Marketing; Human Resource Management; Management of Global Business- are offered to students to gain advanced exposure to an elective of their choice.

A Student would be free to choose any FOUR courses (TWO courses in semester V and TWO in semester VI, from the courses offered) from ONE group The programme offers FOUR groups viz. Finance (DSE - I), Marketing (DSE - II) ,

Human Resource Management (DSE - III) and Management of Global Business (DSE – IV)

**2.2 Generic Elective (GE) Course:** An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.

P.S.: A core course offered in a discipline/subject may be treated as an elective by other discipline/subject and vice versa and such electives may also be referred to as Generic Elective.

**3. Ability Enhancement Compulsory Courses (AECC)/ Skill Enhancement Course:** The Ability Enhancement (AE) Courses may be of two kinds: AE Compulsory Course (AECC) and Skill Enhancement Courses (SEC). "AECC" courses are the courses based upon the content that leads to Knowledge enhancement. They (i) Environmental Science, (ii) English/MIL Communication) are mandatory for all disciplines. SEC courses are value-based and/or skill-based and are aimed at providing hands-on-training, competencies, skills, etc.

**3.1 AE Compulsory Course (AECC):** Environmental Science, English Communication/MIL Communication.

**3.2 Skill Enhancement Courses (SEC):** These courses may be chosen from a pool of courses designed to provide value-based and/or skill-based instruction.

**2.2Aims of Bachelor's Degree Program in (LOCF) Bachelor of Management Studies**

The curriculum of BMS is planned to have the following aims:

1. The progression of the program and structure will enable students to build on their learning in a systematic manner leading to critical evaluation and application of the concepts to the real world.
2. Build fundamentals in core areas of Accounts, Statistics, Economics, Financial Management, Marketing, Business Research & Quantitative Techniques and exposure to relevant software.
3. Sensitize students towards environment through EVS course.
4. Develop ability to use software for data extractions and analysis through statistical and econometric tools under SEC papers.

5. Enabling students to gain advanced exposure in area of their choice- Finance, Marketing, HRM and Management of Global Business
6. The program encourages students to undertake summer internship to gain practical insight from industry which makes their understanding of courses taught more meaningful.
7. Through academic exposure, practical training, skill enhancement develop students into becoming leaders/entrepreneurs.

# Graduate Attributes in Bachelor of Management Studies

## Disciplinary Knowledge

Academic excellence: Sound knowledge of the courses studied.

## Communication Skills

Strong presentation and communication skills: Presentations, group discussions, role plays and class room discussions form an integral part of the course curriculum. Each student on an individual basis or as group assignment prepare term papers which are presented and reviewed. This teaching pedagogy develops and enhances the communication and presentation skill of students leading to them becoming effective presenters of their innovative ideas/views.

## Critical Thinking

Inculcating an intellectually disciplined process of actively and skilfully conceptualizing, applying, analysing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reasoning, as a guide to action.

## Problem Solving

The Program focuses on well researched and solution based thinking and application of theoretical concepts to real life case studies enabling students to develop problem solving skills. Students develop an ability to take up challenges in their professional carrier and provide effective solutions.

## Analytical Reasoning

The ability to solve problems quickly and effectively. Systematic and methodical step-by-step approach to thinking that allows graduates to break down complex problems into single and manageable components.

## Research-Related Skills

The students are engaged with their faculty on research projects of current relevance and critical outcome. They work on live projects and collect data on industry for research based

projects and term papers. The students are taught the skill of using software for making analysis.

**Cooperation/Team Work**

Leadership and team spirit: Working on various assignments both academic and extra-curricular help them in becoming team worker. Group projects and presentations and case studies give opportunity to students to learn team skills and understand team dynamics.

**Scientific Reasoning**

Business data analysis that is researched/observed or collected through surveys for projects and term papers requires logical thinking and reasoning for arriving at conclusions and analytical outcomes.

**Reflective Thinking**

The assessment methods adopted for the courses include presentation on the specified class projects which requires the use of analytical thinking and critical evaluation.

**Information/Digital Literacy**

Students are required to prepare assignments/term papers based on data assimilated through primary and secondary sources. The data for secondary sources is largely procured from digital sources/online sources. The students are encouraged and taught the use of online database and research of website and organizations' literature.

**Self-Directed Learning**

Curiosity to acquire general knowledge and explore information to make better decisions, develop rational and logical beliefs and thinking.

**Multicultural Competence**

Students are enabled to understand the subjects during their classroom discussion. In addition to that they are advised, motivated and facilitated for co-curricular activities to serve the society especially to those at bottom of the pyramid. Further, they are sensitized towards Environmental care which has taken prime position because of the threat caused.

This sensitization is through the EVS paper in their first year of study. They are also expected to sensitize the society towards social issues and aspects concerning larger national issues.

**Moral and Ethical Awareness/Reasoning**

Courses include sensitization and cultivation of moral and ethical value in students. The program includes courses on ethics and social responsibility. Further through classroom discussions the students are made to understand the importance of adopting ethical practices in pursuit of business profits.

**Leadership Readiness/Qualities**

Creating an inspiring vision of the future. Motivates and inspires people to engage with that vision. Manages delivery of the vision. Accepting team spirit as an important contributor to both personal and professional life. Participate in healthy competition, generation of more ideas, improved productivity

**Lifelong Learning**

The course also orients the students towards better learning and application on business data. This will be possible only when they will update themselves on a daily basis and keep aware of changing environment.

Encouraging students to generate a variety of ideas and responses, across different categories and to look at things from different points of view. Generating new ideas and innovation.

## Qualification Descriptors for Graduates Bachelor of Management Studies

1. Demonstrate
   (i) A coherent understanding of business operations and management
   (ii) Managerial and analytical skills in designing business strategies and decisions
   (iii) Higher order skills in chosen area of specialization, namely Finance, Marketing, Human Resource Management, or Management of Global Business;
2. Use knowledge, understanding and skills required for identifying problems and issues, collection of relevant quantitative and/or qualitative data drawn form a wide range of sources and application of the information to designing solutions.
3. Develop innovative thinking and entrepreneurial skills
4. Demonstrate subject-related and transferable skills that are relevant for entry level management positions in diverse industries;
5. Create a sound foundation for students to pursue higher level studies and research in areas of management.

## Programme Learning Outcomes for Bachelor of Management Studies

1. Provide students with a sound theoretical base and exposure to current business challenges
2. Prepare students with capabilities and skills in areas of general management, marketing, finance, global business and human resource management, to take up roles in managerial position across diverse industries.
3. To encourage creativity and innovative thinking leading to entrepreneurial skills.
4. Enhance the ability of students to meet global challenges through sensitivity towards organizational, economic and cultural diversity.

## 6. Structure of Bachelor of Management Studies

### 6.1 Credit Distribution for Bachelor of Management Studies

| Courses | Number of Courses | Credits (Theory + Practical) | Total Credits |
|---|---|---|---|
| Core Courses | 14 | 6 | 84 |
| Generic Elective/Interdisciplinary | 4 | 6 | 24 |
| Discipline Specific Elective | 4 | 6 | 24 |
| Skill Enhancement Courses | 2 | 4 | 8 |
| Ability Enhancement Compulsory Course | 2 | 4 | 8 |
| **TOTAL CREDIT** | | | **148*** |

*** Extra 6 Credit may be earned by taking Research Project as an additional paper. It will also be evaluated at the end of sixth semester.**

6.2 Semester-wise Distribution of Courses.

| S.NO | COURSE CODE | COURSE TITLE | CREDITS | |
|---|---|---|---|---|
| | | | | |
| | | SEMESTER I | | |
| 1 | AECC101 | Language/EVS | 4 | Ability Enhancement-Compulsory Course |
| 2 | MC 102 | Fundamentals of Management and Organisational Behaviour | 6 | Core Discipline |
| 3 | MC 103 | Statistics for Business Decisions | 6 | Core Discipline |
| 4 | | Any One from the List of Generic Elective / Interdisciplinary Courses | 6 | Elective Course – Generic /Interdisciplinary |
| | | | | |
| | | SEMESTER II | | |
| 5 | AECC 201 | Language/EVS | 4 | Ability Enhancement-Compulsory Course |
| 6 | MC 202 | Managerial Economics | 6 | Core Discipline |
| 7 | MC 203 | Business Accounting | 6 | Core Discipline |
| 8 | | Any One from the List of Generic Elective / Interdisciplinary Courses | 6 | Elective Course – Generic /Interdisciplinary |
| | | | | |
| | | SEMESTER III | | |
| 9 | MC 301 | Macroeconomics | 6 | Core Discipline |
| 10 | MC 302 | Principles of Marketing | 6 | Core Discipline |
| 11 | MC 303 | Management Accounting | 6 | Core Discipline |
| 12 | | Any One from the List of Generic Elective / | 6 | Elective Course – Generic |

| | | | | |
|---|---|---|---|---|
| | | Interdisciplinary Courses | | /Interdisciplinary |
| 13 | | Any one from list of skill enhancement course (SEC) I/II/III/IV | 4 | Skill Enhancement Courses |
| | | | | |
| **SEMESTER IV** | | | | |
| 14 | MC 401 | Business Research | 6 | Core Discipline |
| 15 | MC 402 | Human Resource Management | 6 | Core Discipline |
| 16 | MC 403 | Financial Management | 6 | Core Discipline |
| 17 | | Any One from the List of Generic Elective / Interdisciplinary Courses | 6 | Elective Course – Generic /Interdisciplinary |
| 18 | | Any one from list of skill enhancement course (SEC) V/VI/VII/VIII | 4 | Skill Enhancement Courses |
| | | | | |
| **SEMESTER V** | | | | |
| 19 | MC 501 | Quantitative Techniques for Management | 6 | Core Discipline |
| 20 | MC 502 | Legal Aspects of Business | 6 | Core Discipline |
| 21 | | Any one course from the list of Elective I/II/III/IV | 6 | Discipline Specific Elective |
| 22 | | Any one from the list of Elective I/II/III/IV | 6 | Discipline Specific Elective |
| | | | | |
| **SEMESTER VI** | | | | |
| 23 | MC 601 | Business Policy and Strategy | 6 | Core Discipline |
| 24 | MC 602 | Financial Institutions and Markets | 6 | Core Discipline |
| 25 | | Any one from the list of | 6 | Discipline Specific |

| | | | | |
|---|---|---|---|---|
| | | Elective V/VI/VII/VIII | | Elective |
| 26 | | Any one from the list of Elective V/VI/VII/VIII | 6 | Discipline Specific Elective |
| | | | | |
| **DISCIPLINE SPECIFIC ELECTIVE COURSE**: A Student would be free to choose any FOUR courses (TWO courses in semester V and TWO in semester VI, from the courses offered) from ONE group The programme offers FOUR groups viz. Finance (DSE - I), Marketing (DSE - II) , Human Resource Management (DSE - III) and Management of Global Business (DSE – IV). An additional paper in Research project mode (Semester-long Research Project) may be offered at semester VI as extra credit paper under discipline specific electives. **Students can choose one Research project as extra paper under the guidance of a teacher.** | | | | |
| **DSE I FINANCE** | | | | |
| I | MDF 503 | Strategic Corporate Finance | 6 | Discipline Specific Elective |
| II | MDF 504 | Investment Analysis and Portfolio Management | 6 | Discipline Specific Elective |
| III | MDF 505 | Project Appraisal and Implementation | 6 | Discipline Specific Elective |
| IV | MDF 506 | Business Analysis and Valuation | 6 | Discipline Specific Elective |
| V | MDF 603 | International Finance | 6 | Discipline Specific Elective |
| VI | MDF 604 | Investment Banking and Financial Services | 6 | Discipline Specific Elective |
| VII | MDF 605 | Financial Time Series Econometrics | 6 | Discipline Specific Elective |
| VIII | MDF 606 | Derivatives and Risk Management | 6 | Discipline Specific Elective |
| IX | | **Research Projects** | 6 | |
| **DSE II MARKETING** | | | | |
| I | MDM 503 | Consumer Behaviour | 6 | Discipline Specific |

| | | | | |
|---|---|---|---|---|
| | | | | Elective |
| II | MDM 504 | Personal Selling | 6 | Discipline Specific Elective |
| III | MDM 505 | Marketing of Services | 6 | Discipline Specific Elective |
| IV | MDM 506 | International Marketing | 6 | Discipline Specific Elective |
| V | MDM 603 | Retail Management | 6 | Discipline Specific Elective |
| VI | MDM 604 | Advertising and Brand Management | 6 | Discipline Specific Elective |
| VII | MDM 605 | Distribution and Supply Chain Management | 6 | Discipline Specific Elective |
| VIII | MDM 606 | Digital Marketing | 6 | Discipline Specific Elective |
| IX | | **Research Projects** | | |
| | **DSE III HUMAN RESOURCE MANAGEMENT** | | | |
| I | MDH 503 | Training and Management Development | 6 | Discipline Specific Elective |
| II | MDH 504 | Management of Industrial Relations | 6 | Discipline Specific Elective |
| III | MDH 505 | HRD: Systems and Strategies | 6 | Discipline Specific Elective |
| IV | MDH 506 | Counselling and Negotiation Skills for Management | 6 | Discipline Specific Elective |
| V | MDH 603 | Talent and Knowledge Management | 6 | Discipline Specific Elective |
| VI | MDH 604 | Performance and Compensation Management | 6 | Discipline Specific Elective |
| VII | MDH 605 | Organizational Development | 6 | Discipline Specific Elective |

| | | | | |
|---|---|---|---|---|
| VIII | MDH 606 | International Human Resource Management | 6 | Discipline Specific Elective |
| IX | | **Research Projects** | | |
| **DSE IV MANAGEMENT OF GLOBAL BUSINESS** | | | | |
| I | MDG 503 | International Trade: Policies and Strategies | 6 | Discipline Specific Elective |
| II | MDG 504 | Transnational and Cross Cultural Marketing | 6 | Discipline Specific Elective |
| III | MDG 505 | International Accounting and Reporting System | 6 | Discipline Specific Elective |
| IV | MDG 506 | Multinational Business Finance | 6 | Discipline Specific Elective |
| V | MDG 603 | Global Business Environment | 6 | Discipline Specific Elective |
| VI | MDG 604 | International Supply Chain Management | 6 | Discipline Specific Elective |
| VII | MDG 605 | International Joint Ventures, Mergers and Acquisitions | 6 | Discipline Specific Elective |
| VIII | MDG 606 | Cross Cultural Human Resource Management | 6 | Discipline Specific Elective |
| IX | | **Research Projects** | | |
| **GENERIC ELECTIVE** | | | | |
| I | MG 104 | Fundamental of Marketing Management | 6 | Generic Elective |
| II | MG 105 | India's Diversity and Business | 6 | Generic Elective |
| III | MG 204 | Business Legislation | 6 | Generic Elective |
| IV | MG 205 | Ethics and Corporate Social Responsibility | 6 | Generic Elective |
| V | MG 304 | Fundamentals of Human Resource Management | 6 | Generic Elective |

| | | | | |
|---|---|---|---|---|
| VI | MG 305 | Entrepreneurship and New Venture Creation | 6 | Generic Elective |
| VII | MG 404 | Production and Operations Management | 6 | Generic Elective |
| VIII | MG 405 | Money and Banking | 6 | Generic Elective |
| | | | | |
| | **SKILL ENHANCEMENT COURSES** | | | |
| I | MS 305 | Advanced Spreadsheet Tools for Business Analysis | 4 | Skill Enhancement Courses |
| II | MS 306 | Software for Data Extraction and Analysis | 4 | Skill Enhancement Courses |
| III | MS 307 | IT tools for Business | 4 | Skill Enhancement Courses |
| IV | MS 308 | Personality Development and Communication | 4 | Skill Enhancement Courses |
| V | MS 405 | Statistical Software Package | 4 | Skill Enhancement Courses |
| VI | MS 406 | E Commerce | 4 | Skill Enhancement Courses |
| VII | MS 407 | Basic Econometrics Using Software | 4 | Skill Enhancement Courses |
| VIII | MS 408 | Business Analytics | 4 | Skill Enhancement Courses |

# UNIVERSITY OF DELHI

## BACHELOR OF SCIENCE (HONS.) IN MATHEMATICS

## (B.Sc. (Hons.) Mathematics)

**Learning Outcomes based Curriculum Framework (LOCF)**

2019

## 1. Introduction

The current focus in higher education is to shift from teacher-centric approach to learner-centric approach. For this as one of the aims, UGC has introduced the learning outcomes-based curriculum framework for undergraduate education. The learning outcomes-based curriculum framework for B.Sc. (Hons.) Mathematics is prepared keeping this in view. The framework is expected to provide a student with knowledge and skills in mathematics along with generic and transferable skills in other areas that help in personal development, employment and higher education in the global world. The programme-learning outcomes and course learning outcomes have been clearly specified to help prospective students, parents and employers understand the nature and extent of the degree programme; to maintain national and international standards, and to help in student mobility.

