



UNIVERSITY OF DELHI

B.Tech. Information Technology and Mathematical Innovations

Cluster Innovation Centre

B. Tech. (IT & Mathematical Innovations)

Preamble

INTRODUCTION

This unique course, the first one to be offered at Cluster Innovation Centre, is designed to inculcate an innovation mindset as part of the curriculum and pedagogy. Building strong analytical skills through Mathematics and application skills of Information Technology (IT), this course encourages students to recognize the connectedness of various disciplines. Using IT as a vehicle for connecting mathematics with other disciplines, students are encouraged to develop innovative products and processes as part of curriculum. The course aims to produce adequately skilled graduates with a creative mindset who can provide new solutions to industry in particular and to society in general. It is hoped that some of these innovators will be entrepreneurs, who will be job providers rather than job seekers. The course is specifically designed to boost undergraduate research.

The course amalgamates important fields of education with significant interface with Mathematics and IT. The mode of learning is a healthy and productive blend of the formal and the inquiry based, with special focus on “hands on” and “project based” mode of learning. Learning happens to a large extent through teacher mentoring and peer learning that encourages creativity and relies on innovations. This is in tandem with the requirement of NEP tenets.

Upon graduation, these students would have acquired innovation-based creativity and would have matured in their thinking. They will have enhanced their communication and leadership abilities, and will have understood the deep and abiding connections between knowledge and its uses - between understanding the needs of society and the relevance of knowledge and the importance of societal obligations. Experiments, hands-on projects, innovative projects, model implementations linked to the curriculum will be carried out in the “Engineering Kitchen: Innovation Lab”. Assessment, at each stage, is designed in a manner to incentivize innovation by encouraging students to carry out new creative application of the theoretical knowledge acquired, either through a project, or through a laboratory activity/prototype in the engineering kitchen.

PROGRAMME LEARNING OUTCOMES (PLO)

PLO1: To inculcate an innovation mindset as part of the curriculum and pedagogy. Building strong analytical skills through Mathematics and application skills of Information Technology.

PLO2: To create an interdisciplinary learning approach.

PLO3: To promote learning based on “hands-on” and “project-based” modes of learning.

PLO4: To aim to produce adequately skilled graduates with a creative mindset who can provide new solutions to industry in particular and to society in general.

PLO5: To encourage students under mentoring of teachers, for innovation and entrepreneurship. In addition to this, the course is specifically designed to boost undergraduate research.

GRADUATE ATTRIBUTES

Disciplinary knowledge: Capable of demonstrating comprehensive knowledge of fundamentals, understanding and applications of Information Technology and Mathematics.

Communication Skills: Capability to communicate complex engineering concepts with peers, faculty, industry and society at large. Such ability includes reading, writing, speaking and the ability to comprehend. Write effective reports and respond effectively to instructions.

Critical thinking and Problem Solving: An ability to use acquired knowledge and skills to identify, formulate, analyze and solve complex engineering problem. Extrapolate from what one has learned in theory and apply their competencies to solve different kinds of non-familiar problems.

Investigation: Demonstrate competence to investigate complex problems by methods that include appropriate experiments, analysis and interpretation of data and synthesis of information in order to reach valid conclusions.

Design thinking: Capability to design solutions, system components or processes that meet the specified needs to solve the local, national and global challenges. Ability to analyse, interpret and draw conclusions from quantitative/qualitative data collected during practical sessions; and critically evaluate ideas, evidence and experiences.

Use of ICT and other engineering tools: Capability to select, apply, create, adapt and extend modern tools including modeling and prediction to a range of simple and complex situations with a complete understanding of their usage and associated limitations.

Entrepreneurial skill: Ability to drive innovation to lead breakthrough changes. Apart from strong technology skills, develop traits of creativity and decision making to develop a new business idea, start-up or an innovative process.

Interdisciplinary Approach: Ability to incorporate knowledge and skills from multiple areas of learning in order to obtain a comprehensive and a detailed solution of a problem/situation.

Cooperation/Team work: Ability to work effectively with various project teams, build strong peer-to-peer associations to achieve educational and professional goals.

Self-directed learning: Ability to work independently, identify appropriate resources required for a project, and manage a project through to completion.

