Based on Undergraduate Curriculum Framework 2022

UNIVERSITY OF DELHI

UNDERGRADUATE PROGRAMMES OF STUDY

STRUCTURE, COURSES & SYLLABI OF

SEMESTER IV

Of

B.Tech. Information Technology and Mathematical Innovations

Cluster Innovation Centre

COURSES OFFERED BY CLUSTER INNOVATION CENTRE (CIC)

Category I

[UG Programme for B.Tech. (Information Technology and Mathematical Innovations) in four years]

B.Tech. (Information Technology and Mathematical Innovations)

SEMESTER-IV

Course Structure

B. Tech. (Information Technology and Mathematical Innovations)

Semester-IV

Paper No.	Interactive Learning Modules (Paper Titles)	Credits			
		L	T	P	Total
IV.1 DSC 10	Applied probability and statistics	3	0	1	4
IV.2 DSC 11	Analysis and Design of Algorithms	3	1	0	4
IV.3 DSC 12	Data Base Management Systems	3	0	1	4
IV.4 GE 4*	IV.4.1 Strategies and Concept for Innovation Management	3	1	0	
	IV.4.2 Electronics at Work & Circuit Simulations	3	1	0	
	IV.4.3 In silico Biology	2	0	2	
	IV.4.4 Exploring Living systems	2	0	2	4
IV.5 AEC 4	Choose one from a pool of AEC	0	0	2	2
IV.6 VAC 4	To be added from the pool VAC	2	0	0	2
IV.7 IAPC 2	Problems drawn from Industry, Society and Villages	0	0	2	2
Grand Total					22

- **Any one GE option with opted by students**
- **Key: L: Lecture, T: Tutorial, P: Project/Practical/Internship**

DISCIPLINE SPECIFIC CORE COURSE -10 (DSC-10)
IV.1. Applied Probability and Statistics

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Applied probability and statistics, DSC 10, IV.1.	**4**	**3**	**0**	**1**	**12th pass**	**Mathematics till XII**

Learning Objectives

Probability theory is the branch of mathematics that deals with modelling uncertainty. It is an important course as it has direct application in areas such as genetics, finance and telecommunications. It also forms the fundamental basis for many other areas in the mathematical sciences, such as modern optimization methods and risk modelling. This course introduces probability theory, random variables. This unit will concentrate on the following: Sampling distributions, hypothesis testing, interval estimation, likelihood, analysis of categorical data, joint, marginal and conditional distributions, and regression. R software will be introduced through practical classes in the beginning of the course. Its use will be supported with examples in lectures and tutorials with supplementary material on the course website.

Learning outcomes

- A good understanding of basic concepts of statistical distributions.
- A good understanding of elementary probability theory, the laws of probability and the use of Bayes and various other theorems of probability .
- Able to derive the probability density functions of transformations of random variables and use these to generate data from various distributions.
- Able to represent and statistically analyze data both graphically and numerically.
- A good understanding of exploratory data analysis by working on datasets related to human resources, image segmentation analysis, pollution levels in a city, health diagnosis, etc. along with the ability to write a short-report describing a simple statistical data set.
- Able to translate real-world problems into probability models.

SYLLABUS

Unit I: Probability space - Conditional probability - Bayes theorem – Independence - Descriptive measures (Mean, median, mode, standard deviation, dispersion, moments) - Random variables - Joint distributions **[9 hours]**

Unit II: Discrete distributions (Bernoulli, Binomial, Poisson) and their properties (Expectation, variance, conditional expectation, moments) - Continuous distributions (Uniform, Normal, Exponential) with their properties (Expectation, variance, conditional expectation, moments) **[12 hours]**

Unit III: Joint, marginal and conditional distributions - Weak and strong law of large numbers, -Central limit theorem - Curve fitting - linear regression, Correlation **[9 hours]**

Unit IV: Sampling distributions - Hypothesis testing, interval estimation - Likelihood, analysis of categorical data - Test statistic and their significance **[15 hours]**

Practicals – **[30 Hours]**

Computer program R and its application to simple models

- Introduction to basic syntax of R for arithmetic operations, creating arrays and matrices
- Getting data into R and basic data analysis in R
- Statistical computations in R (evaluation of density functions and distribution functions, computation of descriptive measures for given data)
- Data visualization in R