## 2. Learning Outcomes based approach to Curriculum Planning

The learning outcomes-based curriculum framework for B.Sc. (Hons.) Mathematics is based on the expected learning outcomes and graduate attributes that a graduate in mathematics is expected to attain. The curriculum for B.Sc. (Hons.) Mathematics is prepared keeping in mind the needs and aspirations of students in mathematics as well as the evolving nature of mathematics as a subject. The course learning outcomes and the programme learning outcomes specify the knowledge, understanding, skills, attitudes and values that a student completing this degree is expected to know. The qualification of B.Sc. (Hons.) Mathematics is awarded to a student who can demonstrating the attainment of these outcomes.

### 2.1 Nature and extent of the B.Sc. (Hons.) Mathematics

Mathematics is usually described as the abstract science of number, quantity and space along with their operations. The scope of Mathematics is very broad and it has a wide range of applications in natural sciences, engineering, economics and social sciences. B.Sc. (Hons.) Mathematics Programme aims at developing the ability to think critically, logically and analytically and hence use mathematical reasoning in everyday life. Pursuing a degree in mathematics will introduce the students to a number of interesting and useful ideas in preparations for a number of mathematics careers in education, research, government sector, business sector and industry.

The B.Sc. (Hons.) Mathematics programme covers the full range of mathematics, from classical Calculus to Modern Cryptography, Information Theory, and Network Security. The course lays a structured foundation of Calculus, Real & Complex analysis, Abstract Algebra, Differential Equations (including Mathematical Modelling), Number Theory, Graph Theory, and C++ Programming exclusively for Mathematics.

An exceptionally broad range of topics covering Pure & Applied Mathematics: Linear Algebra, metric Spaces, Statistics, Linear Programming, Numerical Analysis, Mathematicl Fi nance, Coding Theory, Mechanics and Biomathematics cater to varied interests and

ambitions. Also hand on sessions in Computer Lab using various Computer Algebra Systems (CAS) softwares such as Mathematica, MATLAB, Maxima, **R** to have a deep conceptual understanding of the above tools are carried out to widen the horizon of students' self-experience. The courses like Biomathematics, Mathematical Finance etc. emphasize on the relation of mathematics to other subjects like Biology, Economics and Finance.

To broaden the interest for interconnectedness between formerly separate disciplines one can choose from the list of Generic electives for example one can opt for economics as one of the GE papers. Skill enhancement Courses enable the student acquire the skill relevant to the main subject. Choices from Discipline Specific Electives provides the student with liberty of exploring his interests within the main subject.

Of key importance is the theme of integrating mathematical and professional skills. The well-structured programme empowers the student with the skills and knowledge leading to enhanced career opportunities in industry, commerce, education, finance and research.

## 2.2 Aims of Bachelor's degree programme in Mathematics

The overall aims of B.Sc.(Hons) Mathematics Programme are to:

- inculcate strong interest in learning mathematics.
- evolve broad and balanced knowledge and understanding of definitions, key concepts, principles and theorems in Mathematics
- enable learners/students to apply the knowledge and skills acquired by them during the programme to solve specific theoretical and applied problems in mathematics.
- develop in students the ability to apply relevant tools developed in mathematical theory to handle issues and problems in social and natural sciences.
- provide students with sufficient knowledge and skills that enable them to undertake further studies in mathematics and related disciplines
- enable students to develop a range of generic skills which will be helpful in wage-employment, self-employment and entrepreneurship.

## 3. Graduate Attributes in Mathematics

Some of the graduate attributes in mathematics are listed below:

**3.1 Disciplinary knowledge:** Capability of demonstrating comprehensive knowledge of basic concepts and ideas in mathematics and its subfields, and its applications to other disciplines.

**3.2 Communications skills:** Ability to communicate various concepts of mathematics in effective and coherent manner both in writing and orally, ability to present the complex mathematical ideas in clear, precise and confident way, ability to explain the development and importance of mathematics and ability to express thoughts and views in mathematically or logically correct statements.

**3.3 Critical thinking and analytical reasoning:** Ability to apply critical thinking in understanding the concepts in mathematics and allied areas; identify relevant assumptions, hypothesis, implications or conclusions; formulate mathematically correct arguments; ability to analyse and generalise specific arguments or empirical data to get broader concepts.

**3.4 Problem solving:** Capacity to use the gained knowledge to solve different kinds of non-familiar problems and apply the learning to real world situations; Capability to solve problems in computer graphics using concepts of linear algebra; Capability to apply the knowledge gained in differential equations to solve specific problems or models in operations research, physics, chemistry, electronics, medicine, economics, finance etc.

**3.5 Research-related skills:** Capability to ask and inquire about relevant/appropriate questions, ability to define problems, formulate hypotheses, test hypotheses, formulate mathematical arguments and proofs, draw conclusions; ability to write clearly the results obtained.

**3.6 Information/digital literacy:** Capacity to use ICT tools in solving problems or gaining knowledge; capacity to use appropriate softwares and programming skills to solve problems in mathematics,

**3.7 Self-directed learning:** Ability to work independently, ability to search relevant resources and e-content for self-learning and enhancing knowledge in mathematics.

**3.8 Moral and ethical awareness/reasoning:** Ability to identify unethical behaviour such as fabrication or misrepresentation of data, committing plagiarism, infringement of intellectual property rights.

**3.9 Lifelong learning:** Ability to acquire knowledge and skills through self-learning that helps in personal development and skill development suitable for changing demands of work place.

## 4. Qualification descriptors for B.Sc. (Hons.) Mathematics

Students who choose B.Sc. (Hons.) Mathematics Programme, develop the ability to think critically, logically and analytically and hence use mathematical reasoning in everyday life.

Pursuing a degree in mathematics will introduce the students to a number of interesting and useful ideas in preparations for a number of mathematics careers in education, research, government sector, business sector and industry.

The programme covers the full range of mathematics, from classical Calculus to Modern Cryptography, Information Theory, and Network Security. The course lays a structured foundation of Calculus, Real & Complex analysis, Abstract Algebra, Differential Equations (including Mathematical Modeling), Number Theory, Graph Theory, and C++ Programming exclusively for Mathematics.

An exceptionally broad range of topics covering Pure & Applied Mathematics: Linear Algebra, Metric Spaces, Statistics, Linear Programming, Numerical Analysis, Mathematical Finance, Coding Theory, Mechanics and Biomathematics cater to varied interests and ambitions. Also hand on sessions in Computer Lab using various Computer Algebra Systems (CAS) softwares such as Mathematica, MATLAB, Maxima, R to have a deep conceptual understanding of the above tools are carried out to widen the horizon of students' self-experience.

To broaden the interest for interconnectedness between formerly separate disciplines one can choose from the list of Generic electives for example one can opt for economics as one of the GE papers. Skill enhancement courses enable the student acquire the skill relevant to the main subject. Choices from Discipline Specific Electives provides the student with liberty of exploring his interests within the main subject.

Of key importance is the theme of integrating mathematical and professional skills. The well-structured programme empowers the student with the skills and knowledge leading to enhanced career opportunities in industry, commerce, education, finance and research. The qualification descriptors for B.Sc. (Hons.) Mathematics may include the following:

i. demonstrate fundamental/systematic and coherent knowledge of the academic field of mathematics and its applications and links to engineering, science, technology, economics and finance; demonstrate procedural knowledge that create different professionals like teachers and researchers in mathematics, quantitative analysts, actuaries, risk managers, professionals in industry and public services.
ii. demonstrate educational skills in areas of analysis, geometry, algebra, mechanics, differential equations etc.
iii. demonstrate comprehensive knowledge about materials, including scholarly, and/or professional literature, relating to essential learning areas pertaining to the field of mathematics, and techniques and skills required for identifying mathematical problems.
iv. Apply the acquired knowledge in mathematics and transferable skills to new/unfamiliar contexts and real-life problems.
v. Demonstrate mathematics-related and transferable skills that are relevant to some of the job trades and employment opportunities.

## 5. Programme Learning Outcomes in B.Sc. (Hons.) Mathematics

The completion of the B.Sc. (Hons.) Mathematics Programme will enable a student to:

i) Communicate mathematics effectively by written, computational and graphic means.
ii) Create mathematical ideas from basic axioms.
iii) Gauge the hypothesis, theories, techniques and proofs provisionally.
iv) Utilize mathematics to solve theoretical and applied problems by critical understanding, analysis and synthesis.
v) Identify applications of mathematics in other disciplines and in the real-world, leading to enhancement of career prospects in a plethora of fields and research.

## 6. Structure of B.Sc. (Hons.) Mathematics

The B.Sc. (Hons.) Mathematics programme is a three-year, six-semesters course. A student is required to complete 148 credits for completion of the course.

| | | Semester | Semester |
|---|---|---|---|
| Part – I | First Year | Semester I: 22 | Semester II: 22 |
| Part – II | Second Year | Semester III: 28 | Semester IV: 28 |
| Part - III | Third Year | Semester V: 24 | Semester VI: 24 |

### Semester wise Details of B.Sc. (Hons.) Mathematics Course & Credit Scheme

| Semester | Core Course(14) | Ability Enhancement Compulsory Course (AECC)(2) | Skill Enhancement Course (SEC)(2) | Discipline Specific Elective (DSE)(4) | Generic Elective (GE)(4) | Total Credits |
|---|---|---|---|---|---|---|
| I | BMATH101:Calculus (including practicals)<br>BMATH102: Algebra | (English Communication/MIL)/ Environmental Science | | | GE-1 | |
| L+T/P | 4+2 = 6;<br>5+1 = 6 | 4 | | | 5+1 = 6 | 22 |
| II | BMATH203: Real Analysis<br>BMATH204: Differential Equations (including practicals) | (English Communication/MIL)/ Environmental Science<br>4 | | | GE-2 | |
| L+T/P | 5+1 = 6;<br>4+2 = 6 | | | | 5+1 = 6 | 22 |

| | | | | | | |
|---|---|---|---|---|---|---|
| III | BMATH305: Theory of Real Functions<br>BMATH306: Group Theory-I<br>BMATH307: Multivariate Calculus (including practicals) | | SEC-1 LaTeX and HTML | | GE-3 | |
| L+T/P | 5+1=6; 5+1=6; 4+2=6 | | 4 | | 5+1=6 | 28 |
| IV | BMATH408: Partial Differential Equations (including practicals)<br>BMATH409: Riemann Integration and Series of Functions<br>BMATH410: Ring Theory and Linear Algebra-I | | SEC-2 Computer Algebra Systems and Related Software | | GE-4 | |
| L+T/P | 4+2=6; 5+1=6; 5+1=6 | | 4 | | 5+1=6 | 28 |
| V | BMATH511: Metric Spaces<br>BMATH512: Group Theory-II | | | DSE-1 (including practicals)<br>DSE-2 | | |
| L+T/P | 5+1=6; 5+1=6 | | | 4+2=6; 5+1=6 | | 24 |
| **Semester** | **Core Course(14)** | **Ability Enhancement Compulsory Course (AECC)(2)** | **Skill Enhancement Course (SEC)(2)** | **Discipline Specific Elective (DSE)(4)** | **Generic Elective (GE)(4)** | **Total Credits** |
| VI | BMATH613: Complex Analysis (including practicals)<br>BMATH614: Ring Theory and Linear Algebra-II | | | DSE-3<br>DSE-4 | | |
| L+T/P | 4+2=6; 5+1=6 | | | 5+1=6; 5+1=6 | | 24 |
| | | | | | **Total Credits =** | **148** |

**Legend**: L: Lecture Class; T: Tutorial Class; P: Practical Class

**Note**: One-hour lecture per week equals 1 Credit, 2 Hours practical class per week equals 1 credit. Practical in a group of 15-20 students in Computer Lab and Tutorial in a group of 8-12 students.

## List of Discipline Specific Elective (DSE) Courses:

**DSE-1** (Including Practicals): Any *one* of the following

(at least *two* shall be offered by the college)

(i) Numerical Analysis
(ii) Mathematical Modeling and Graph Theory
(iii) C++ Programming for Mathematics

**DSE-2**: Any *one* of the following

(at least *two* shall be offered by the college)

(i) Probability Theory and Statistics
(ii) Discrete Mathematics
(iii) Cryptography and Network Security

**DSE-3**: Any *one* of the following

(at least *two* shall be offered by the college)

(i) Mathematical Finance
(ii) Introduction to Information Theory and Coding
(iii) Biomathematics

**DSE-4**: Any *one* of the following

(at least *two* shall be offered by the college)

(i) Number Theory
(ii) Linear Programming and Applications
(iii) Mechanics

# दिल्ली विश्वविद्यालय
# UNIVERSITY OF DELHI

Bachelor of Science (Hons) Microbiology

(Effective from Academic Year 2019-20)

**Revised Syllabus as approved by**

**Academic Council**

**Date:** **No:**

**Executive Council**

**Date:** **No:**

**Applicable for students registered with Regular Colleges**

# Preamble

The objective of any programme at Higher Education Institute is to prepare their students for the society at large. The University of Delhi envisions all its programmes in the best interest of their students and in this endeavour it offers a new vision to all its Under-Graduate courses. It imbibes a Learning Outcome-based Curriculum Framework (LOCF) for all its Under Graduate programmes.
The LOCF approach is envisioned to provide a focused, outcome-based syllabus at the undergraduate level with an agenda to structure the teaching-learning experiences in a more student-centric manner. The LOCF approach has been adopted to strengthen students' experiences as they engage themselves in the programme of their choice. The Under-Graduate Programmes will prepare the students for both, academia and employability.

Each programme vividly elaborates its nature and promises the outcomes that are to be accomplished by studying the courses. The programmes also state the attributes that it offers to inculcate at the graduation level. The graduate attributes encompass values related to well-being, emotional stability, critical thinking, social justice and also skills for employability. In short, each programme prepares students for sustainability and life-long learning.

## 1. Introduction to Programme

The Choice-based credit system (CBCS) offers flexibility of programme structure while ensuring that the student gets a strong foundation in the subject and gains in-depth knowledge of all aspects of the field. The Learning outcomes-based curriculum framework is designed around the CBCS and is intended to suit the present day needs of the student in terms of securing their path towards higher studies or employment.

## 2. Learning Outcome – based Curriculum Framework in Programme B.Sc. (Hons) Microbiology

The Learning Outcomes-based Curriculum Framework (LOCF) for the B.Sc. (Honours) degree in Microbiology is designed to afford a skeletal structure within which the programme can be developed to suit the need of the hour, in keeping with the emergence of new areas of microbiology. The framework is architected to allow for flexibility in programme design and course content development, while at the same time maintaining a basic uniformity in structure in comparison with other universities across the country.

### 2.1. Nature and extent of the programme in B.Sc. (Hons) Microbiology

***Program Duration:***
The B.Sc. (Honours) Microbiology programme will be of three years duration. Each year will be called an academic year and will be divided into two semesters. Thus there will be a total of six semesters. Each semester will consists of sixteen weeks.

***Design of Program:***
The teaching-learning will involve theory classes (Lectures) of one hour duration and practical classes. The curriculum will be delivered through various methods including chalk and talk, power-point presentations, audio, video tools, E-learning/E-content, virtual labs, simulations, field trips/Industry visits, seminars (talks by experts), workshops, projects, models and class discussions. The assessment broadly will comprise of Internal Assessment (Continous Evaluation) and End Semester Examination. Each theory paper will be of 100 marks with 25% marks for Internal Assessment and 75% for End Semester examination. The internal Assessment will be through MCQ, test, assignment, oral presentation, worksheets and short project. Each practical paper will be of 50 marks.

## 2.2. Aims of Bachelor Degree Programme in B.Sc. (Hons) Microbiology

The B.Sc. (Honours) Microbiology programme covers a wide range of basic and applied microbiology courses as well as courses of interdisciplinary nature. The core courses that are a part of the programme are designed to build a strong microbiology knowledge base in the student, and furthermore, acquaints the students with the applied aspects of this fascinating discipline as well. The student is thus equipped to pursue higher studies in an institution of her/his choice, and to apply the skills learnt in the programme to solving practical societal problems. The programme offers a wide range of elective courses to the student. These include skill enhancement courses that prepare the student for an eventual job in academia or industry.