Professional Ethics: Ability to embrace ethical principles and commit to professional ethics, accountability and responsibilities

Lifelong learning: An ability to identify and to address their own educational needs in a changing world in ways sufficient to maintain their competence and to allow them to contribute to the advancement of knowledge and nation.

QUALIFICATION DESCRIPTORS

- Enable the students to realize their true potential in terms of innovation for real world applications that is largely driven by the engine of mathematics and IT.
- Ability to work and learn in an environment of creativity, through real world situations that opens up links to ideas and disciplines from various areas and realms.
- Acquirement of expertise in innovative ways of technology based problem solving, a 'hands on' approach to real world thinking with an ability to think creatively and work in groups with a flair for communication and leadership
- Solve innovative projects in collaboration with industry and other segments of society
- Recognition of the fact that disciplines are connected and need each other.
- Recognition of the importance and centrality of mathematics and the advantages of using IT as a vehicle for connecting mathematics with other disciplines
- In addition to having built up deep knowledge in mathematics and IT, acquirement of expertise at a deep level in one of the following: Economics and Management, Robotics and Embedded Systems, System Biology.
- Imbibe innovation based creativity and mature thinking
- Enhancement of communication and leadership abilities an understanding of the deep and abiding connections between knowledge and its uses
- Understand the needs of society and the relevance of knowledge and the importance of societal obligations

B. Tech. (IT & Mathematical Innovations)

GENERAL COURSE STRUCTURE & THEME

A. Definition of Credit

1 Hr. Lecture (L) per week	1 Credit
1 Hr. Tutorial (T) per week	1 Credit
1 Hr. Practical (P) per week	0.5 Credit
2 Hours Practical (P) per week	1 Credit

B. Course Code and definition

Course Code	Category
L	Lectures
T	Tutorials
P	Practical

C. Course Structure

COURSE STRUCTURE

Key: L: Lecture, T: Tutorial, P: Project/Practical

Semester I

PS. No.	Course Title	Course Code	Credits			
			L	T	P	Total
1	Single and Multivariable Calculus	DSC 01	3	-	1	4
2	Discrete Mathematics and its applications	DSC 02	3	1	-	4
3	Programming Fundamentals	DSC 03	3	-	1	4
4	Engineering Physics I	GE 01	2	-	2	4
	OR Engineering Chemistry I		2	-	2	
5	Choose one from a pool of AEC	AEC 01	2	-	-	2
6	Choose one from a pool of VAC	VAC 01	-	-	-	2
7	Choose one from a pool of SEC	SEC 01	-	-	-	2
	Total					22

COURSE STRUCTURE

Key: L: Lecture, T: Tutorial, P: Project/Practical

Semester II

PS. No.	Course Title	Course Code	Credits			
			L	T	P	Total
1	Engineering through Linear Algebra	DSC 04	3	-	1	4
2	Data Structure and Design	DSC 05	3	1	-	4
3	Object Oriented Programming	DSC 06	3	-	1	4
4	Engineering Physics II OR	GE 02	2	-	2	4
	Engineering Chemistry II		2	-	2	
5	Choose one from a pool of AEC	AEC 02	2	-	-	2
6	Choose one from a pool of VAC	VAC 02	-	-	-	2
7	Choose one from a pool of SEC	SEC 02	-	-	-	2
	Total					22

COURSE STRUCTURE

Key: L: Lecture, T: Tutorial, P: Project/Practical

Semester-III

Paper No.	Interactive Learning Modules (Paper Title)		Credits			
			L	T	P	Total
1	Modeling continuous changes through ordinary differential equations	DSC 7	3	-	1	4
2	Operating Systems	DSC 8	3	-	1	4
3	Computer Systems Architecture	DSC 9	3	-	1	4
4	III.4.1 Economic Behavior	GE 3	3	1	-	4
	III.4.2 Electronics circuit elements and innovation lab		2	-	2	
	III.4.3 Flow of Information in living systems					
	III.4.4 The Living world: Systems Approach					
5	III.4.5. Health Data Analysis	DSE 1	-	-	4	
	III.4.6. Game Development Using UNITY					
	III.4.7. 3D Printing using Blender					
	III. 4.8. IT Project Leadership		1	-	3	
	III.4.9. Fabrication of nanomaterials for devices					
6	Choose one from a pool of AEC		2	-	-	2
7	Choose one from a pool of VAC		-	-	-	2
8	Choose one from a pool of SEC/IAPC		-	-	-	2
	Total					22

***Any one from III.4 (either GE 3/ DSE 1) option will be opted by students**

****Any one option may be opted by students from III.7 (either SEC 3 or IAPC 1)**

❖ All DSE 1 papers will be available in Semester V also.