Essential/recommended readings

1. Introduction to Probability and Statistics for Engineers and Scientists, S.M.Ross, AcademicPress,2009.
2. Applied Statistics and Probability for Engineers, D.C. Montgomery and G.C. Runger, John Wiley and Sons, 2014.
3. Design of Experiments: A No-Name Approach, Thomas Lorenzen and Virgil Anderson, CRC Press 1993.
4. Statistics and Experimental Design in Engineering and the Physical Sciences, Vol. I and II, N.L. Johnson and F.C. Xeen Leone, Wiley Interscience, 1977.

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

DISCIPLINE SPECIFIC CORE COURSE -11 (DSC-11)
IV.2. Analysis and Design of Algorithms

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Analysis and Design of Algorithms, DSC 11, IV.2.	4	3	1	-	Class XII pass	NIL

Learning Objectives

The objective is to teach techniques for effective problem-solving in computing. The use of different paradigms of problem-solving will be used to illustrate clever and efficient ways to solve a given problem. In each case, emphasis will be placed on rigorously proving the correctness of the algorithm. In addition, the analysis of the algorithm will be used to show the efficiency of the algorithm over the naive techniques.

Learning outcomes

After completing this course, student should be able to;

- Understand basics of algorithmic analysis and their practical understanding of the real world examples.
- Learn mathematical design of algorithms and their algorithmic correctness through proofs.
- Understand computational complexity with asymptotic notations and their analysis.
- Have an introduction of different types of paradigm and domain of algorithms such as NP completeness.
- Have hands-on experiments on dynamic programming and greedy approaches.
- Do hands-on experiments on advanced data structures such as AVL tree, Red black, Search heuristics, Approximation algorithms, Distributed and parallel algorithms.

SYLLABUS

Unit I: Algorithmic analysis and modeling - Algorithmic proofs - Computational complexity - Asymptotic notation and analysis **[15 hours]**

Unit II: Sorting methods analysis – Randomization – NP Completeness – Advanced data structure **[15 hours]**

Unit III: Geometric algorithms – Graph algorithms – Linear Programming – Design paradigm such as Divide & conquer **[15 hours]**

Unit IV: Dynamic Programming – Greedy Approaches – Search heuristics – Approximation algorithms – Compression and streaming algorithms – Distributed and parallel algorithms. **[15 hours]**

Essential/recommended readings

- Introduction to Algorithms. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein. MIT Press, 2009.
- Problem Solving with Algorithms and Data Structures Using Python. Bradley W. Miller, and David L. Ranum. Franklin, Beedle & Associates, 2011.
- Data Structures and Algorithms in C++, A. Drozdek, Course Technology, 2013.
- The Art of Computer Programming, Vol. 1,2,3,4. Donald E. Knuth, Pearson Education, 2013.

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

DISCIPLINE SPECIFIC CORE COURSE -12 (DSC-12)
IV.3. Database Management Systems

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Database Management Systems, DSC 12, IV.3.	4	3	0	1	12th pass	NIL

Learning Objectives

The objective is to present an introduction to database management systems, with an emphasis on how to organize, maintain and retrieve - efficiently, and effectively - information from a DBMS. In addition, Course also introduces the present day modern databases with implementation on real-world projects.

Learning outcomes

After completing this course, student should be able to;

- Install, configure, and interact with a relational database management system.
- Describe, define and apply the major components of the relational database model to database design.
- Learn and apply the Structured Query Language (SQL) for database definition and manipulation.
- Utilize a database modeling technique for a single entity class, a one-to-one (1:1) relationship between entity classes, a one-to-many (1:M) relationship between entity classes, a many-to-many (M:M) relationship between entity classes, and recursive relationships.
- Define, develop and process single entity, 1:1, 1:M, and M:M database tables.
- Learn and implement the principles and concepts of information integrity, security and confidentiality.
- Apply ethical computing concepts and practices to database design and implementation.