# 3. Graduate Attributes in B.Sc. (Hons) Microbiology

Some of the characteristic attributes of an Honors graduate in Microbiology include:

- **Knowledge acquisition:** gathers in-depth knowledge of basic and applied areas of microbiology.
- **Core microbiology laboratory skills:** understands various methods of safe handling, culturing and storage of microorganisms in the laboratory.
- **Interdisciplinary approach:** becomes aware of the role of microbiology in interdisciplinary research as well as in daily life.
- **Environmental literacy:** develops a basic understanding of the microbiological principles that that have environmental implications, and gains an awareness of regulatory requirements and their compliance in biotechnology and microbiological research.
- **Scientific logic:** develops scientific logic and approaches a problem with critical reasoning.
- **Independence in thought:** cultivates independent thinking and is able to integrate knowledge from other disciplines and fit that knowledge into the context of microbiology.
- **Team work:** understands the importance and strengths of interacting with and working alongside people from diverse backgrounds.
- **Global perspective:** becomes acquainted with standard international practices and emerging technologies used to study microbes.
- **Communication skills:** develops effective communication skills through oral presentations of ongoing developments in the field and the compiling of information in the form of reports.
- **Ethics:** acquires an awareness of work ethics and ethical issues in scientific research as well as plagiarism policies.
- **Self-motivation:** develops self-discipline, planning and organization skills, and time management skills.

# 4. Qualification descriptors for Graduates of B.Sc. (Hons) Microbiology

The qualification descriptors for graduates of B.Sc. (Honours) programme in Microbiology include:

- Demonstration of a clear and exhaustive understanding of the basic concepts of Microbiology, and an awareness of the emerging areas of the field.
- Acquisition of in-depth comprehension of the applied aspects of microbiology in day-to-day life.
- Enhancement of ability to read, assimilate and discuss scholarly articles and research papers showcasing microbiology as well as interdisciplinary areas of life sciences.
- Sharpening of critical thinking skills facilitating the application of knowledge gained in the field of microbiology in the classroom to the practical solving of societal problems.
- Development of intellectual capabilities promoting the ability to formulate and test a hypothesis.

- Acquisition of practical laboratory skills, enabling the accurate design of an experiment and systematic collection of experimental data.
- Exhibition of ability to interprete and quantitatively analyze experimental data and maintain records of the same.
- Development of strong oral and written communication skills promoting the ability to present studies in the field of microbiology using the concepts and knowledge acquired.
- Demonstration of the ability to work effectively and productively, independently or as part of a team.

## 5. Program Learning Outcomes for B.Sc. (Hons) Microbiology

- Students of the B.Sc. (Honours) Microbiology programme will learn to use scientific logic as they explore a wide range of contemporary subjects spanning various aspects of basic microbiology such as Bacteriology, Virology, Biochemistry, Microbial Physiology, Immunology, Cell Biology, Molecular Biology, Genetics, Systems Biology, Immunology and Molecular biology, in addition to becoming aware of the applied aspects of microbiology such as Industrial Microbiology, Food and Dairy Microbiology, Environmental Microbiology and Medical Microbiology to name just a few.
- Students will appreciate the biological diversity of microbial forms and be able to describe/explain the processes used by microorganisms for their replication, survival, and interaction with their environment, hosts, and host populations. They will become aware of the important role microorganisms play in maintenance of a clean and healthy environment. They will learn of the role of microorganisms in plant, animal and human health and disease.
- Students will gain knowledge of various biotechnological applications of microorganisms and will learn of industrially important substances produced by microorganisms. They will gain familiarity with the unique role of microbes in genetic modification technologies.
- Students will become familiar with scientific methodology, hypothesis generation and testing, design and execution of experiments. Students will develop the ability to think critically and to read and analyze scientific literature.
- Students will acquire and demonstrate proficiency in good laboratory practices in a microbiological laboratory and be able to explain the theoretical basis and practical skills of the tools/technologies commonly used to study this field.
- Students will develop proficiency in the quantitative skills necessary to analyze biological problems (e.g., arithmetic, algebra, and statistical methods as applied to biology)
- Students will develop strong oral and written communication skills through the effective presentation of experimental results as well as through seminars.
- Graduates of the B.Sc. (Honours) Microbiology programme will be informed citizens who can understand and evaluate the impact of new research discoveries in the life sciences, and will be able to pursue a wide range of careers, including biological and medical research in higher education institutions as well as careers in public and global health, scientific writing, environmental organizations, and food, pharmaceuticals and biotechnology industries.

## 6. Structure of Programme

### 6.1. Credit Distribution for B.Sc. (Hons) Microbiology

The programme will consist of six-credit courses and four-credit courses. All six-credit courses will comprise of theory classes (four credits) and practicals (two credits). Four credit courses will comprise of theory classes (two credits) and practicals (two credits). The Ability Enhancement Courses will be four credit courses of theory classes only. For theory classes one credit indicates a one hour lecture per week while for practicals one credit indicates a two-hour session per week. Each practical batch will be of fifteen students. A number exceeding fifteen (by at least ten) will be divided into two equal batches.

The programme includes Core Courses (CC) and elective courses. The core courses are all compulsory courses. There are three kinds of elective courses: Discipline-Specific Elective (DSE), Generic Elective (GE) and Skill Enhancement Course (SEC). In addition there are two compulsory Ability Enhancement Courses (AEC).

To acquire a degree in Microbiology a student must study fourteen Core Courses, four Discipline-Specific Electives, four Generic Electives, two Skill Enhancement Courses and two compulsory Ability Enhancement Courses. The Core Courses, Discipline-Specific Electives and Generic Electives are six-credit courses. The Skill Enhancement Courses and Ability Enhancement Courses are four-credit courses. A student has to earn a minimum of 148 credits to get a degree in B.Sc. (H) Microbiology.

There will be fourteen Core Courses which are to be compulsorily studied to complete the requirements for an Honours degree in B.Sc. Microbiology. The students will study two Core Courses each in Semesters I and II, three Core Courses each in Semesters III and IV, and two Core Courses each in Semesters V and VI. The Core Courses will be of six credits each (four credits theory and two credits practicals).

The programme offers nine Discipline-Specific Electives (DSEs), of which the student must choose any two in each of the Semesters V and VI. The DSEs will be of six credits each (four credits theory and two credits practicals). A particular option of DSE course will be offered in Semesters V and VI semesters only if the minimum number of students opting for that course is 10. The DSE course that is project work will also carry six credits. The number of students who will be allowed to opt for project work will vary from college to college depending upon the infrastructural facilities and may vary each year. The college shall announce the number of seats for project work well in advance and may select the students for the same based on merit. Project work will involve experimental work and the student will have to do this in the time after their regular theory and practical classes. The final evaluation of the project work will be through a committee involving internal and external examiners. In this regard guidelines provided by University of Delhi for executing and evaluation of project work will be final. Students will be asked their choice for Project work at the end of IV semester and all formalities of topic and mentor selection will be completed by this time.

Different Generic Elective (GE) courses will be offered to the students of the B.Sc. (H) Microbiology programme by other departments of the college and the student will have the option to choose one GE course each in Semesters I, II, III, and IV. The GEs will be of six credits each (four credits theory and two credits practicals). The Department of Microbiology will offer nine GE courses for students of other departments.

The students will undertake two Skill Enhancement (SE) courses of four credits each in Semesters III and IV. which they can choose from the list of SE courses offered by their college. The SE courses will be of four credits each (two credits theory and two credits practicals). The Department of Microbiology is offering eight such courses.

The two compulsory Ability Enhancement Courses (AECs): AE1 (Environmental Sciences) and AE2 (English communication/Modern Indian Language) will be of four credits each (theory only). The student will take one each in Semesters I and II.

## COURSES OFFERED UNDER B.SC. (H) MICROBIOLOGY PROGRAMME (CBCS)

| Core Courses | | | |
|---|---|---|---|
| SEMESTER | COURSE CODE | NAME OF THE COURSE | CREDITS |
| I | MICR08-CC101 | Introduction to Microbiology and Microbial Diversity | L=4 P=2 |
| | MICR08-CC102 | Bacteriology | L=4 P=2 |
| II | MICR08-CC201 | Biochemistry | L=4 P=2 |
| | MICR08-CC202 | Cell Biology | L=4 P=2 |
| III | MICR08-CC301 | Microbial Physiology and Metabolism | L=4 P=2 |
| | MICR08-CC302 | Environmental Microbiology | L=4 P=2 |
| | MICR08-CC303 | Molecular Biology | L=4 P=2 |
| IV | MICR08-CC401 | Microbial Genetics and Genomics | L=4 P=2 |
| | MICR08-CC402 | Virology | L=4 P=2 |
| | MICR08-CC403 | Food and Dairy Microbiology | L=4 P=2 |
| V | MICR08-CC501 | Industrial Microbiology | L=4 P=2 |
| | MICR08-CC502 | Immunology | L=4 P=2 |
| VI | MICR08-CC601 | Medical Microbiology | L=4 P=2 |
| | MICR08-CC602 | Recombinant DNA Technology | L=4 P=2 |
| **Discipline Specific Elective Courses (DSE)** | | | |
| V | MICR08-DSE501 | Bioinformatics | L=4 P=2 |
| | MICR08-DSE502 | Instrumentation and Biotechniques | L=4 P=2 |
| | MICR08-DSE503 | Principles of Genetics | L=4 P=2 |
| | MICR08-DSE504 | Biomathematics and Biostatistics | L=4 P=2 |
| VI | MICR08-DSE601 | Microbial Biotechnology | L=4 P=2 |
| | MICR08-DSE602 | Advances in Microbiology | L=4 P=2 |
| | MICR08-DSE603 | Plant Pathology | L=4 P=2 |
| | MICR08-DSE604 | Biosafety and Intellectual Property Rights (IPR) | L=4 P=2 |
| | MICR08-DSE605 | Project Work | L=4 P=2 |
| **Generic Electives Courses (GE)** | | | |
| I | MICR08-GE101 | Introduction and Scope of Microbiology | L=4 P=2 |
| II | MICR08-GE201 | Bacteriology and Virology | L=4 P=2 |
| III | MICR08-GE301 | Microbial Metabolism | L=4 P=2 |
| | MICR08-GE302 | Microbial Genetics and Molecular Biology | L=4 P=2 |
| | MICR08-GE303 | Applications of Microbes in Biotechnology | L=4 P=2 |
| IV | MICR08-GE401 | Industrial and Food Microbiology | L=4 P=2 |
| | MICR08-GE402 | Microbes in Environment | L=4 P=2 |
| | MICR08-GE403 | Medical Microbiology and Immunology | L=4 P=2 |
| | MICR08-GE404 | Genetic Engineering and Biotechnology | L=4 P=2 |
| **Skill Enhancement Elective Courses (SEC)** | | | |
| III-IV | MICR08-SE1 | Microbial Quality Control in Food and Pharmaceutical Industries | L=2 P=2 |
| | MICR08-SE2 | Microbial Diagnosis in Health Clinics | L=2 P=2 |
| | MICR08-SE3 | Biofertilizers and Biopesticides | L=2 P=2 |
| | MICR08-SE4 | Food Fermentation Techniques | L=2 P=2 |
| | MICR08-SE5 | Management of Human Microbial Diseases | L=2 P=2 |
| | MICR08-SE6 | Microbiological Analysis of Air and Water | L=2 P=2 |
| | MICR08-SE7 | Fundamentals of Bioinformatics | L=2 P=2 |
| | MICR08-SE8 | Biostatistics | L=2 P=2 |

## 6.2. Semester-wise Distribution of Courses

| Semester | CORE COURSE (14) | Ability Enhancement Compulsory Course AECC | Skill Enhancement Course SEC | Discipline Specific Elective DSE | Generic Elective GE |
|---|---|---|---|---|---|
| I | Introduction to Microbiology and Microbial Diversity MICROB-CC101 | Environmental Science | | | GE-1 |
| | Bacteriology MICROB-CC102 | | | | |
| II | Biochemistry MICROB-CC201 | English communication/ Modern English Language | | | GE-2 |
| | Cell Biology MICROB-CC202 | | | | |
| III | Microbial Physiology and Metabolism MICROB-CC301 | | SEC -1 | | GE-3 |
| | Environmental Microbiology MICROB-CC302 | | | | |
| | Molecular Biology MICROB-CC303 | | | | |
| IV | Microbial Genetics and Genomics MICROB-CC401 | | SEC -2 | | GE-4 |
| | Virology MICROB-CC402 | | | | |
| | Food and Dairy Microbiology MICROB-CC403 | | | | |
| V | Industrial Microbiology MICROB-CC501 | | | DSE-1 | |
| | Immunology MICROB-CC502 | | | DSE-2 | |
| VI | Medical Microbiology MICROB-CC601 | | | DSE -3 | . |
| | Recombinant DNA Technology MICROB-CC602 | | | DSE-4 | |

# 7. Teaching Learning Methods

The B.Sc. (Honours) Microbiology programme aims to make the student proficient in microbiology through the transfer of knowledge in the classroom as well as in the laboratory. In the classroom this will be done through blackboard and chalk lectures, charts, powerpoint presentations, and the use of audio-visual resources that are available on the internet such as virtual lab. An interactive mode of teaching will be used. The student will be encouraged to participate in discussions and deliver seminars on some topics. A problem-solving approach will be adopted wherever suitable. In the laboratory the student will first learn good laboartory practices and then get hands-on training on basic microbiological techniques and methods. Emphasis on laboratory work is particularly important keeping in mind the practical nature of the subject, and the time devoted to practicals will enable the student to better understand the applications of the different courses. The student will participate in field trips to industries that will facilitate his/her understanding of the practical aspects of the programme and enable him to gain exposure to future places/areas of employment.

# 8. Assessment Methods

The student will be assessed over the duration of the programme by many different methods. These include short objectives-type quizzes, assignments, written and oral examinations, group discussions and presentations, problem-solving exercises, case study presentations, experimental design planning, execution of experiments, seminars, preparation of reports, and presentation of

practical records. The wide range of assessment tasks aim to break the monotony of having a single assessment method.

## 9. Keywords

Microbial Diversity, Microbial Physiology, Industrial microbiology, Environmental Microbiology.

# दिल्ली विश्वविद्यालय
# UNIVERSITY OF DELHI

Bachelor of Science (Honours) Physics

(Effective from Academic Year 2019-20)

**Revised Syllabus as approved by**

| | | |
|---|---|---|
| Date: | **Academic Council** | No: |
| Date: | **Executive Council** | No: |

**Applicable for students registered with Regular Colleges.**

# Preamble

Higher Education in India is in need of reform. On the one hand, while there is a need for increased access to higher education in the country, it is also necessary to improve the quality of higher education. New initiatives and sustained efforts are needed to develop and enhance the spirit of enquiry, analytical ability and comprehension skills of the young generation of students. An emerging knowledge based society requires that they are able to acquire and generate new knowledge and skills, and can creatively apply them to excel in their chosen vocations. Our higher education system needs to inculcate exemplary citizenship qualities and motivate students to contribute to the society at large. Such abilities and qualities of our youth will be crucial for the country to face the challenges of the future.

One of the reforms in undergraduate (UG) education, initiated by the University Grants Commission (UGC) at the national level in 2018, is to introduce the Learning Outcomes-based Curriculum Framework (LOCF) which makes it student-centric, interactive and outcome-oriented with well-defined aims and objectives.

The Department of Physics and Astrophysics, University of Delhi took up the task of drafting the LOCF for UG Physics courses according to guidelines sent in March 2019 by the Undergraduate Curriculum Review Committee (UGCRC)-2019 of the University of Delhi. The Committee of Courses of the Department constituted a Steering Committee, whose composition is given in Annexure 1A, to plan and formulate the LOCF for UG Physics courses of the University. The Steering Committee formed Subject Working Groups (Annexure 1B) to formulate the content of different sets of courses. The Subject Working Groups included teachers from more than twenty colleges of the University, who have experience of teaching the respective courses. About eighty faculty members from the Department of Physics and Astrophysics and Physics Departments of colleges of the University have contributed to this important task. The inputs of the Subject Working Groups were compiled, and the present document prepared by a final drafting team (Annexure 1C).

The University of Delhi offers the undergraduate B.Sc. (Honours) Physics programme, the B.Sc. Physical Sciences programme with Physics and Electronics disciplines, as well as general elective courses in Physics for students of Honours programmes in disciplines other than Physics. The LOCF has been prepared for all of the above.

An earlier draft of the LOCF of the University of Delhi was put in the public domain for stakeholders' comments in May 2019. This was a revised version of the existing Choice Based Credit System (CBCS) undergraduate programme at the University of Delhi. We thank the stakeholders who took time and made effort to give us feedback on the earlier draft. Many of the comments received have helped us improve the LOCF draft.

We acknowledge the use of the document "Learning Outcomes based Curriculum Framework (LOCF) for Undergraduate Programme B.Sc. (Physics) 2019" put up by the UGC on its website in May 2019 (https://www.ugc.ac.in/pdfnews/1884134_LOCF-Final_Physics-report.pdf) and prepared by its Subject Expert Committee for Physics. This document has helped in clarifying the features of the LOCF and is the original source of a significant part of the text of the present document.