COURSE STRUCTURE

Key: L: Lecture, T: Tutorial, P: Project/Practical

Semester IV

PS. No.	Course No.	Interactive Learning Modules (Course Title)	Credits			
			L	T	P	Total
1.	DSC 10	Applied probability and statistics	3	-	1	4
2.	DSC 11	Analysis and Design of Algorithms	3	-	1	4
3.	DSC 12	Data Base Management Systems	3	-	1	4
4.	GE 4	Strategies and Concept for Innovation Management	3	1	-	4
		Electronics at Work & Circuit Simulations	2	-	2	
<i>in silico</i> Biology						
The Living world: Systems Approach						
5.	DSE 2	Mathematical Modeling & Simulation [#]	-	-	4	
		Computational Fluid Dynamics (CFD) [#]				
		Technology based solutions of societal issues [#]				
		Medical Imaging techniques [#]				
		Virtual Reality [#]				
6.	AEC 4	Choose one from a pool of AEC	2	-	-	2
7.	VAC 4	Choose one from a pool of VAC	-	-	-	2
8.	SEC 4/ IAPC 2	Choose one from a pool of SEC	-	-	-	2
		Internship/ Apprenticeship/ Project/ Community Outreach	-	-	-	
	Total					22

- Any one from 4 & 5 (Either GE 4 or DSE 2) may be opted by students
- Any one option from 8 & 9 (Either SEC 4 or IAPC 2) may be opted by students
- # These DSE 2 papers will be available in Semester VI also.

COURSE STRUCTURE

Key: L: Lecture, T: Tutorial, P: Project/Practical

Semester-V

PS. No.	Course No.	Interactive Learning Modules (Course Title)	Credits				
			L	T	P	Total	
1	DSC 13	Linear Programming and Game Theory	3	-	1	4	
2	DSC 14	Data Communication and Networking	3	-	1	4	
3	DSC 15	Software Engineering	3	-	1	4	
4	GE 5	Consumer behaviour and Marketing Research	2	-	2	4	
		Circuit Analysis and Synthesis					
		Genes to Genomes					
5	DSE 3	Health Data Analysis [#]	-	-	4	4	
		Game Development Using UNITY [#]					
		3D Printing using Blender [#]					
		Applications of Data Science: A case study approach					
		Urban Computing					
		IT Project Leadership [#]					
		Fabrication of nanomaterials for devices [#]	1	-	3		
		IoT, Security and Machine Learning					
		Integral Transforms and Applications					
6	SEC 5/ IAPC	Any one from the pool of SEC	-	-	-	2	
		Internship/ Apprenticeship/ Project/ Community Outreach	-	-	-		
	Total					22	

- Any one GE option with opted by students from GE 5 papers
- Any one DSE option will be opted by students from DSE 3 papers
- Student will either opt for SEC 5 or choose internship (IAPC) in paper V
- # These papers are also being offered in Semester III

COURSE STRUCTURE

Key: L: Lecture, T: Tutorial, P: Project/Practical

Semester VI

PS. No.	Course No.	Interactive Learning Modules (Course Title)	Credits			
			L	T	P	Total
1	DSC 16	Numerical Methods for Computational Mathematics	2	-	2	4
2	DSC 17	Information Security	3	1	-	4
3	DSC 18	Artificial Intelligence	3	1	-	4
4	GE 6	e-Business: Organisation and Strategy	2	-	2	4
		Control Systems				
		Genomics and Proteomics				
5	DSE 4	Mathematical Modeling & Simulation [#]	-	-	4	4
		Computational Fluid Dynamics (CFD) [#]				
		Technology based solutions of societal issues [#]				
		Medical Imaging Techniques [#]				
		Computational Analysis of OMICS data				
		Virtual Reality [#]				
		Complex Systems				
		Research Methodology				
6	SEC/ IAPC 4	Any one from the pool of SEC	-	-	-	2
		Internship/ Apprenticeship/ Project/ Community Outreach	-	-	-	
	Total					22

- # These DSE 4 papers are also offered in Semester IV.