SYLLABUS

Unit I: Traditional Files & Databases – Database Management Systems **[9 hours]**
Unit II: Relational Model - ER Modeling – Constraints, Query language & features – Normalization – Indexing **[12 hours]**
Unit III: Transaction Processing & Concurrency Control – PL/SQL Basics Graph Databases - Data Modeling Techniques & UML **[12 hours]**
Unit IV: Analysis of Data using Mining Techniques – MongDB - NoSQL – Object Oriented Databases - Study of Real-World Applications **[12 hours]**

Practicals- **[30 Hours]**

- ER Diagram of Existing systems and new systems
- SQL Commands, Structures & execution of Commands on Test Database
- Creation of Databases and identifying the Constraints
- Execution of DDL, DML, TCL Queries on created database
- XML Databases • Executing Aggregate Functions and Extraction of Data elements
- Programs on Database Objects including Procedures, Functions, Exception
- Modeling of Systems and Requirements using UML
- Design of Application(s) using Mining Techniques
- Reverse Engineering & Study of a Database System Architecture
- Innovation Project

Essential/recommended readings

- Fundamental of Database Systems, R. Elmasri and S. B. Navathe, Pearson Education Asia, 7th edition, 2016.
- Database System Concepts, Abraham, H. and Sudershan, S., 5 Ed., McGraw-Hill, 2013
- Introduction to Data Mining, Pang, N. T., Pearson Education, 2013
- Database System: The Complete Book, Jeffrey Ullman, Jennifer Widom, and Héctor García-Molina, Pearson Education, 2008
- Data Modeling: A Beginners Guide, Andy Oppel, McGrew Hill, 2010

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COMMON POOL OF GENERIC ELECTIVES (GE) COURSES

GENERIC ELECTIVES (GE-4.1): Strategies and Concept for Innovation Management

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical/ Practice			
Strategies and Concept for Innovation Management . GE 4.1.	4	3	1	0	12th pass	NIL	Management Faculty of CIC

Learning Objectives

The course presents an integrated view of the skills, tools and techniques in innovation management. Innovation relies on different disciplines that ranges from creativity to organizational behaviour. Rather than focusing on just one aspect of innovation management – Idea generation, the course delves into other aspects such as consumer behaviour, teamwork, leadership and thought processes that would foster creativity and a better understanding of managing innovation.

Learning outcomes

After completing this course, student should be able to:

- Understand the basic need to innovate for growth, profit and survival
- Comprehend that the ability to innovate and innovation management as vital core competency.
- Identify innovation opportunities
- Distinguish between incremental, standard and radical innovations
- Optimize a portfolio of high risk and low risk innovation
- Understand how the in box thinking lead to out of the box creativity

SYLLABUS

Unit-I. The innovation imperative: Why innovate?; Innovation to energize; Innovate for growth and profit; innovate for survival; Discussion of relevant case study. **[15 hours]**

Unit-II. The innovation portfolio: What to innovate?; Vision, portfolios and feelings; Identifying the right question, feelings and needs; Innovating Experiences, Battling Commoditization; Technology and Psychology; Creating Emotional Appeal; Searching for Innovation Opportunities; Innovation Portfolios for Established Organizations **[15 hours]**

Unit-III. The innovation voices: How to innovate?; Thinking 'Inside and outside The Box'; Profiling Product for Profit and Growth; Understanding the voice of the product, customer and organization; Fostering creativity in organizations**.** **[15 hours]**

Unit-IV. The innovative mind: Who Innovates?; Three Levels of Innovation; The Individual Innovator; Creativity Muscles; Innovative Teams; Building a Global Team; The Innovative Organization **[15 hours]**

Essential/recommended readings

1. Innovation Management: Strategies, concept and tools for growth and profit, S. Maital D.V.R. Sheshadri, Response Books, 2007.
2. Innovation Management and New Product Development, P. Trott, Pearson Education, 7th Edition, 2021.
3. Innovation and Entrepreneurship, M. Kennard, Routledge, 2021.

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

GENERIC ELECTIVES (GE-4.2): Electronics at work & circuit simulation

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical/ Practice			
Electronics at work and Circuit simulation, GE 4.2.	4	3	1	0	Class XII pass	Mathematics till XII	Physics/ Electronics Faculty of CIC

Learning Objectives

This is a basic introductory module to provide an insight of the field of electronics to the students. In this paper students learn about three aspects of electronics namely analog world, digital world and signals & systems. The emphasis is on basic electronics components and devices and their application in real world.