## Keywords

Core Courses (CC)

Course Learning Outcomes (CLO)

Ability Enhancement Compulsory Course (AECC)

Discipline Specific Electives (DSE)

Generic Electives (GE)

Learning Outcome-based Curriculum Framework (LOCF)

Programme Learning Outcomes

Skill Enhancement Courses (SEC)

Student Centric

Teaching Learning Processes

# Learning Outcomes-Based Curriculum Framework for Undergraduate Education in Physics

## 1. INTRODUCTION

The learning outcomes-based curriculum framework for a degree in B.Sc. (Honours) Physics is intended to provide a comprehensive foundation to the subject, and to help students develop the ability to successfully continue with further studies and research in the subject. The framework is designed to equip students with valuable cognitive abilities and skills so that they are successful in meeting diverse needs of professional careers in a developing and knowledge-based society. The curriculum framework takes into account the need to maintain globally competitive standards of achievement in terms of the knowledge and skills in Physics, as well develop scientific orientation, enquiring spirit, problem solving skills and values which foster rational and critical thinking.

Due to the large diversity in India, a central university like the University of Delhi gets students from very different academic backgrounds, regions and language zones. While maintaining high standards, the learning outcome-based curriculum provides enough flexibility to teachers and colleges to respond to diverse needs of students.

The learning outcome-based curriculum framework for undergraduate courses in Physics also allows for flexibility and innovation in the programme design to adopt latest teaching and assessment methods and include introduction to new areas of knowledge in the fast-evolving subject domains. The process of learning is defined by the following steps which form the basis of final assessment of the achievement at the end of the program.

(i) Development of an understanding and knowledge of basic Physics. This involves exposure to basics facts of nature discovered by Physics through observations and experiments. The other core component of this development is introduction to physics concepts and principles, their theoretical relationships in laws of Physics, and deepening of their understanding via appropriate problems.

(ii) The ability to use this knowledge to analyze new situations and learn skills and tools like laboratory techniques, computational methods, and mathematics to find solutions, interpret results and make meaningful predictions.

(iii) The ability to synthesize the acquired knowledge and experience for an improved comprehension of the physical problems and to create new skills and tools for their possible solutions.

# 2. LEARNING OUTCOMES BASED CURRICULUM FRAMEWORK FOR PROGRAMME IN B.SC. (HONS.) PHYSICS

## 2.1 NATURE AND EXTENT OF THE PROGRAMME IN B.SC. (HONS.) PHYSICS

The B.Sc. (Hons.) Physics programme builds on the basic Physics taught at the +2 level in all the schools in the country. Ideally, the +2 senior secondary school education should achieve a sound grounding in understanding the basic Physics with sufficient content of topics from modern Physics and contemporary areas of exciting developments in physical sciences. The curricula and syllabi should be framed and implemented in such a way that the basic connection between theory and experiment and its importance in understanding Physics is made clear to students. This is very critical in developing a scientific temperament and the urge to learn and innovate in Physics and other sciences. Unfortunately, our school system in most parts of the country lacks the facilities to achieve the above goal, and it is incumbent upon the college/university system to fill the gaps in the scientific knowledge and understanding of the country's youth who complete school curricula and enter university education.

Physics is an experimental and theoretical science that studies systematically the laws of nature operating at length scales from the sub-atomic domains to the entire universe. The scope of Physics as a subject is very broad. The core areas of study within the disciplinary/subject area of the B.Sc. (Hons.) Physics programme are: Classical and Quantum Mechanics, Electricity and Magnetism, Thermal and Statistical Physics, Wave theory and Optics, Physics of the Materials, Digital Electronics, and specialized methods of Mathematical Physics and their applications in different branches of the subject. Along with the theoretical course work students also learn physics laboratory methods for different branches of physics, specialized measurement techniques, analysis of observational data, including error estimation, and scientific report writing. The latest addition to Physics pedagogy incorporated in the LOCF framework is computational physics, which involves adaptation of Physics problems for algorithmic solutions, and modelling and simulation of physical phenomenon. The elective modules of the framework offer students choice to gain knowledge and expertise in more specialized domains of Physics like Nuclear and Particle physics, Nanophysics, Astronomy and Astrophysics, etc. and interdisciplinary subject areas like Biophysics, Geophysics, Environmental Physics, Medical Physics, etc.

The physics-based knowledge and skills learnt by students also equip them to be successful in careers other than research and teaching in Physics.

## 2.2 AIMS OF BACHELOR'S DEGREE PROGRAMME IN B.SC. (HONS.) PHYSICS

The LOCF based UG educational program in Physics aims to

- create the facilities and learning environment in educational institutions to consolidate the knowledge acquired at +2 level, motivate students to develop a deep interest in Physics, and to gain a broad and balanced knowledge and understanding of physical concepts, principles and theories of Physics.
- provide opportunities to students to learn, design and perform experiments in lab, gain an understanding of laboratory methods, analysis of observational data and report writing, and acquire a deeper understanding of concepts, principles and theories learned in the classroom through laboratory demonstration, and computational problems and modelling.
- develop the ability in students to apply the knowledge and skills they have acquired to get to the solutions of specific theoretical and applied problems in Physics.
- to prepare students for pursuing the interdisciplinary and multidisciplinary higher education and/or research in interdisciplinary and multidisciplinary areas, as Physics is among the most important branches of science necessary for interdisciplinary and multidisciplinary research.
- to prepare students for developing new industrial technologies and theoretical tools for applications in diverse branches of the economic life of the country, as Physics is one of the branches of science which contribute directly to technological development, and it has the most advanced theoretical structure to make quantitative assessments and predictions, and
- in light of all of the above to provide students with the knowledge and skill base that would enable them to undertake further studies in Physics and related areas, or in interdisciplinary/multidisciplinary areas, or join and be successful in diverse professional streams including entrepreneurship.

# 3. GRADUATE ATTRIBUTES FOR B.SC. (HONS.) PHYSICS

Some of the characteristic attributes of a graduate in Physics are

- **Disciplinary knowledge**
  - (i) Comprehensive knowledge and understanding of major concepts, theoretical principles and experimental findings in core areas of Physics -like Classical and Quantum mechanics, Thermodynamics and Statistical mechanics, Electricity, Magnetism and Electromagnetic theory, Wave Theory, Optics, Solid State Physics, and Analogue and Digital electronics; and in the chosen disciplinary elective sub-fields of the subject like Nuclear and Particle Physics, Analytical dynamics, Astronomy and Astrophysics, Advanced Mathematical Physics, Nanophysics and interdisciplinary subfields like Biophysics, Geophysics, Atmospheric Physics, Medical Physics, Embedded Systems, etc.
  - (ii) Ability to use physics laboratory methods and modern instrumentation for designing and implementing new experiments in physics, interdisciplinary/multidisciplinary research areas and industrial research.

- **Skilled communicator**: Ability to transmit abstract concepts and complex information relating to all areas in Physics in a clear and concise manner through scientific report writing. Ability to express complex relationships and information through graphical methods and proper tabulation. Ability to explain complex processes through simulation and modelling. Ability to express complex and technical concepts orally in a simple, precise and straightforward language for better understanding.
- **Critical thinking**: Ability to distinguish between relevant and irrelevant facts and information, discriminate between objective and biased information, apply logic to arrive at definitive conclusions, find out if conclusions are based upon sufficient evidence, derive correct quantitative results, make rational evaluations, and arrive at qualitative judgments according to established rules.
- **Sense of inquiry**: Capability for asking relevant/appropriate questions relating to the issues and problems in the field of Physics and beyond. Planning, executing and reporting the results of theoretical or experimental investigation.
- **Team player/worker**: Capable of working effectively in diverse teams in both classroom, laboratory, Physics workshop and in field-based situation.
- **Skilled project manager**: Capable of identifying/mobilizing appropriate resources required for a project, and managing a project through to completion, while observing responsible and ethical scientific conduct, safety and laboratory hygiene regulations and practices.
- **Digitally Efficient**: Capable of using computers for computational and simulation studies in Physics. Proficiency in appropriate software for numerical and statistical analysis of data, accessing and using modern e-library search tools, ability to locate, retrieve, and evaluate Physics information from renowned physics archives, proficiency in accessing observational and experimental data made available by renowned research labs for further analysis.
- **Ethical awareness/analytical reasoning**: The graduates should be capable of demonstrating the ability to think and analyze rationally with modern and scientific outlook and adopt unbiased objectives and truthful actions in all aspects of work. They should be capable of identifying ethical issues related to their work. They should be ready to appropriately acknowledge direct and indirect contributions received from all sources, including from other personnel in the field of their work. They should be willing to contribute to the free development of knowledge in all forms. Further, unethical behavior such as fabrication, falsification or misrepresentation of data, or committing plagiarism, or not adhering to intellectual property rights should be avoided.
- **Social, National and International perspective**: The graduates should be able to develop a perspective about the significance of their knowledge and skills for social well-being and a sense of responsibility towards human society and the planet. They should have a national as well as an international perspective about their work and career in the chosen field of academic and research activities.
- **Lifelong learners**: Capable of self-paced and self-directed learning aimed at personal development and for improving knowledge/skill development and reskilling in all areas of Physics.

# 4. QUALIFICATION DESCRIPTORS FOR GRADUATES IN B.Sc. (HONS.) PHYSICS

The qualification descriptor for B.Sc. (Hons.) Physics graduates include the following: They should be able to:

- Demonstrate

(i) a systematic and coherent understanding of basic Physics including the concepts, theories and relevant experimental techniques in the domains of Mechanics, Electricity and Magnetism, Waves and Optics, Thermal Physics, Quantum Mechanics, Statistical Mechanics, Mathematical Physics and their applications in other areas of Physics;

(ii) the ability to relate their understanding of physics to other sciences and hence orient their knowledge and work towards multi-disciplinary/inter-disciplinary contexts and problems;

(iii) procedural knowledge that creates different types of professionals related to different areas of study in Physics and multi/interdisciplinary domains, including research and development, teaching, technology professions, and government and public service;

(iv) skills in areas of specializations of their elective subfields so that they can continue with higher studies and can relate their knowledge to current developments in those subfields.

- Use knowledge, understanding and skills required for identifying problems and issues relating to Physics, and its interface with other subjects studied in the course; collect relevant quantitative and/or qualitative data from a wide range of sources including various research laboratories of the world, and do analysis and evaluation using appropriate methodologies.

- Communicate the results of studies undertaken accurately in a range of different contexts using the main concepts, constructs and techniques of Physics and other subjects studied in the course. Develop communication abilities to present these results in technical as well as popular science meetings.

- Ability to meet their own learning needs, drawing on a range of pedagogic material available on the internet and books, current research and development work and professional materials, and in interaction with other science professionals.

- Demonstrate Physics-related technological skills that are relevant to Physics-related trades and employment opportunities.

- Apply their knowledge, understanding and skills to new/unfamiliar contexts beyond Physics to identify and analyze problems and issues, and to solve complex problems.

# 5. PROGRAMME LEARNING OUTCOMES IN B.Sc. (HONS.) PHYSICS

Students graduating with the B.Sc. (Honours) Physics degree should be able to

- Acquire
  - (i) a fundamental/systematic and coherent understanding of the academic field of basic Physics in areas like Mechanics, Electricity and Magnetism, Waves and Optics, Thermal and Statistical Physics, Quantum Mechanics, Mathematical Physics and their applications to other core subjects in Physics;
  - (ii) a wide ranging and comprehensive experience in physics laboratory methods in experiments related to mechanics, optics, thermal physics, electricity, magnetism, digital electronics, solid state physics and modern physics. Students should acquire the ability for systematic observations, use of scientific research instruments, analysis of observational data, making suitable error estimates and scientific report writing;
  - (iii) procedural knowledge that creates different types of professionals related to the disciplinary/subject area of Physics, including professionals engaged in research and development, teaching and government/public service;
  - (iv) knowledge and skills in areas related to their specialization area corresponding to elective subjects within the disciplinary/subject area of Physics and current and emerging developments in the field of Physics.

- Demonstrate the ability to use skills in Physics and its related areas of technology for formulating and tackling Physics-related problems and identifying and applying appropriate physical principles and methodologies to solve a wide range of problems associated with Physics.
- Recognize the importance of mathematical modelling, simulation and computational methods, and the role of approximation and mathematical approaches to describing the physical world and beyond.
- Plan and execute Physics-related experiments or investigations, analyze and interpret data/information collected using appropriate methods, including the use of appropriate software such as programming languages and purpose-written packages, and report accurately the findings of the experiment/investigations while relating the conclusions/findings to relevant theories of Physics.
- Demonstrate relevant generic skills and global competencies such as
  - (i) problem-solving skills that are required to solve different types of Physics-related problems with well-defined solutions, and tackle open-ended problems that belong to the disciplinary area boundaries;
  - (ii) investigative skills, including skills of independent investigation of Physics-related issues and problems;
  - (iii) communication skills involving the ability to listen carefully, to read texts and research papers analytically and to present complex information in a concise manner to different groups/audiences of technical or popular nature;
  - (iv) analytical skills involving paying attention to detail and ability to construct logical arguments using correct technical language related to Physics and ability to translate them with popular language when needed;
  - (v) ICT skills;
  - (vi) personal skills such as the ability to work both independently and in a group.
- Demonstrate professional behavior such as

(i) being objective, unbiased and truthful in all aspects of work and avoiding unethical, irrational behavior such as fabricating, falsifying or misrepresenting data or committing plagiarism;
(ii) the ability to identify the potential ethical issues in work-related situations;
(iii) be committed to the free development of scientific knowledge and appreciate its universal appeal for the entire humanity;
(iv) appreciation of intellectual property, environmental and sustainability issues;
(v) promoting safe learning and working environment.

# 6. TEACHING LEARNING PROCESSES

The teaching learning processes play the most important role in achieving the desired aims and objectives of the undergraduate programs in Physics. The LOCF framework emphasizes learning outcomes for every physics course and its parts. This helps in identifying most suitable teaching learning processes for every segment of the curricula. Physics is basically an experimental science with a very elaborate and advanced theoretical structure. Systematic observations of controlled experiments open up windows to hidden properties and laws of nature. Physics concepts and theories are meant to create a systematic understanding of these properties and laws. All principles and laws of physics are accepted only after their verification and confirmation in laboratory, or observations in the real world, which require scientists trained in appropriate experimental techniques, and engineers to design and make advanced scientific instruments. At the same time physics graduates also need a deep understanding of physics concepts, principles and theories, which require familiarity with different branches of mathematical physics. To achieve these goals, the appropriate training of young individuals to become competent scientists, researchers and engineers in future has to be accomplished. For this purpose, a very good undergraduate program in Physics is required as a first step. An appropriate teaching-learning procedure protocol for all the colleges is therefore essential. To be specific, it is desirable to have:

- Sufficient number of teachers in permanent positions to do all the class room teaching and supervise the laboratory experiments to be performed by the students.
- All teachers should be qualified as per the UGC norms and should have good communication skills.
- Sufficient number of technical and other support staff to run laboratories, libraries, and other equipment and to maintain the infrastructural facilities like buildings, ICT infrastructure, electricity, sanitation, etc.
- Necessary and sufficient infrastructural facilities for the class rooms, laboratories and libraries.
- Modern and updated laboratory equipment needed for the undergraduate laboratories and reference and text books for the libraries.
- Sufficient infrastructure for ICT and other facilities needed for technology enabled learning like computer facilities, PCs, laptops, Wi-Fi and internet facilities with all the necessary software.

Teachers should make use of these approaches for an efficient teaching-learning process:

i. Class room teaching with lectures using traditional as well as electronic boards.
ii. Demonstration of the required experiments in laboratory and sessions on necessary apparatuses, data analysis, error estimation and scientific report writing for effective and efficient learning of laboratory techniques.

iii. Imparting the problem solving ability which enables a student to apply physical and mathematical concepts to a new and concrete situation is essential to all courses. This can be accomplished through examples discussed in the class or laboratory, assignments and tutorials.

iv. CBCS curriculum has introduced a significant content of computational courses. Computational physics should be used as a new element in the physics pedagogy, and efforts should be made to introduce computational problems, including simulation and modeling, in all courses.

v. Teaching should be complimented with students' seminar to be organized very frequently.

vi. Guest lectures and seminars should be arranged by inviting eminent teachers and scientists.

vii. Open-ended project work should be given to all students individually, or in groups of 2-3 students depending upon the nature of the course.

viii. Since actual undergraduate teaching is done in affiliated colleges which have differing levels of infrastructure and student requirements, the teachers should attend workshops organized by the University Department for college faculty on teaching methodology, reference materials, latest laboratory equipment and experiments, and computational physics software for achieving uniform standards. Common guidelines for individual courses need to be followed/evolved.

ix. Internship of duration varying from one week anytime in the semester, and/or 2-6 weeks during semester break and summer breaks should be arranged by the college for the students to visit other colleges/universities/HEI and industrial organizations in the vicinity. If needed, financial assistance may also be provided for such arrangements.

x. Special attempts should be made by the institution to develop problem-solving skills and design of laboratory experiments for demonstration at the UG level. For this purpose, a mentor system may be evolved where 3-4 students may be assigned to each faculty member.

xi. Teaching load should be managed such that the teachers have enough time to interact with the students to encourage an interactive/participative learning.