COURSE STRUCTURE

- **Key: L: Lecture, T: Tutorial, P: Project/Practical/Internships**

Semester VII

PS. No.	Course No.	Interactive Learning Modules (Course Title)	Credits			
			L	T	P	Total
1	DSC 19	Data Mining and Data Warehousing	3	1	-	4
2	DSE 5	Theory of Computation	3	1	-	4+4+4=12
		Computational Social Systems	3	1	-	
		Network Science	3	1	-	
		Deep Learning and Applications	3	1	-	
		Business Intelligence and Advance Data Analytics	3	1	-	
		Natural Language Processing	3	1	-	
		Operation Research	3	1	-	
		Mathematical Modeling with emphasis on Robotics	3	1	-	
		Mathematical Approach to Signal Processing	3	1	-	
		Biological Networks and Data Analysis	2	-	2	
		IoT Security and Machine Learning#	1	-	3	
		Integral Transformation and Application#				
3	GE 7	Environment Management	2	-	2	
		Principles of Financial Decision Making	3	1	-	
		Biodefense and Bioengineering	2	-	2	
		Devices and Nanotechnology	3	1	-	
4	Project	Academic Projects/ Research Dissertation/ Entrepreneurial Ventures *	-	-	6	6
	Total					22

- ***Note: Per the University of Delhi UGCF structure, students can choose 3 DSE OR 2 DSE and 1 GE OR 1 DSE and 2 GE from the provided list.**
- **# These papers are also being offered in Semester V**

COURSE STRUCTURE

- **Key: L: Lecture, T: Tutorial, P: Project/Practical/Internships**

Semester VIII

PS. No.	Course No.	Interactive Learning Modules (Course Title)	Credits			
			L	T	P	Total
1	DSC 20	Complex Analysis and Algebra	3	1	-	4
2	DSE 6	Computer Graphics	1	-	3	4+4+4=12
		Machine Learning for Business Intelligence	1	-	3	
		Crafting Digital Experiences: A Practical Approach to Web Design and Programming	-	-	4	
		Partial Differential Equations	3	1	-	
		Brain and Cognition: Computational Neurosciences	1	-	3	
		Systems Biology	1	-	3	
		Virtual Reality#	-	-	4	
		Complex Systems#	-	-	4	
		Computational Analysis of OMICS data#	-	-	4	
3	GE 8	Contribution of Indian Knowledge System to Science, Engineering and Technology	3	1	-	
		Public Health and Health Informatics	2	-	2	
		Income Tax Essentials: From Basic Concepts to Tax Planning	3	-	1	
		Integrative Biology	3	-	1	
4	Project	Academic Project/ Research Dissertation/ Entrepreneurship	-	-	6	6
	Total					22

***Note: As per the University of Delhi UGCF structure, students can choose either 3 DSE OR 2 DSE and 1 GE OR 1 DSE and 2 GE from the provided list.**

- **# These DSE 6 papers are offered in Semester VI also.**

Semester I

DISCIPLINE SPECIFIC CORE COURSE -1 (DSC-1): Single and Multivariable Calculus

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Single and Multivariable Calculus, DSC-1	04	3	0	1	Class XII pass	Mathematics till XII

Learning Objectives

Calculus is the most powerful tool in mathematics with widespread applications. The goal of this course is for students to gain proficiency in calculus computation. The course builds up on the topics, namely limits and continuity, differentiation and integration. These topics will use to solve application problem in a variety of fields such as physics, biology, business and economics.