Learning Outcomes

• Familiarizing students with concepts of Electronics.
• Familiarizing students with following analog electronic components and their identification: resistor, capacitor, inductor, power source, transducer, sensor, detector, switch, Potentiometer - Integrated Circuit – Transformer;
• Familiarizing students with following digital electronic components, circuits, devices and their identification: logic families, logic gates, Boolean algebra - Combinational circuits: adders, encoders, decoders, multiplexer and de- multiplexer - Sequential circuits: like flip flops, counters, shift registers, memories
• Familiarizing students with following semiconductor devices, circuits and their identification: PN Junctions characteristics, Zener and Avalanche breakdown, diode applications, transistor & applications. FET, MOSFET, FET, Operational Amplifier (Op Amp): inverting and noninverting amplifier, integrator, differentiator, summing amplifier, active filters
• Familiarizing students with following Signal and Systems: Types, Generation, Audio and Video Signals and their applications, Operation on Signals, Classification of Signals and Systems.

SYLLABUS

Unit I: Analog World: resistor, capacitor, inductor, power source, transducer, sensor, detector, switch – Potentiometer - Integrated Circuit – Transformer [15 hours]

Unit II: Digital World: logic families, logic gates, boolean algebra - Combinational circuits: adders, encoders, decoders, multiplexer and de-multiplexer - Sequential circuits: like flip flops, counters, shift registers, memories [15 hours]

Unit III: Semiconductor Devices: PN Junctions characteristics, Zener and Avalanche breakdown, diode applications, transistor & applications. FET, MOSFET, FET, Operational Amplifier (Op Amp): inverting and non-inverting amplifier, integrator, differentiator, summing amplifier, active filters [15 hours]

Unit IV: Signal and System: Types, Generation, Audio and Video Signals and their applications, Operation on Signals, Classification of Signals and Systems [15 hours]

Practical Component: NIL

Reference:

1.Electronic Principles. Albert Paul Malvino, McGraw-Hill, 1998

2.Electronic Devices & Circuit Theory. Robert L. Boylestad, and Louis Nashelsky, Pearson Education,2009

3. Digital Logic and Computer Design. M. Morris Mano, Pearson Education, 2008

4. Signals and Systems. Alan V. Oppenheim, Alan S.willsky, and Nawab S.Hamid, Prentice Hall, 1997

5. Art of Electronics. Paul Horowitz, and Winfield Hill, Cambridge University Press, 2008

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GENERIC ELECTIVES (GE-4.3): *In Silico* Biology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical/ Practice			
In Silico Biology, GE 4.3.	4	2	0	2	Class XII pass	NIL	Chemistry/ Biology Faculty of CIC

Learning Objectives

This module is designed to:

- Develop an understanding of the advancement of computational models and simulations in studies applied to complex biological phenomena.
- Aware students of different types of bioinformatics analysis software and their related applications so that they can solve biological problems

Learning Outcomes

Upon completion of the course the students will be able to:

- Do computational simulations using protein and DNA sequences
- Be able to build computational models of biological data and systems
- Will be aware of the software and databases related to computational biology
- Will do homology modelling, docking, building cladograms etc.

SYLLABUS

Unit I: Handling protein and DNA sequences [12 hours]

Sequence patterns and profiles; Sequence file formats; Basic concept and definition of sequence patterns, motifs and profiles; sequence representations types; Sequence similarity based search engines (BLAST and FASTA); Pattern based and Motif-based searches; Profile-based database searches; Basic concepts of sequence similarity, identity and homology; homologues, orthologues, paralogues and xenologues sequences; Scoring matrices; Matrices for nucleic acid and proteins sequences, PAM and BLOSUM series, matrix derivation methods and principles; Basic concepts of sequence alignment, pair wise alignment; application of sequences alignments.

Multiple sequence alignments; concept of dendrogram and its interpretation, phylogeny and cladistics.