In the first year students are fresh from school. Given the diversity of their backgrounds, and the lack of adequate infrastructure and training in science learning in many schools, special care and teacher attention is essential in the first year. Mentorship with senior students and teachers can help them ease into rigors of university level undergraduate learning.

A student completing the Physics (Hons.) course under the CBCS takes 14 core courses, 4 discipline specific elective (DSE) courses, 4 general elective (GE) courses, two skill enhancement courses (SEC) and two ability enhancement compulsory courses (AECC). Since different categories of courses have different objectives and intended learning outcomes, the most efficient and appropriate teaching learning processes would not be same for all categories of courses.

## 6.1 TEACHING LEARNING PROCESSES FOR CORE COURSES

The objective of Core courses is to build a comprehensive foundation of physics concepts, principles and laboratory skills so that a student is able to proceed to any specialized branch. Rather than a quantitative amalgamation of disparate knowledge, it is much more preferable

that students gain the depth of understanding and ability to apply what they have learnt to diverse problems.

All Core courses have a theory component. In addition, every core course has a physics laboratory component, or a computational physics component, which are integrated with their theoretical component. Even though the learning in theory and lab components proceeds in step, the teaching learning processes for the different components need specific and different emphases.

### 6.1.1 Teaching Learning Processes for Theory component of Core Courses

A significant part of the theoretical learning in core courses is done in the traditional lecture cum black-board method. Demonstrations with models, power-point projection, student project presentations, etc., are some other methods which should be judiciously used to enhance the learning experience. Problem solving should be integrated into theoretical learning of core courses and proportionally more time should be spent on it. It is advisable that a list of problems is distributed to students before the discussion of every topic, and they are encouraged to solve these in the self-learning mode, since teachers are unlikely to get time to discuss all of them in the class room.

Under the current CBCS system the teaching of core courses suffers from a serious lacuna. A structural reform under CBCS system to allow for tutorial sessions to accompany the core course would greatly facilitate theoretical learning of these courses.

### 6.1.2 Teaching Learning Processes for Physics Laboratory component of Core Courses

Students learn essential physics laboratory skills mainly while preparing for experiments, performing them in the laboratory, and writing appropriate laboratory reports. Most of this learning takes place in the self-learning mode. However, teachers' role is crucial at critical key points. Physics laboratory learning suffers seriously if students do not get appropriate guidance at these key points. Many students get their first proper exposure to physics laboratory work in their first year of undergraduate studies. Hence, laboratory teaching to first year students requires special care.

Demonstration on the working of required apparatuses should be given in few beginning laboratory sessions of all courses. Sessions on the essentials of experimental data analysis, error estimation, and scientific report writing are crucial in the first year physics laboratory teaching. Once the essentials have been learnt, sessions may be taken on applications of these for specific experiments in lab courses of later years. Students should be encouraged to explore experimental physics projects outside the curricula.

Many college laboratories lack latest laboratory equipment due to resource crunch. For example, very few laboratories have equipment for sensor and microprocessor based data acquisition, whose output can be directly fed into a computer for further analysis. Colleges need to make strategic planning, including student participation under teacher guided projects, to gradually get their laboratories equipped with latest equipment. The Department of the Physics and Astrophysics of the University can provide key guidance and help in this regard.

It is recommended that the maximum size of group for all Physics Laboratory courses should be 12-15 students.

### 6.1.3 Teaching Learning Processes for Computational Physics component of Core Courses

The CBCS has introduced computational physics as an integral component of undergraduate physics core courses. This is a crucial advance in the pedagogy of undergraduate physics learning. Computational physics is an essential tool to introduce physics concepts and principles into domains which cannot be accessed via analytical methods. Since computational work can easily be done outside the designated laboratory hours, it strengthens the self-learning ability among students.

Essential programming skills are the foremost requirement of computational physics learning. Many students get their first exposure to computers as a working tool (rather than a means of communication and entertainment) in computational lab courses. A great degree of hand holding is necessary during first computational physics courses. The second requirement of computational physics learning is the ability to transform a physics problem into a computable problem for which a suitable program can be written. Appropriate problem based assignments are crucial in developing this ability. Every computational physics lab course should involve sessions on essential computational techniques, and the reduction of relevant physics problems to computational problems. Advanced level student project can be easily integrated into the learning of computational physics. Every student should be encouraged to undertake at least one project in a computational lab course. Since computational work can easily be done outside the scheduled laboratory hours, mentorship can be very useful in helping students become comfortable with computers. Colleges should ensure that students from weaker economic backgrounds have adequate access to computers.

It is recommended that the maximum size of group for all computational Physics Laboratory courses should be 12-15 students per group.

## 6.2 TEACHING LEARNING PROCESSES FOR DISCIPLINE SPECIFIC ELECTIVES

The objective of DSE papers is to expose students to domain specific branches of physics and prepare them for further studies in the chosen field. While students must learn basic theoretical concepts and principles of the chosen domain, a sufficient width of exposure to diverse topics is essential in these papers. Student seminars and projects can be a very fruitful way to introduce students to the latest research level developments. Students should be encouraged to use their computational physics skills to work on publicly available observational data put out by many research labs and observatories worldwide.

Besides a theory component, every DSE paper has either an associated tutorial, or a physics laboratory, or a computational physics component. Teaching learning processes for theory, physics laboratory and computational physics components described above in sub-sections 6.1.1, 6.1.2 and 6.1.3 for core courses, should be applicable for DSE courses too.

### 6.2.1 Tutorials

It provides an opportunity for attending closely to learning issues with individual students, and hence an effective means to help create interest in the subject and assess their understanding. Pre-assigned weekly problem sets and assignments help structure tutorial sessions and should be used as often as possible. Students' performance in tutorials should be used for determining their internal assessment marks for the course.

It is recommended that the maximum size of group in a tutorial should be 8-10 students per group.

## 6.3 TEACHING LEARNING PROCESSES FOR SKILL ENHANCEMENT COURSES

Skill Enhancement papers are intended to help students develop skills which may or may not be directly applicable to physics learning. These courses introduce an element of diversity of learning environments and expectations. Efforts should be made that students gain adequate "hands-on" experience in the desired skills. The theory parts of these courses are intended to help students get prepared for such experiences. Since the assessment of these courses is largely college based, teachers should make full use of it to design novel projects.

It is recommended that the maximum size of group in the Laboratory for SEC courses should be 12-15 students per group.

## 6.4 TEACHING LEARNING PROCESSES FOR GENERIC ELECTIVES

Physics GE papers are taken by students of other honours courses. Most of these students would have studied physics at the school level, so these courses are not meant to be introductory. However, the teaching of these courses should be oriented to expose the non-physics students to the wonders of physics. Basic level projects that focus on real life applications of physics can be a useful means to generate student interest and motivate them for self-study.

Besides a theory component, every GE paper has either an associated physics laboratory, or a computational physics or a tutorial component. Teaching learning processes for theory, physics laboratory and computational physics components described above in sub-sections 6.1.1, 6.1.2 and 6.1.3 for core courses, and for tutorials described in sub-section 6.2.1 should be applicable for GE courses too.

At the end, the main purpose of Physics teaching should be to impart higher level objective knowledge to students in concrete, comprehensive and effective ways. Here, effectiveness implies gaining knowledge and skill which can be applied to solve practical problems as

well as attaining the capability of logical thinking and imagination which are necessary for the creation of new knowledge and new discoveries. Once the students understand 'why is it worth learning?' and 'how does it connect to the real world?', they will embrace the curriculum in a way that would spark their imagination and instill a spirit of enquiry in them, so that in future they can opt for further investigations or research. All in all, the teacher should act as a facilitator and guide and not as a guardian of the curriculum.

## 7. ASSESSMENT METHODS

In the undergraduate education of Physics leading to the B.Sc. (Honours) Physics degree, the assessment and evaluation methods should focus on testing the conceptual understanding of basic concepts and theories, experimental techniques, development of mathematical skills, and the ability to apply the knowledge acquired to solve new problems and communicate the results and findings effectively.

The two perennial shortfalls of the traditional science examination process in our country are the reliance on rote learning for written exams, and a very perfunctory evaluation of laboratory skills. Greater emphasis on problem solving and less importance to textbook derivations discourages rote learning. Theory examinations should be based primarily on unseen problems. Continuous evaluation of students' work in the laboratory, and testing them on extensions of experiments they have already performed can give a more faithful evaluation of their laboratory skills.

Needless to say, there should be a continuous evaluation system for students. This will enable teachers not only to ascertain the overall progress of learning by the students, but also to identify students who are slow learners and for whom special care should be taken. An appropriate grading system is the 'relative grading system'. It introduces a competitive element among students, but does not excessively penalizes weaker students.

Since the Learning Objectives are defined clearly for each course in the LOCF framework, it is easier to design methods to monitor the progress in achieving the learning objectives during the course and test the level of achievement at the end of the course.

The courses offered in the undergraduate Physics are the first courses at the college/university level. Formative Assessment for monitoring the progress towards achieving the learning objectives is an important assessment component, which provides both teachers and students feedback on progress towards learning goals. University of Delhi examination system has 20 percent internal assessment for theory component, and 50 percent for physics laboratory and computational physics laboratory components. These marks should be distributed in periodic assessments in different modes to serve the intended purpose.

Since core courses, discipline specific courses, skill enhancement courses and general elective courses have qualitatively different kinds of objectives and learning outcomes, one model of assessment methods will not work for these different kinds of courses.

## 7.1 ASSESSMENT METHODS FOR CORE COURSES

Core courses and associated physics laboratory and computational physics curricula lead to the essential set of learning outcomes, which every physics graduate is expected to have. Their assessment methods require rigour, comprehensiveness and uniformity about what is minimally expected from students. Regular interactions mediated through the University Department among teachers teaching these courses in different colleges is helpful in this regard. Since depth of understanding of core topics is a highly desirable outcome, assessment for these courses should put greater emphasis on unseen problems, including extensions of textbook derivations done in class.

### 7.1.1 Assessment Methods for the Theory component of Core courses

The evaluation scheme of the University of Delhi allots 20 percent marks for internal assessment of theory papers. Teachers should use a judicious combination of the following methods to assess students for these marks: i) periodic class tests, ii) regular problem based assignments, iii) unannounced short quizzes, iv) individual seminar presentations v) longer assignments for covering theory and derivations not discussed in regular lectures, vi) True/False Tests, and vii) Multiple Choice Tests for large classes.

To help students prepare themselves for formative assessment during the semester, and to motivate them for self-learning, it is advisable that a Model Problem Set is made available to them in the beginning of the course, or problem sets are given before discussion of specific topics in class.

In preparing students for Substantive Summative Assessment at the end of the semester it is helpful if a Model/mock question paper is made available to them in the beginning of the course.

### 7.1.2 Assessment Methods for the Physics Laboratory component of Core courses

The 50 percent internal assessment for the evaluation scheme for laboratory courses is best used in continuous evaluation of students' performance in the lab. This evaluation should include these components: i) Regular evaluation of experiments through (a) written report of each experiment and (b) Viva-Voce on each experiment, ii) Test through setting experiments by assembling components, iii) written test on experiments done in the lab and data analysis, iv) Designing innovative kits to test the comprehension and analysis of the experiment done by the students, and v) audio visual recording of the experiments being performed by students and its self-appraisal.

The end semester laboratory examination should ideally involve extensions of experiments done by students during the semester. Two or more experiments can be combined for this purpose. Open ended problems for which students can get the answer by designing their own experimental method should also be tried.

### 7.1.3 Assessment Methods for the Computational Physics component of Core courses

Computational Physics lab evaluation allots 50 percent marks to the internal evaluation of students' performance during the semester. Students should be assessed for every computational assignment done during the semester. This should involve assessment of their program, report and a viva-voce. Periodic tests on unseen problems may form a part of the internal assessment.

It is essential that the end semester examination is based upon unseen computational physics problems.

## 7.2 ASSESSMENT METHODS FOR DISCIPLINE SPECIFIC ELECTIVES

Discipline specific courses build upon general principles learnt in core courses, and also prepare students for further studies in specific domains of physics. Given the time constraint of only one semester, specific domain exposure is mostly introductory in character. Assessment for these courses should have significant component of open ended methods like seminars and project work. Students have greater chance of proving their individual initiative and ability for self-learning in these methods. These methods also have greater flexibility to reward students for out of curriculum learning.

Besides a theory component, every DSE paper has either an associated tutorial, or a physics laboratory, or a computational physics component. Assessment methods for theory, Physics laboratory and computational physics components described above in sub-sections 7.1.1, 7.1.2 and 7.1.3 for core courses, should be applicable for DSE courses too.

Students should be assessed for their performance in **tutorials**, and this assessment should contribute to their internal assessment marks. Their work on pre-assigned problem sets/assignments, and participation in tutorial discussions should be taken into account while assessing their performance.

## 7.3 ASSESSMENT METHODS FOR SKILL ENHANCEMENT COURSES

Learning in skill enhancement courses is largely experience based. Student performance in these courses is best assessed under continuous evaluation. Students could be assigned a specific task for a class or group of classes, and they could be assessed for their success in meeting the task.

## 7.4 ASSESSMENT METHODS FOR GENERIC ELECTIVES

General Elective courses are taken by students specializing in disciplines other than physics. The assessment methods for these courses should be oriented towards kindling student interest in the subject. Testing their ability to apply physics concepts in various practical situations through simple problems, and student specific writing and presentation assignments are most suited for assessing students' learning outcomes for these courses. Giving students greater choice of questions to be answered in semester end examinations,

and asking a larger fraction of open-ended qualitative questions is recommended for these courses.

Besides a theory component, every GE paper has either an associated tutorial, or a physics laboratory, or a computational physics component. Assessment methods for theory, Physics laboratory and computational physics components described above in sub-sections 7.1.1, 7.1.2 and 7.1.3 for core courses, should be applicable for GE courses too.

Students should be assessed for their performance in **tutorials**, and this assessment should contribute to their internal assessment marks. Their work on pre-assigned problem sets/assignments, and participation in tutorial discussions should be taken into account while assessing their performance.

# 8. STRUCTURE OF COURSES IN B.SC. (HONS.) PHYSICS

## 8.1 CREDIT DISTRIBUTION FOR B.SC. (HONS.) PHYSICS

The B.Sc.(Hons.) Physics programme consists of 148 credits based on the Choice Based Credit System (CBCS) approved by the UGC. In a course 1 hour per week of theory or tutorial corresponds to one credit. 2 hours per week of practicals or hands-on work also correspond to one credit. The 148 credits include 84 credits of Core Courses (CC) and 8 credits of Ability Enhancement Compulsory Courses (AECC) which are mandatory. Choice is provided through 24 credits of Discipline Specific Electives (DSE), 8 credits of Skill Enhancement Courses (SEC) and 24 credits of Generic Elective Courses (GEC), the latter to be chosen from disciplines other than Physics.