Learning outcomes

- A good understanding of basic concepts of limits, derivatives, continuity, asymptotes, sequence and series, integrals, vector valued functions, partial differentiation, multiple integrals, etc.
- Able to find points of discontinuity for functions and classify them and understand the consequences of the intermediate value theorem for continuous functions.
- Able to solve applied problems using basic concepts of calculus.
- Able to explain why calculus is valuable in daily life.
- Create a project using the fundamental knowledge and principle of differential and integral calculus that helps to provide a hands-on experience of the same.
- Able to plot and manipulate the curves appropriately to make various real-life models like studying the projectile motion in firecrackers and

the flow of water in fountain.

- Create animations of given problems using MATHEMATICA software.

SYLLABUS OF DSC-1

UNIT – I (12 hours)

Limits and continuity

Limits at infinity - Indeterminate forms - Special limits involving exponential and logarithmic functions – Asymptotes - Graphs of function and its derivatives - Optimization problems - Fluency in differentiation - Concavity and inflexion points - Sequences, infinite series including Taylor approximations, Power series

UNIT – II (9 hours)

Integration

Parametric equations of curves, arc length and surface area-Vector valued functions, differentiation and integration of vector valued functions

UNIT – III (15 hours)

Functions of several variables

Level curves and surfaces - Limits and continuity of functions of two and three real variables - Partial differentiation (two variables), partial derivative as a slope, partial derivative as a rate, Maxima and Minima

UNIT – IV (12 hours)

Multiple Integrals

Line, surface and volume integrals - Applications of Green's, Stokes and Gauss's Theorem.

Practical component – (32 hours)

Engineering Kitchen Activity (Symbolic Mathematics Software) [Laboratory]

- Introduction of basic functions
- Plotting of graphs of functions and their derivatives
- Manipulating the parameters in a graph
- Fitting of a curve
- Parametric plot of curves (Eg. Trochoid, Cycloid, Epicycloid)
- Obtaining surfaces of revolution of curves
- Plotting functions of two variables and their level curves
- Graphical illustration of limits for functions of two variables
- Innovation Project

Essential/recommended readings

1. *Calculus*, T. M. Apostol, Volumes 1 and 2, Wiley Eastern, 1980.
2. *Calculus - Single and Multivariable*, Hughes-Hallett et al., John-Wiley and Sons,

2003.

3. *Calculus*, James Stewart, Thomson, 2003.
4. *Calculus and Analytic Geometry*, G. B. Thomas and R. L. Finney, Addison-Wesley, 1998.

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

DISCIPLINE SPECIFIC CORE COURSE – 2 (DSC-2): Discrete Mathematics

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		
Discrete Mathematics and its applications DSC-2	04	3	1	0	Class XII pass	Mathematics till XII

Learning Objectives

The objective of this paper is to familiarize the student with basic concepts of logic and combinatorics. The aim of the paper is also to conceptualize the terminologies of graph theory, isomorphism, paths, cycles, circuits, graph coloring in various physical situations. Throughout this paper, students will be encouraged to develop their own algorithms and to analyze their computational complexities. Further, students may develop codes in any of the programming language for implementation of various algorithms.

Learning outcomes

After completing this course, student should be able to;

- Familiarize with basic concepts of logic

- Understand combinatorics principles: sets, permutations, combinations, recurrence relations etc.
- Conceptualize basic terminologies of graph theory, isomorphism, connectivity etc
- Understand concepts of paths, cycles, circuits and their applications in various fields
- Learn different shortest path algorithms, their computational complexities, implementation & programming
- Understand travelling salesman problem and its importance
- Understand the concept of graph coloring with real applications, planar graphs and algorithms
- Conceptualize trees, spanning trees and algorithms

SYLLABUS OF DSC-2

UNIT – I (16 hours)

Logic and Combinatorics

Propositional Logic; Truth tables; Conditional statements; Logic and Bit operations; Propositional and logical equivalences; De Morgan's law; Applications of propositional logic. Sets, counting of sets - Permutation - Combination - Inclusion - exclusion - Generating functions - Recurrence relations

UNIT – II (16 hours)

Graph Theory

Introduction - Basic terminologies - Graph representation - Euler relation Isomorphism- Connectivity - Cut vertices and edges - Covering - Euler and Hamilton paths and circuits

UNIT – III (16 hours)

Applications of Graph Theory

Shortest Path Algorithms: Dijkstra's algorithm -Travelling salesman problem - Scheduling problems - Matching - Independent sets - Coloring - *Planar graph*: idea of region - Euler formula - Kuratowski theorem and application

UNIT – IV (16 hours)

Tree

Basic terminology, traversal, Prefix code - Idea of data compression: Huffman code - Spanning tree - Minimum spanning tree: Prim's and Kruskal method.