Unit II: Handling biological data and data models [10 Hours]

Types of Biological data- Genomic DNA, cDNA, transcriptomics and RNA sequence analysis; Primary Databases: Nucleotide and protein sequence databases, Metagenomic and Environmental Sequences, Literature Databases, Secondary or Derived Databases; Sequence motifs Databases; Composite Databases; Genome organization databases; Organism specific database; Database search engines.

Unit III: Programming languages and software [08 hours]

Algorithm and programming languages, Stochastic models; Introduction to biopython; Introduction to new software and bio packages

Practicals- [60 hours]

- Sequence analysis (BLAST, FASTA).
- Database (NCBI, DDBJ, EMBL).
- Motif and Promoter searches (e.g. CD-Search, SMART, SignalP)
    - Phylogenetic analysis (PHYLIP, MEGA)
    - Protein interaction (STRING, BioGRID)
    - Protein structure, Function (PROSITE programs, Chimera
    - Gene expression, function (GEA, Gene card, OMIM)
    - Introduction to molecular docking

Essential/Suggested Readings

1. *Marketing*, M. J. Etzel, J. W. Bruce, W. J. Stanton, & A. Pandit, New Delhi: Tata McGraw-Hill, 14th edition, 2010.
2. *Marketing management: a south Asian perspectiv*e, P. Kotler, K. Keller, L. Koshy & M. Jha, New Delhi: Pearson, 13th Edition, 2009.
3. *Marketing management: Global perspective Indian context*, V. S. Ramaswamy, & S. Namakumari, New Delhi: Macmillan, 4th Edition, 2009.
4. *Marketing management*, R. Saxena, New Delhi: Tata McGrawHill, 4th Edition, 2009.

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GENERIC ELECTIVES (GE-3.4): Exploration of living systems

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical/ Practice			
*GE 3.4 Exploration of Living Systems	4	2	0	2	Class XII pass	NIL	Chemistry/ Biology Faculty of CIC

***GE 3.4 can be opted by students in either 3rd or 4th semester.**

Learning Objectives

This module is designed to:

- Introduce students to the living system in terms of their hierarchal organization and their distinction from the nonliving.
- The specific objective of the module is to introduce biology even to students with no biology background and enable them to understand living systems.
- To enthuse students with tools and techniques for studying biology.
- Introduce students to the origin and evolution of living systems
- Introduce students to the essence of model organisms for studying biology

Learning outcomes

After studying this course, the students will be able to:

- Understand the diversity and complexity of living systems
- To comprehend different fields within Bio-Sciences
- To understand experimental processes undertaken in Biology
- Will develop a philosophical understanding of the origin and evolution of living systems, the nature of genetic materials etc.

SYLLABUS

Unit I: Introduction and organization of living systems [6 hours]

Introduction to living state: (living versus non-living), Hierarchy of organization of living systems and classification (cellular, multicellular and organismic and population levels), Cell as the unit of life.

Unit II: Origin and diversification of the living systems **[6 hours]**

Nature of the genetic material (DNA versus RNA), Introduction to molecular evolution, Origin of life, Evidence of evolution, Theories of evolution, Creating living systems (synthetic cell).

Unit III: Designing living systems **[6 hours]**

Nature of biological processes - Approaches to study Biology: Observational and Experimental, Physiology and Behaviour

Unit IV: Tools and materials for studying living systems **[12 hours]**

Observational, synthetic and reductionist approaches for studying living organisms, Microscopy, Centrifugation and separation techniques as basic tools for studying components of living systems, Model organisms.

Practicals - **[60 hours]**

Basic equipment and techniques

a. Observation or permanent slides of pollens, microbes, hydra, Daphnia and bacteria under a microscope
b. Separation techniques:
    - Fraction of cell organelles through centrifugation
    - Separation of chlorophyll pigments by paper chromatography

Exploring different levels of organization (using model organisms)

a. Tissue organization and diversity in cell shapes: studying through plant and animal tissues sections
b. Inflorescence as a model of organization
c. Understanding parts of the flower

Studying cells:

a. Bacterial growth curve analysis
b. Genomic DNA isolation
c. Preparation of metaphase chromosome
d. Preparation of karyotypes using photographs of metaphase spreads
e. Demonstration of osmosis and plasmolysis

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