Table 8.1 Table showing distribution of credits.

| Semester | Core Courses (CC) each with 06 credit All 14 courses are compulsory | Generic Elective (GE). To be selected from GE listings of other disciplines | Skill Enhancement Course (SEC) Select any 2 Out of 11 courses | Discipline Specific Elective (DSE) Select four out of 20 courses | Ability Enhancement Compulsory Courses (AECC) Select any 2 out of 3 courses | Total Credit |
|---|---|---|---|---|---|---|
| Sem I | CC-I<br>CC-II | GEC-1 | | - | AECC-1 | 22 |
| Sem II | CC-III<br>CC-IV | GEC-2 | | - | AECC-2 | 22 |
| Sem III | CC-V<br>CC-VI<br>CC-VII | GEC-3 | SEC-1 | - | - | 28 |
| Sem IV | CC-VIII<br>CC-IX<br>CC-X | GEC-4 | SEC-2 | - | - | 28 |
| Sem V | CC-XI<br>CC-XII | - | | DSE-1<br>DSE-2 | - | 24 |
| Sem VI | CC-XIII<br>CC-XIV | - | | DSE-3<br>DSE-4 | - | 24 |
| Total Credit | 84 | 24 | 8 | 24 | 8 | 148 |

## Table 8.2 DETAILS OF COURSES UNDER B.Sc. (Hons.) PHYSICS

| Course | *Credits<br>No. of Courses × (Theory + Practical/Tutorials) = Total |
|---|---|
| **I. Core Course (CC)*** | |
| (14 Courses) | 14 × (4 + 2)* = 84 |
| **II. Elective Course** | |
| (8 Courses) | |
| A.1. **Discipline Specific Elective*** (4 Courses) | 4 × (4 + 2)* = 24<br>or<br>4 × (5 + 1)** = 24 |
| B.1. **Generic Elective/Interdisciplinary*** (4 Courses) | 4 × (4 + 2)* = 24<br>or<br>4 × (5 + 1)** = 24 |

**Optional Dissertation or project work in place of one Discipline Specific Elective Course (6 credits) in 6th Semester**

| | |
|---|---|
| **III. Ability Enhancement Courses (AECC)** | |
| 1. **Ability Enhancement Compulsory** | |
| (2 Courses of 4 credit each) | 2 × 4 = 8 |
| Environmental Science | |
| English/MIL Communication | |
| 2. **Ability Enhancement Elective (Skill Enhancement Courses) *** | |
| (2 Courses of 4 credit each) | 2 × (2 + 2)* = 8 |
| **Total Credits** | **148** |

**College should evolve a system/policy about ECA/Interest/Hobby/ Sports/NCC/ NSS/related courses on its own.**

**#Theory with practical/ Hands-on exercise**

**##Theory with tutorials**

*** Wherever there is a practical there will be no tutorial and vice-versa. The maximum size of group for practical papers is recommended to be 12 to 15 students and for tutorials 8 to 10 students per group.**

## 8.2 SEMESTER-WISE DISTRIBUTION OF COURSES

### CORE COURSES (CC)

**Table 8.3 All the courses have 6 credits with 4 credits of theory (4 hours per week) and 2 credits of practicals (4 hours per week).**

| Core Course type | Unique Paper Code | Semester | Core Course Name |
|---|---|---|---|
| CC-I | 32221101 | I | Mathematical Physics – I (Theory + Lab) |
| CC-II | 32221102 | I | Mechanics (Theory + Lab) |
| CC-III | 32221201 | II | Electricity and Magnetism (Theory + Lab) |
| CC-IV | 32221202 | II | Waves and Optics (Theory + Lab) |
| CC-V | 32221301 | III | Mathematical Physics – II (Theory + Lab) |
| CC-VI | 32221302 | III | Thermal Physics (Theory + Lab) |
| CC-VII | 32221303 | III | Digital Systems and Applications (Theory + Lab) |
| CC-VIII | 32221401 | IV | Mathematical Physics – III (Theory + Lab) |
| CC-IX | 32221402 | IV | Elements of Modern Physics (Theory + Lab) |
| CC-X | 32221403 | IV | Analog Systems and Applications (Theory + Lab) |
| CC-XI | 32221501 | V | Quantum Mechanics and Applications (Theory + Lab) |
| CC-XII | 32221502 | V | Solid State Physics (Theory + Lab) |
| CC-XIII | 32221601 | VI | Electromagnetic Theory (Theory + Lab) |
| CC-XIV | 32221602 | VI | Statistical Mechanics (Theory + Lab) |

## DISCIPLINE SPECIFIC ELECTIVES (DSE)

**Table 8.4 All the courses have 6 credits with 4 credits of theory and 2 credits of practical or 5 credits of theory and 1 credit of Tutorials.**

Discipline Specific (Physics) Elective courses (Credit: 06 each): Select any 02 courses (DSE-1 and DSE-2)* in V semester and select any 02 courses (DSE-3 and DSE-4) in VI semester from the following options. **(Numbers in brackets indicate number of hours per week dedicated.)**

| No. | Unique Paper Code | DSE Course Name |
|---|---|---|
| **Odd Semester – V Semester only (DSE-1 and DSE-2)** | | |
| 1 | 32227501 | Experimental Techniques (4) + Lab (4) |
| 2 | 32227502 | Advanced Mathematical Physics (4) + Lab (4)* |
| 3 | 32227504 | Nuclear and Particle Physics (5) + Tutorial (1) |
| 4 | 32227505 | Physics of Devices and Communication (4) + Lab (4) |
| 5 | 32227506 | Astronomy and Astrophysics (5) + Tutorial (1) |
| 6 | 32227507 | Atmospheric Physics (4) + Lab (4) |
| 7 | 32227508 | Biological Physics (5) + Tutorial (1) |
| 8 | 32227518 | Embedded Systems– Introduction of Microcontroller (4) + Lab(4) |
| 9 | xxx3 | Linear Algebra and Tensor Analysis (5) + Tutorial (1)* |
| **Even Semester – VI semester only (DSE-3 and DSE-4)** | | |
| 10 | 32227612 | Nano Materials and Applications (4) + Lab (4) |
| 11 | 32227613 | Communication System (4) + Lab (4) |
| 12 | 32227615 | Medical Physics (4) + Lab (4) |
| 13 | 32227616 | Applied Dynamics (4) + Lab (4) |
| 14 | 32227621 | Digital Signal processing (4) + Lab (4) |
| 15 | 32227624 | Physics of the Earth (5) + Tutorial (1) |
| 16 | 32227625 | Advanced Mathematical Physics II (5) + Tutorial (1) |
| 17 | 32227626 | Classical Dynamics (5) + Tutorial (1) |
| 18 | 32227627 | Dissertation (8) |
| 19 | 32227628 | Verilog and FPGA based system design (4) + Lab (4) |
| 20 | xxx4 | Advanced Quantum Mechanics (5) + Tutorial (1) |

*Papers listed at S. No. 02 (Advanced Mathematical Physics) and 09 (Linear Algebra and Tensor Analysis) are not allowed to be taken together as DSE-1 and DSE-2 in Semester-V.

## SKILL ENHANCEMENT COURSES (SEC)

**Table 8.5 All courses have 4 credits with 2 credits of theory and 2 credits of Practical /Hands-On/Projects and Field Work to be decided by the College. *Teachers may give a long duration project based on a SEC paper in the Practical Lab.***

| S.No. | Unique Paper Code | Semester | SEC Name |
|---|---|---|---|
| 1 | 32223901 | III/IV | Physics Workshop Skills |
| 2 | 32223902 | III/IV | Computational Physics Skills |
| 3 | 32223903 | III/IV | Electrical Circuit and Network Skills |
| 4 | 32223904 | III/IV | Basic Instrumentation Skills |
| 5 | 32223905 | III/IV | Renewable Energy and Energy Harvesting |
| 6 | 32223906 | III/IV | Engineering design and prototyping/Technical Drawing |
| 7 | 32223907 | III/IV | Radiation Safety |
| 8 | 32223908 | III/IV | Applied Optics |
| 9 | 32223909 | III/IV | Weather Forecasting |
| 10 | XXX1 | III/IV | Introduction to Physical Computing |
| 11 | XXX2 | III/IV | Numerical Analysis |

## ABILITY ENHANCEMENT COMPULSORY COURSES (AECC)

**Table 8.6 All the courses have 4 credits. The detailed content of these courses is NOT mentioned in this document. (See the course document of the relevant department.)**

| No. | AECC Name |
|---|---|
| 1 | English |
| 2 | Modern Indian Language Communication |
| 3 | Environmental Science |

## GENERAL ELECTIVE COURSES (GE)

**Table 8.7 All the courses have 6 credits including Theory/Practicals/ Projects. These courses are meant for students in Honours programmes of other disciplines.**

| No. | Unique Paper Code | Semester | GE Course Name |
|---|---|---|---|
| 1 | 32225101 | I | Electricity and Magnetism + Lab |
| 2 | 32225102 | I | Mathematical Physics + Lab |
| 3 | 32225103 | I | Digital, Analog and Instrumentation + Lab |
| 4 | 32225104 | I | Applied Dynamics + Lab |
| 5 | 32225105 | I | Medical Physics + Lab |
| 6 | 32225201 | II | Mechanics + Lab |
| 7 | 32225202 | II | Elements of Modern Physics + Lab |
| 8 | 32225203 | II | Solid State Physics + Lab |
| 9 | 32225204 | II | Embedded Systems – Introduction of Microcontroller + Lab |
| 10 | 32225205 | II | Biological Physics + Tutorial |
| 11 | 32225310 | III | Waves and Optics + Lab |
| 12 | 32225311 | III | Quantum Mechanics + Lab |
| 13 | 32225312 | III | Communication System + Lab |
| 14 | 32225313 | III | Verilog and FPGA based system design + Lab |
| 15 | 32225314 | III | Nano Materials and Applications + Lab |
| 16 | 32225415 | IV | Thermal Physics and Statistical Mechanics + Lab |
| 17 | 32225416 | IV | Digital Signal processing + Lab |
| 18 | 32225417 | IV | Nuclear and Particle Physics + Tutorial |
| 19 | 32225418 | IV | Astronomy and Astrophysics + Tutorial |
| 20 | 32225419 | IV | Atmospheric Physics + Lab |
| 21 | 32225420 | IV | Physics of the Earth + Tutorial |

**Table 8.8 Semester-wise breakup of types of courses with their credits.**
**Core Courses are listed in Table 8.3**
**GE courses are to be chosen from the course listings of other Departments.**
**SEC courses are to be chosen from Table 8.5**
**DSE courses are to be chosen from Table 8.4**

| S.No. | Course opted | Course name | Credits |
|---|---|---|---|
| I | Ability Enhancement Compulsory Course-I | English/ MIL communication/ Environmental Science | 4 |
| | Core course I | Mathematical Physics-I | 4 |
| | Core Course-I Practical* | Mathematical Physics-I Lab | 2 |
| | Core course-II | Mechanics | 4 |
| | Core Course-II Practical* | Mechanics Lab | 2 |
| | Generic Elective -1 | GE-1 | 4/5 |
| | Generic Elective – 1 Practical/Tutorial* | GE-1 Lab/Tutorial | 2/1 |
| II | Ability Enhancement Compulsory Course-II | English/MIL communication/ Environmental Science | 4 |
| | Core course-III | Electricity and Magnetism | 4 |
| | Core Course-III Practical* | Electricity and Magnetism Lab | 2 |
| | Core course-IV | Waves and Optics | 4 |
| | Core Course-IV Practical * | Waves and Optics Lab | 2 |
| | Generic Elective -2 | GE-2 | 4/5 |
| | Generic Elective -2 Practical/Tutorial* | GE-2 Lab/Tutorial | 2/1 |
| III | Core Course-V | Mathematical Physics-II | 4 |
| | Core Course-V Practical* | Mathematical Physics-II Lab | 2 |
| | Core course-VI | Thermal Physics | 4 |
| | Core Course-VI Practical* | Thermal Physics Lab | 2 |
| | Core course-VII | Digital Systems and Applications | 4 |
| | Core Course-VII Practical* | Digital Systems & Applications Lab | 2 |
| | Skill Enhancement Course -1 | SEC-1 | 2 |
| | Skill Enhancement Course -1 Practical* | SEC-1 Lab/Hands-on/field work/project | 2 |
| | Generic Elective -3 | GE-3 | 4/5 |
| | Generic Elective -3 Practical/Tutorial* | GE-3 Lab/Tutorial | 2/1 |
| IV | Core course-VIII | Mathematical Physics III | 4 |
| | Course-VIII Practical/Tutorial* | Mathematical Physics-III Lab | 2 |
| | Core course-IX | Elements of Modern Physics | 4 |
| | Course-IX Practical/Tutorial* | Elements of Modern Physics Lab | 2 |
| | Core Course-X | Analog Systems and Applications | 4 |
| | Course- X Practical/Tutorial* | Analog Systems & Applications Lab | 2 |
| | Skill Enhancement Course -2 | SEC -2 | 2 |
| | Skill Enhancement Course -2 Practical* | SEC -2 Lab/Hands-on/field work/project | 2 |
| | Generic Elective -4 | GE – 4 | 4/5 |
| | Generic Elective-4 Practical/Tutorial* | GE – 4 Lab/Tutorial | 2/1 |
| V | Core course-XI | Quantum Mechanics & Applications | 4 |
| | Core Course-XI Practical* | Quantum Mechanics Lab | 2 |
| | Core course-XII | Solid State Physics | 4 |
| | Core Course-XII Practical* | Solid State Physics Lab | 2 |
| | Discipline Specific Elective -1 | DSE-1 | 4/5 |

| | | | |
|---|---|---|---|
| | Discipline Specific Elective -1 Practical/Tutorial* | DSE-1 Lab/Tutorial | 2/1 |
| | Discipline Specific Elective -2 | DSE-2 | 4/5 |
| | Discipline Specific Elective- 2 Practical/Tutorial* | DSE-2 Lab/Tutorial | 2/1 |
| VI | Core course-XIII | Electro-magnetic Theory | 4 |
| | Core Course-XIII Practical* | Electro-magnetic Theory Lab | 2 |
| | Core course-XIV | Statistical Mechanics | 4 |
| | Core Course-XIV Practical* | Statistical Mechanics Lab | 2 |
| | Discipline Specific Elective -3 | DSE-3 | 4/5 |
| | Discipline Specific Elective -3 Practical/Tutorial* | DSE-3 Lab/Tutorial | 2/1 |
| | Discipline Specific Elective-4 | DSE-4 | 4/5 |
| | Discipline Specific Elective -4 Practical/Tutorial* | DSE-4 Lab/Tutorial | 2/1 |
| | | **TOTAL** | **148** |

*** Wherever there is a practical there will be no tutorial and vice-versa.**
**The maximum size of group for practical papers is recommended to be 12-15 students and for tutorials 8-10 students per group.**

# दिल्लीविश्वविद्यालय

# UNIVERSITY OF DELHI

Bachelor of Arts (Hons.) Psychology

(Effective from Academic Year 2019-20)

**Revised Syllabus as approved by**

**Academic Council**

**Date:** **No:**

**Executive Council**

**Date:** **No:**

**Applicable for students registered with Regular Colleges, Non Collegiate Women's Education Board and School of Open Learning**

## Preamble

The objective of any programme at Higher Education Institute is to prepare their students for the society at large. The University of Delhi envisions all its programmes in the best interest of their students and in this endeavour it offers a new vision to all its Under-Graduate courses. It imbibes a Learning Outcome-based Curriculum Framework (LOCF) for all its Under Graduate programmes.

The LOCF approach is envisioned to provide a focused, outcome-based syllabus at the undergraduate level with an agenda to structure the teaching-learning experiences in a more student-centric manner. The LOCF approach has been adopted to strengthen students' experiences as they engage themselves in the programme of their choice. The Under-Graduate Programmes will prepare the students for both, academia and employability.

Each programme vividly elaborates its nature and promises the outcomes that are to be accomplished by studying the courses. The programmes also state the attributes that it offers to inculcate at the graduation level. The graduate attributes encompass values related to well-being, emotional stability, critical thinking, social justice and also skills for employability. In short, each programme prepares students for sustainability and life-long learning.

The revised curriculum of B. A. (Hons.) Psychology offers a wide range of courses aimed at providing the interested student strong grounding in the discipline of Psychology. The syllabus covers a wide range of theoretical courses, courses on methodology, research and application as well as course reflecting the growth and recent interest in the field of Psychology. In addition to the rigorous foundation in the discipline of Psychology, the course curriculum extends itself to include and encourage interdisciplinary frameworks and research.

## CURRICULUM REVISION COMMITTEE 2019

Head and Course Coordinator, Prof. Anand Prakash, Department of Psychology, University of Delhi
Dr. Meetu Khosla, Associate Professor, Dept of Psychology, Daulat Ram College
Dr. Kanika K. Ahuja, Associate Professor, Dept of Psychology, Lady Shri Ram College for Women
Dr. Surabhika Maheshwari, Assistant Professor, Dept. of Psychology, Indraprastha College for Women

# 1. INTRODUCTION TO PROGRAMME

The document containing the curriculum outline and details is an exercise in explicating the Choice Based Curriculum Structure in terms of the Learning Outcomes. The discipline of Psychology is a relatively young and dynamic field of academic study and inquiry. While understanding and learning the historical influences, the curriculum addresses the fast paced changes in the subject matter. The curriculum development and pedagogy of Psychology is

sensitive to the advances in the knowledge base and the growing application and research possibilities. It is expected that the course is transacted keeping in mind the current realities of the discipline including the socio-cultural context. The undergraduate coursework in Psychology touches upon the diverse areas in discipline including, among others - biopsychology, cognitive psychology, history of psychology, research methods, social psychology, Industrial/Organizational psychology, counseling psychology, health psychology.

# 2. LEARNING OUTCOME-BASED CURRICULUM FRAMEWORK IN B.A. (HONS) PSYCHOLOGY

## 2.1 NATURE AND EXTENT OF THE PROGRAMME IN B.A. (HONS) PSYCHOLOGY

The study of Psychology at the undergraduate level facilitates explorations on the vast canvas of knowledge interested in understanding human beings – their nature, behavior and influences. The study material concerns itself with relevant developments in theory and practice of Psychology. The dynamic nature and rapid changes in the field need to be addressed as the student moves along the various courses. The current structure aims to impart basic knowledge in Psychology via the core papers, specialized area are introduced in the discipline centered course and the students are exposed to the application possibilities via the skill based courses. The course also includes papers that have been designed to cater to interested students who are chosen other subjects as their primary area of study at the undergraduate level. The General Electives offer a wide array of basic psychological information to the larger (non-psychology) student population. The study of Psychology at the collegiate level ought to be aimed at developing a basic understanding and equipping the student with knowledge to choose further advancement and specialization in the field.

## 2.2 AIMS OF BACHELOR DEGREE PROGRAMME IN B.A. (HONS) PSYCHOLOGY

The Psychology programme at the undergraduate level focuses on the following aims:

- Imparting knowledge of basic psychological concepts and models, and developing ability to apply this knowledge in field settings.
- Promoting and understanding of research skills so that students are able to design and conduct systematic and ethical psychological research studies.
- Developing psychological sensitivity and social sensibility so that students can respond empathically to human subjectivity and critically to social institutions.
- Examining the complexities of and debates within the discipline and to dwell upon its unique relevance in understanding the human subjectivity as shaped by the social, historical and political.

- Developing sensibility towards varied socio-cultural contexts and appreciating diversity.
- Facilitating acquisition of basic skills for building responsible professionals in varied settings.
- Encouraging self-understanding, reflection and personal growth.

## 3. GRADUATE ATTRIBUTES IN PSYCHOLOGY

- DISCIPLINARY KNOWLEDGE

Ability to understand core psychological concepts, models, classical theories, varied perspectives, evolution of the field, new researches being carried out, as also knowledge of the sub fields of psychology.

- COMMUNICATION SKILLS

Acquiring the skill for self presentation and self management, communicating effectively in writing and orally, asking questions, conveying information to others in a simple and unambiguous way, active listening, giving and receiving feedback, making presentations, and report writing.

- CRITICAL THINKING

The ability to engage in independent thinking, identify, construct and evaluate arguments, solve problems systematically, reason clearly, rigorously question ideas and critique theories and researches in psychology.

- PROBLEM SOLVING

Applying one's knowledge to solve real life issues and problems of society at large, finding solutions that are context-specific, being able to use technology, use of methods such as simulation, brainstorming, and experimentation.

- ANALYTICAL REASONING

The ability to break complex problems into simpler components, scrutinize a situation, inductive and deductive reasoning, drawing inferences.

- RESEARCH RELATED SKILLS

The ability to plan, design and conduct research while adhering to ethical guidelines, is critical for psychology graduates, as the participants are human. This also includes collecting data using qualitative and quantitative research methods.

- COOPERATION/TEAM WORK

Working in groups for projects, presentations and practical, knowledge sharing and appreciation of diversity- essential attributes for a graduate in psychology.

- SCIENTIFIC REASONING

The values of accuracy, objectivity, scepticism, and open mindedness are desirable to instil in graduates of psychology to develop a scientific temperament. Towards this end, breaking stereotypes, thinking out-of-the-box, imagining, analyzing and trying alternatives, and questioning conclusions based on newer evidence is required.

- REFLECTIVE THINKING

Awareness of one's own knowledge, assumptions and past experiences, interpreting and evaluating as one responds to new experiences will help a graduate in psychology to create meaning, solve problems and plan. It also includes becoming aware of one's strengths and weaknesses, having insight into the trajectories of life and plan so as to move further in the desired direction. The use of introspection may be helpful in not only constructing experience, but also distancing students from social pressure, take different perspectives, and take responsibility for their actions.

- INFORMATION/DIGITAL LITERACY

The ability to use information and communication technologies to find, evaluate, create, and communicate information is required. This includes searching through legitimate online resources, creating digital content such as email, blogs and videos, and sharing it.

- SELF-DIRECTED LEARNING

Taking initiative for one's own learning, diagnosing their own learning needs, implementing appropriate learning strategies is desirable for a psychology graduate. Keeping a journal, setting goals, planning, taking action, and evaluating outcomes will help this process.

- MULTICULTURAL COMPETENCE

An ability to incorporate socio-cultural context in scientific inquiry, understanding psychological realities in varies cultural contexts, appreciating the non-universality of principles and theories, awareness of indigenous Indian perspectives, as also the ability to relate to others from diverse backgrounds is required.

- MORAL AND ETHICAL AWARENESS

Training students to become ethical and morally sound psychologists is important. This includes teaching the APA Ethics Code, understanding the issue of plagiarism, appreciation of rights and dignity of participants as a researcher, and upholding values in academic work. Students should also be able to explore the world of marginalized people with empathy and compassion, and also develop an understanding of social injustice and strive for justice.

- LEADERSHIP QUALITIES

The ability to articulate, motivate oneself, inspire others, organize and plan well, have a sense of abundant positivity that energizes everyone around them, having a clear sense of purpose, self-awareness and adaptability.

- LIFELONG LEARNING

Approaching life with curiosity and wonder, pursuing knowledge, learning how to learn will enhance active citizenship, personal development and self-sustainability. This will turn mistakes into possibilities and encourage ownership of learning. To achieve this, students need to spend

time seeking out new information, understandings, and strategies to make incremental daily improvements that will help move their life forward in a positive way.

## 4. QUALIFICATION DESCRIPTORS FOR GRADUATES B.A. (HONS) PSYCHOLOGY

The Psychology graduate will demonstrate the following qualification descriptors:

- Comprehension of theoretical and practical knowledge of the subject matter of psychology.
- Awareness of the various methods of psychology such as lab and field experimentation, observation methods, field studies, surveys, psychological testing and interviewing skills.
- Training in using self report measures of behavioural investigation, communication skills, counselling, and scientific writing for publication in scientific journals.
- Planning the research, identifying the problem, doing a review of literature, designing the research, and deciding the method and analysis tools.
- Enhanced skills to optimize self understanding, growth and development.
- Competence in terms of applying psychological skills, techniques of data collection, assessment and evaluation of behavioural interaction at an individual and group level.
- Proficiency in using various software and techniques of quantitative and qualitative analysis.

## 5. PROGRAMME LEARNING OUTCOMES FOR B.A. (HONS) PSYCHOLOGY

The learning outcomes that a student should be able to demonstrate on completion of a degree level programme are as follows:

- Knowledge about the discipline and research methods.
- Basic professional skills pertaining to psychological testing, assessment and counselling.
- Ability to use skills in specific areas related to chosen specialization (e.g. cognitive, industrial-organizational, clinical, counselling, health, educational, social, community).
- Ability to connect theory with personal experiences and varied applied settings.
- Understand how psychology can be applied to solve problems facing humankind.
- Computer literacy, including the ability to use various e-resources, technology and social media.
- Articulation of ideas, scientific writing and authentic reporting.

- Tolerating ambiguities and appreciating the limitations of the discipline, and critically analyzing conflicting theories and approaches.
- Understanding varied socio-cultural contexts, and being mindful of indigenous traditions.
- Creating awareness about gender issues.
- Cultivating an ethical mindset, including a strong work ethic, avoiding unethical behaviours such as data fabrication and plagiarism, being mindful of implications of research using human participants.
- Commitment to health and wellbeing at different levels (e.g. individual, organization, community, society).
- Developing skills of communication, negotiation, team work, effective presentation, etc.
- Appreciating and tolerating diversity.
- Developing positive attributes such as empathy, compassion, optimism, social participation, and accountability.
- Self-development and personal growth.

# 6. STRUCTURE IN B.A. (HONS) PSYCHOLOGY

## 6.1 CREDIT DISTRIBUTION FOR B.A. (HONS) PSYCHOLOGY

The UGC recommends a 10-point grading system with the following letter grades as given below:

Table 1: Grades and Grade Points

| Letter Grade | Grade Point |
|---|---|
| O (Outstanding) | 10 |
| A+(Excellent) | 9 |
| A(Very Good) | 8 |
| B+(Good) | 7 |
| B(Above Average) | 6 |
| C(Average) | 5 |
| P (Pass) | 4 |
| F(Fail) | 0 |
| Ab (Absent) | 0 |

Computation of SGPA and CGPA

Illustration for SGPA

| Course | Credit | Grade letter | Grade point | Credit Point (Credit x Grade |
|---|---|---|---|---|
| Course 1 | 3 | A | 8 | 3 X 8 = 24 |

| | | | | |
|---|---|---|---|---|
| Course 2 | 4 | B+ | 7 | 4 X 7 = 28 |
| Course 3 | 3 | B | 6 | 3 X 6 = 18 |
| Course 4 | 3 | O | 10 | 3 X 10 = 30 |
| Course 5 | 3 | C | 5 | 3 X 5 = 15 |
| Course 6 | 4 | B | 6 | 4 X 6 = 24 |
| | 20 | | | 139 |

Thus, SGPA =139/20 =6.95

Illustration for CGPA

| Semester 1 | Semester 2 | Semester 3 | Semester 4 |
|---|---|---|---|
| Credit : 20 | Credit : 22 | Credit : 25 | Credit : 26 |
| SGPA:6.9 | SGPA:7.8 | SGPA: 5.6 | SGPA:6.0 |
| Semester 5 | Semester 6 | | |
| Credit : 26 | Credit : 25 | | |
| SGPA:6.3 | SGPA: 8.0 | | |

Thus, **CGPA** = $\frac{20 \times 6.9 + 22 \times 7.8 + 25 \times 5.6 + 26 \times 6.0 + 26 \times 6.3 + 25 \times 8.0}{144}$ = **6.73**

## 6.2 SEMESTER-WISE DISTRIBUTION OF COURSES

| SEMESTER | CORE COURSE (14) | ABILITY ENHANCEMENT COMPULSORY COURSE (AECC) (2) | ABILITY ENHANCEMET ELECTIVE COURSE (AEEC) (2) (SKILL BASED) | ELECTIVE DISCIPLINE SPECIFIC DSE (4) | ELECTIVE GENERIC (GE) (4) |
|---|---|---|---|---|---|
| I | C-PSY-01 Introduction to Psychology (Theory+ Practical) | Environmental Science | | | GE-1 |
| | C-PSY-02 Statistical Methods for Psychological Research-I (Theory+ Tutorial) | | | | |

| | | | | | |
|---|---|---|---|---|---|
| II | C-PSY-03<br>Biopsychology (Theory+ Tutorial) | English Communication | | | GE-2 |
| | C-PSY-04<br>Psychology of Individual Differences (Theory+ Practical) | | | | |
| III | C-PSY-05<br>Development of Psychological Thought (Theory+ Tutorial) | | SEC-1 | | GE-3 |
| | C-PSY-06<br>Psychological Research (Theory+ Practical) | | | | |
| | C-PSY-07<br>Social Psychology (Theory+ Tutorial) | | | | |
| IV | C-PSY-08<br>Understanding Psychological Disorders (Theory+ Tutorial) | | SEC-2 | | GE-4 |
| | C-PSY-09<br>Statistical Methods for Psychological Research-II (Theory+ Tutorial) | | | | |
| | C-PSY-10<br>Applied Social Psychology (Theory+ Practical) | | | | |
| V | C-PSY-11<br>Understanding and Dealing with Psychological Disorders (Theory+ Practical) | | | DSE-1 | |
| | C-PSY-12<br>Developmental Psychology (Theory+ Practical) | | | DSE-2 | |
| VI | C-PSY-13<br>Organizational Behavior (Theory+ Practical) | | | DSE-3 | |
| | C-PSY-14<br>Counseling Psychology (Theory+ Practical) | | | DSE-4 | |

**ELECTIVE: DISCIPLINE SPECIFIC DSE (ANY 4) (2 IN SEMESTER- V AND 2 IN SEMESTER-VI):**

DSE-PSY-01: Positive Psychology
DSE-PSY-02: Human Resource Management

DSE-PSY-03: Health Psychology
DSE-PSY-04: Community Psychology
DSE-PSY-05: Cultural and Indigenous Psychology
DSE-PSY-06: Project/Dissertation (VI Semester)
DSE-PSY-07 Psychological Perspectives in Education
DSE-PSY-08: Psychology of Disability
DSE-PSY-09: Psychology of Peace
DSE-PSY-10: Forensic Psychology
DSE-PSY-11: Introduction to Indian Psychological Thought
DSE-PSY-12: Environmental Psychology
DSE-PSY-13: Cognitive Psychology

ELECTIVE: GENERIC (GE) (ANY 4, 1 EACH IN SEMESTER I, II, III AND IV):

GE PSY 01 General Psychology
GE PSY 02 Psychology over the Life Span
GE PSY 03 Psychology for Health and Well-being
GE PSY 04 Psychology at Work
GE PSY 05 Psychology and Media
GE PSY 06 Inter Group Relations
GE PSY 07 Youth Psychology
GE PSY 08 Psychology and Mental Health
GE PSY 09 Understanding Intimate Relationships
GE PSY 10 Positive Psychology: Understanding Human Strengths
GE PSY 11 Social Psychology: Understanding Human World

ABILITY ENHANCEMENT ELECTIVE COURSE (AEEC) (SKILL BASED- SEC) (ANY 2: 1 IN SEMESTER III AND 1 IN SEMESTER IV):

SEC PSY 01 Emotional Intelligence
SEC PSY 02 Stress Management
SEC PSY 03 Effective Decision Making
SEC PSY 04 Educational Psychology
SEC PSY 05 Human Resource Practices
SEC PSY 06 Personal Growth and Development
SEC PSY 07 Psychological Skills in Organizations
SEC PSY 08 Psychology of Relationships
SEC PSY 09 Learning how to Learn
SEC PSY 10 Research Publication and Presentation
SEC PSY 11 Skills of Communication

Choice Based Credit System (CBCS)

# UNIVERSITY OF DELHI

## DEPARTMENT OF STATISTICS

### Learning Outcomes-based Curriculum Framework (LOCF)

### of

## BACHELOR OF SCIENCE (HONS.) IN STATISTICS

**(B.Sc. (Hons.) Statistics)**

(Effective from Academic Year 2019-20)


XXXXX Revised Syllabus as approved by Academic Council on XXXX, 2019 and

Executive Council on YYYY, 2019

# 1. Introduction to Programme

B.Sc. (Hons.) Statistics is a three-year undergraduate program with specialization in statistics. The programme fosters interdisciplinary approach to the study of Statistics, Mathematics, and Computers aiming to promote holistic education useful in handling social, economics, engineering, physical and bio-sciences problems. The curriculum is dispensed using a combination of classroom teaching, project-based learning, practical's, group discussions, presentations, home assignments, industry interactions and exposure, internships and fieldwork. The programme has a unique and innovative course structure which engenders creative out of the box thinking.

## 1.1 Eligibility for Admissions

As per admission bulletin for under-graduate programme of University of Delhi.

# 2. Introduction to CBCS (Choice Based Credit System)

**Scope:**

The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill-based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Grading system provides uniformity in the evaluation and computation of the Cumulative Grade Point Average (CGPA) based on students' performance in examinations enables the student to move across institutions of higher learning. The uniformity in evaluation system also enable the potential employers in assessing the performance of the candidates.

**Definitions:**

(i). 'Academic Programme' means an entire course of study comprising its programme structure, course details, evaluation schemes etc. designed to be taught and evaluated in a teaching Department/Centre or jointly under more than one such Department/Centre.

(ii). 'Course' means a segment of a subject that is part of an Academic Programme.

(iii). 'Programme Structure' means a list of courses (Core, Elective, Open Elective) that makes up an Academic Programme, specifying the syllabus, Credits, hours of teaching, evaluation and examination schemes, minimum number of credits required

for successful completion of the programme etc. prepared in conformity to University Rules, eligibility criteria for admission.

(iv). 'Core Course' means a course that a student admitted to a particular programme must successfully complete to receive the degree and which cannot be substituted by any other course.

(v). 'Elective Course' means an optional course to be selected by a student out of such courses offered in the same or any other Department/Centre.

(vi). 'Discipline Specific Elective' (DSE) course is the domain specific elective course offered by the main discipline/subject of study. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature also, but these are needed to be offered by main discipline/subject of study.

(vii). 'Dissertation/Project' is an elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member. Project work/Dissertation is considered as a special course involving application of knowledge in solving / analysing / exploring a real life situation / difficult problem. A Project/Dissertation work would be of 6 credits. A Project/Dissertation work may be given in lieu of a discipline specific elective paper.

(viii). 'Generic Elective' (GE) course is an elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure to other disciplines. A core course offered in a discipline/subject may be treated as an elective by other discipline/subject and vice versa and such electives may also be referred to as Generic Elective.

(ix). 'Ability Enhancement Courses' (AEC) also referred as Competency Improvement Courses/Skill Development Courses/Foundation Course. The Ability Enhancement Courses (AEC) may be of two kinds: AE Compulsory Course (AECC) and AE Elective Course (AEEC).

(x). 'AECC' are the courses based upon the content that leads to Knowledge enhancement. The two AECC are: Environmental Science, English/ MIL Communication.

(xi). 'AEEC' are value-based and/or skill-based and are aimed at providing hands-on-training, competencies, skills, etc. These courses may be chosen from a pool of courses designed to provide value-based and/or skill-based instruction. These courses

are also referred to as Skill Enhancement Courses (SEC).

(xii). 'Credit' means the value assigned to a course which indicates the level of instruction; One-hour lecture per week equals 1 Credit, 2 hours practical class per week equals 1 credit. Credit for a practical could be proposed as part of a course or as a separate practical course

(xiii). 'CGPA' is cumulative grade points calculated for all courses completed by the students at any point of time.

(xiv). 'SGPA' means Semester Grade Point Average calculated for individual semester.

(xv). 'CGPA' is Cumulative Grade Points Average calculated for all courses completed by the students at any point of time. CGPA is calculated each year for both the semesters clubbed together.

(xvi). 'Grand CGPA' is calculated in the last year of the course by clubbing together of CGPA of two years, i.e., four semesters. Grand CGPA is being given in Transcript form. To benefit the student a formula for conversation of Grand CGPA into %age marks is given in the Transcript.

## 3. Programme Structure

The B.Sc. (Hons.) Statistics is a three year programme divided into six semesters. A student is required to complete 148 credits for the completion of programme and the award of degree.

### 3.1 Alignment with CBCS

The B.Sc. (Hons.) Statistics programme is aligned with CBCS structure as given in Table 1

**Table 1: CBCS Course Structure for B.Sc. (Hons.) Programme**

| Course | *Credits | |
|---|---|---|
| | Theory+ Practical | Theory + Tutorial |
| **I. Core Course** | | |
| **(14 Papers)** | 14X4= 56 | 14X5=70 |
| **Core Course Practical / Tutorial*** | | |
| **(14 Papers)** | 14X2=28 | 14X1=14 |
| **II. Elective Course** | | |

| | | |
|---|---|---|
| **(8 Papers)** | | |
| A.1. Discipline Specific Elective | 4X4=16 | 4X5=20 |
| **(4 Papers)** | | |
| A.2. Discipline Specific Elective | | |
| Practical/ Tutorial* | 4 X 2=8 | 4X1=4 |
| **(4 Papers)** | | |
| B.1. Generic Elective/ | | |
| Interdisciplinary | 4X4=16 | 4X5=20 |
| **(4 Papers)** | | |
| B.2. Generic Elective | | |
| Practical/ Tutorial* | 4 X 2=8 | 4X1=4 |

**(4 Papers)**

- Optional Dissertation or project work in place of one Discipline Specific Elective paper (6 credits) in 6th Semester

**III. Ability Enhancement Courses**

| | | |
|---|---|---|
| 1. **Ability Enhancement Compulsory** | | |
| **(2 Papers of 4 credit each)** | 2 X 4=8 | 2 X 4=8 |
| Environmental Science | | |
| English/MIL Communication | | |
| 2. **Ability Enhancement Elective** (Skill Based) | | |
| (Minimum 2) | | |
| **(2 Papers of 4 credit each)** | 2 X 4=8 | 2 X 4=8 |
| **Total credit** | **148** | **148** |

**Institute should evolve a system/policy about Interest/Hobby/Sports/NCC/NSS/related courses on its own.**

*** Wherever there is a practical there courses will be no tutorial and vice-versa**

## 3.2 Details of Programme

**Core Papers (Credits: 6 each) (14 papers)**

STAT-C-101 Descriptive Statistics (Theory+ Practical)
STAT C-102 Calculus (Theory+ Tutorial)
STAT-C-201 Probability and Probability Distributions (Theory+ Practical)
STAT C-202 Algebra (Theory+ Practical)
STAT-C-301 Sampling Distributions (Theory+ Practical)
STAT-C-302 Survey Sampling and Indian Official Statistics (Theory+ Practical)
STAT C-303 Mathematical Analysis (Theory+ Practical)
STAT-C-401 Statistical Inference (Theory+ Practical)
STAT-C-402 Linear Models (Theory+ Practical)
STAT-C-403 Statistical Quality Control (Theory+ Practical)
STAT-C-501 Stochastic Processes and Queuing Theory (Theory+ Practical)
STAT-C-502 Statistical Computing Using C/C++ Programming (Theory+ Practical)
STAT-C-601 Design of Experiments (Theory+ Practical)
STAT-C-602 Multivariate Analysis and Nonparametric Methods (Theory+ Practical)

**Discipline Specific Elective Papers (Credits: 6 each) (4 papers to be selected)**

**DSE-1**

(A) Time Series Analysis (Theory+ Practical) or
(B) Demography and Vital Statistics (Theory+ Practical)

**DSE-2**

(A) Operations Research (Theory+ Practical) or
(B) Econometrics (Theory+ Practical)

**DSE-3**

(A) Actuarial Statistics (Theory+ Practical) or
(B) Biostatistics and Survival Analysis (Theory+ Practical)

**DSE-4**

(A) Financial Statistics (Theory+ Practical) or
(B) Project Work (Sixth Semester)

**Skill Enhancement Courses (Credits: 4 each) (2 papers to be selected)**

1. Statistical-Data Analysis Using Software Packages
2. Statistical Data Analysis Using R
3. Statistical Techniques for Research Methods
4. Statistical Simulation Techniques

**Generic Elective Papers (GE) (Credits: 6 each) (to be offered to other Departments/Disciplines)**

1. Statistical Methods
2. Introductory Probability

3. Basics of Statistical Inference
4. Applied Statistics

**Note:**

1. There will be one batch of 15 students for practical classes.
2. Each practical will carry 50 marks including 25 marks for continuous evaluation and 5 marks for the oral test.
3. Colleges are advised and encouraged to conduct at least 50% of the practicals using spreadsheet (MS Excel) or any statistical package (SPSS/R/MATLAB).
4. At least four questions have to be compulsorily attempted in the final practical examination.
5. Hardcopy of practical file has to be maintained by the students for each practical paper.

## 3.3 Semester-wise Placement of Courses

**Table 2: Semester wise Detail: of B.Sc. (Hons.) Statistics Course & Credit Scheme**

| Year | Semester | Core Course | Ability Enhancement Compulsory Course (AEC) | Skill Enhancement Course (SEC) | Discipline Specific Elective (DSE) | Generic Elective (GE) | Semester -wise Credits |
|---|---|---|---|---|---|---|---|
| I | I | STAT-C-101: Descriptive Statistics (L+P)<br>STAT -C-102: Calculus (L+T) | AECC 1 | | | STAT-GE-1 (L+P) | 22 |
| | L+T/P | 4+2=6;<br>5+1=6. | 4 | | | 4+2=6 | |
| | II | STAT-C-201: Probability and Probability Distributions (L+P)<br>STAT -C-202: Algebra (L+P) | AECC 2 | | | STAT-GE-2 (L+P) | 22 |
| | L+T/P | 4+2=6;<br>4+2=6. | 4 | | | 4+2=6 | |
| II | III | STAT-C-301:Sampling Distributions (L+ P)<br>STAT-C-302: Survey Sampling and Indian Official Statistics (L+ P)<br>STAT-C-303: Mathematical Analysis (L+ P) | | SEC (1/2/3/4) (L+P) | | STAT-GE-3 (L+P) | 28 |
| | L+T/P | 4+2=6;<br>4+2=6;<br>4+2=6. | | 2+2=4 | | 4+2=6 | |
| | IV | STAT-C-401: Statistical Inference (L+ P)<br>STAT-C-402: Linear Models (L+ P)<br>STAT-C-403: Statistical Quality Control (L+ P) | | SEC (1/2/3/4) (L+P) Different from semester III option (L+P) | | STAT-GE-4 (L+P) | 28 |
| | L+T/P | 4+2=6;<br>4+2=6;<br>4+2=6. | | 2+2=4 | | 4+2=6 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| III | V | STAT-C-501: Stochastic Processes and Queuing Theory (L+P) | | | DSE-1-(A/B) (L+P) | | 24 |
| | | STAT-C-502: Statistical Computing Using C/C++ Programming (L+P) | | | DSE-2-(A/B) (L+P) | | |
| | L+T/P | 4+2=6; 4+2=6. | | | 4+2=6; 4+2=6. | | |
| | VI | STAT-C-601: Design of Experiments (T+P) | | | DSE-3-(A/B) (L+P) | | 24 |
| | | STAT-C-602: Multivariate Analysis and Nonparametric Methods (T+P) | | | DSE-4-(A/B) (L+P) | | |
| | L+T/P | 4+2=6; 4+2=6. | | | 4+2=6; 4+2=6. | | |
| | | | | | **Total Credits** | | **148** |

Legend: L -Lecture Class; T -Tutorial Class; P - Practical Class
Note: One-hour lecture per week equals 1 Credit, 2 hours practical class per week equals 1 credit.

### 3.4 Number of Courses offered

**Table 3: Number of courses offered**

| S. No. | Course Type | No. of Courses |
|---|---|---|
| 1. | Core Course | 14 |
| 2. | Ability Enhancement Compulsory Course (AEC) | 4 |
| 3. | Skill Enhancement Course (SEC) | 4 |
| 4. | Discipline Specific Elective (DSE) | 8 |
| 5. | Generic Elective (GE) | 4 |
| | **Total Number of Courses Offered** | **34** |

## 4. Learning Outcome Based Approach

B.Sc. (Hons.) Statistics programme is designed in such a way that students will be exposed to the real world data related to industries and society, identifying the problems and working towards their solutions through various analytical and statistical techniques. The course is designed to imbibe strong foundation of statistics in students.

## 5. Graduate Attributes

On completion of the programme students are expected to have acquired the skills of effective communication, critical thinking, social research methods and social outreach. The attributes expected from the graduates of B.Sc. (Hons.) Statistics are:

i. A holistic knowledge and understanding of basic concepts in statistics and its linkages with art, science and technology.
ii. The capacity to identify, understand and solve the problems of society.
iii. The ability to collect, analyse, interpret and present the data and bring out the meaning, correlations and interrelationships.
iv. Team building and leadership skills, communication, creative and critical thinking skills, and innovative problem solving skills.
v. To provide scientific approaches to develop the domain of human knowledge through the use of empirical data expressed in quantitative form.
vi. To enable the students to understand basic concepts and aspects related to research, various techniques to collect the data, analyse the data and interpret the results thereafter.
vii. Learning the basic programming languages and statistical software will help students to easily switch over to any other statistical software in future.

## 6. Qualification Description

Upon successfully completing the Programme the students will be conferred a degree of B.Sc. (Hons.) Statistics. It is an inter-disciplinary programme equipping the students in the knowledge of statistics. Besides, it also imparts the requisite knowledge of mathematics and statistical softwares.

## 7. Programme Objectives

1. To imbibe strong foundation of statistics in students.
2. To familiarize students with basic to high-level statistical concepts.
3. To update students with mathematical tools that aid in statistical theory.
4. To teach/strengthen students' knowledge of spreadsheets, programming languages and statistical packages.
5. To promote application-oriented pedagogy by exposing students to real world data.
6. To make students do projects, which prepares them for jobs/markets.

## 8. Programme Learning Outcomes

This course exposes the students to the beautiful world of Statistics and how it affects each and every aspect of our daily life. The course is designed to equip students with all the major concepts of Statistics along with the tools required to implement them. Introduction to computer softwares help them in analysis of data by making optimum usage of time and resources. These softwares give them the necessary support and an edge when progressing to their professional careers. Exposure to plethora of real life data helps in honing their analytical skills. Having practical component with every paper invokes their exploratory side and fine-tunes the interpretation abilities. Such a pedagogy goes a long way in giving them the required impetus and confidence for consultancy startups/jobs in near future. The structure of the course also motivates/helps the students to pursue careers in related disciplines, especially the data sciences, financial statistics and actuarial sciences.

## 9. Teaching Learning Process

The faculty of the Statistics department in the constituent colleges of the University of Delhi is primarily responsible for organizing lectures for B.Sc. (Hons.) Statistics. The instructions related to tutorials and practicals are provided by the respective registering units under the overall guidance of the Department of Statistics, University of Delhi.

There shall be 90 instructional days excluding examination in a semester.
(Add details about Projects/Dissertation and role of supervisor)

### Teaching Pedagogy:

Teaching pedagogy involves class room interactions, discussions, presentations, practical work based on courses, class tests and assignments.

This is detailed out for each course of the programme in section 11 under "**Facilitating the Achievement of Course Learning Outcomes**".

## 10. Assessment Methods/ Evaluation Scheme

The students registered for B.Sc. (Hons.) Statistics programme will study semester I to VI at the constituent colleges of the University Delhi. During these semesters Core, AECC, DSE and SEC courses are offered.

(i) English shall be the medium of instruction and examination.

(ii) Examinations shall be conducted at the end of each Semester as per the Academic

calendar notified by the University of Delhi.

(iii) The assessment broadly comprise of internal assessment and end semester examination. Each theory paper will be of 100 marks with 25% marks for internal assessment and 75% marks for end semester examination. Each practical paper will be examined out of 50 marks with 50% marks for continuous evaluation and 50% marks for end semester examination. Skill enhancement paper will be examined out of 100 marks.

## 10.1 Pass Percentage & Promotion Criteria:

The following provisions shall be applicable to students admitted to the B.Sc. (Hons.) Statistics programme:

a) A student who appears in an odd semester examinations or who was eligible to appear in the odd semester examinations but remains absent in any or all the papers of the said semester, shall move on to the next even semester irrespective of his/her result in the said examinations.

b) A student who has obtained 40% on the aggregate taking together all the papers in theory examination (including internal assessment) and practical examination conducted in Ist and IInd semester shall be promoted to the second academic year/IIIrd semester.

c) A student who has obtained 40% on the aggregate taking together all the papers in theory examination (including internal assessment) and practical examinations conducted in IIIrd and IVth semester shall be promoted to the third academic year/ Vth semester.

d) Students who do not fulfill the promotion criteria mentioned above shall be declared fail in the promotion examination of the academic year concerned. However, they shall have the option to retain the marks in the papers in which they want to retain.

e) If a student has secured an aggregate of minimum 40% marks taking together all the papers in theory examination (including internal assessment) and practical examination till the end of the third year, i.e., upto the end of the VIth semester, then she/he shall be awarded the degree in which the student has been admitted.

f) A student who wants to re-appear for improvement in marks in a paper prescribed for semester I/III/V may do so only in the semester examinations to be held in November/December. A student who wants to re-appear for improvement in a paper

prescribed in semester II/IV/VI may do so only in the examinations to be held in May/June.

### 10.2 Semester to Semester Progression:

a) A student may re-appear in any theory paper prescribed for a semester, on foregoing in writing her/his previous performance in the paper/s concerned. This can be done in the odd/even semester examination only (for example , a student reappearing in paper prescribed for semester I examination may do so along with subsequent semester IIIrd examination and not along with papers for semester Vth).

b) A candidate who has cleared examinations of third academic year (Vth and VIth semesters) may re-appear in any paper of V or VI semester only once, at the odd/even examinations on foregoing in writing her/his previous performance in the paper/s concerned, within the prescribed span period. (Note: The candidate of this category will not be allowed to join any post-graduate courses).

c) In the case of re-appearance in paper, the result will be prepared on the basis of candidate's current performance in the examinations.

d) In the case of a candidate, who opts to re-appear in any paper/s under the aforesaid provisions, on surrendering her/his earlier performance but fails to reappear in the paper/s concerned, the marks previously secured by the candidate in the paper/s in which she/he has failed to re-appear shall be taken into account while determining her/his result of the examination held currently.

e) Re-appearance in practical/internal assessment shall not be allowed.

f) Duration of end semester theory examinations of Core and Elective subjects shall be three hours.

g) The entire evaluation process for AECC and Skill Enhancement Courses (SEC) shall be undertaken by each college where the AECC and SEC are being taught and the teacher responsible for the conduct of learning of the AECC and SEC shall be responsible for the evaluation.

### 10.3 Span Period

No student shall be admitted as a candidate for the examination for any of the Parts/Semesters after the lapse of five years from the date of admission to the Part-I/Semester-I of the B.Sc. (Hons.) Statistics Programme.

### 10.4 Grade Points

A student who becomes eligible for the degree shall be categorized on the basis of the combined result of semester I to semester VI examinations under CBCS on a 10 point grading system with the letter grades. Grade point table as per university examination rules.

### 10.5 CGPA Calculation

As per university examination rules.

### 10.6 SGPA Calculation

As per university examination rules.

### 10.7 Grand SGPA Calculation

As per university examination rules.

### 10.8 Conversion of Grand CGPA into Marks

As notified by competent authority the formula for conversion of Grand CGPA into marks is: Final %age of marks = CGPA based on all four semesters × 9.5.

### 10.9 Division of Degree into Classes

As per university examination rules.

### 10.10 Attendance Requirement

As per university examination rules.

### 10.11 Guidelines for the Award of Internal Assessment Marks B.Sc. (Hons.) Statistics Programme (Semester Wise)

As per university examination rules.