Practical component

– NIL

Essential/recommend

ed readings

1. *Discrete and Combinatorial Mathematics*, Ralph Grimaldi, International Edition, 2003.
2. *Discrete Mathematical Structures*, Bernard Kolman, Robert Busby, Sharon Ross, International Edition, 2008.
3. *Discrete Mathematics and Its Applications*, K. H. Rosen, McGraw-Hill, 2008.

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

DISCIPLINE SPECIFIC CORE COURSE– 3 (DSC-3): Programming Fundamentals

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Programming Fundamentals, DSC-3	04	3	0	1	Class XII pass	Mathematics till XII

Learning Objectives

This course aims at providing the fundamental knowledge of programming. This course trains students to design code, write programs to instruct computer systems. In addition, the course objective is to give an understanding of real-world data, tasks and their representation in terms of programs.

Learning outcomes

After completing this course, students will have:

- understanding of Programming Concepts
- understanding of real-world applications development through programs
- understanding of independent data and collection of data and their organization
- understanding of memory allocation on runtime
- understanding of the program life cycle
- understanding of testing, coding guidelines, debugging and integration.

SYLLABUS OF DSC-3

UNIT – I (16 Hour)

Philosophy of programming and algorithm

Algorithm and its characteristics-Programming philosophy-Problem solving process- Programming language concepts-Program life cycle

UNIT – II (16 Hour)

Data representation and storage

Data definition structures such as types-constants-variables-Expressions such as arithmetic- logical-Precedence and associative rules-Control Structures-Functions-Variable scope

UNIT – III (16 Hour)

Multiple data item and processing

Preprocessing - Arrays, Structures – Strings - Pointers - Memory allocation

UNIT – IV (16 Hour)

Permanent storage and information handling

Files handling – Coding guidelines - testing & debugging-System testing & Integration

Practical component –

Engineering Kitchen Activity [Laboratory]

- User input and output programs having mathematical operations
- Pattern printing programs
- Programs for operators implementation
- Programs to implement function
- Programs to implement collection such as Array and String
- Programs to implement structure
- Innovation Project

Essential/recommended readings

1. *C++: The Complete Reference, Fourth Edition*, Herbertz Schildt, McGraw Hill, 2015.
2. *The C++ Programming Language, 4th Edition*, Bjarne Stroustrup, Addison-Wesley, 2013.
3. *Computer Science: A Structured Approach Using C++ 2nd Edition*, Behrouz A. Forouzan, Richard F. Gilberg, 2004
4. *The C Programming Language (Ansi C Version)*, Brian W. Kernighan, Dennis M. Ritchie, 1990.

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

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES

NOTE: The core papers offered in the B.Tech. Course at CIC are Mathematics and Information Technology. Therefore, the students will choose GE offered by Physics and Chemistry faculty members of CIC.

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			
Engineering Physics I, GE-1	4	2	0	2	Class XII pass	Science Till Class X	Physics Faculty of CIC

Learning Objectives

This interactive learning module intends to provide basic theoretical understanding of Classical Mechanics with special emphasis on learning how these theoretical concepts are applied in designing mechanical and energy efficient systems etc.

Learning outcomes

- Understanding of physics principles in machines.
- Ability to conceptualize and build machines for real life use.
- Reverse engineering of mechanical devices and redesigning of such objects.
- Practical hands-on skills and understanding of simple engineering concepts derived from Mechanics.

SYLLABUS OF GE-1

UNIT – I (16 Hour)

Classical mechanics at work

Newtonian Mechanics (Kinematics & Dynamics) - Classical Mechanics at work
- deconstructing mechanical systems - Universal Gravitation

UNIT – II (16 Hour)

Oscillation & Rotation

Oscillations - Inertial & Non-inertial frames - Central force motion -
Understanding rotational dynamics

UNIT – III (16 Hour)

Machines

Efficiency and mechanical advantage in simple and complex machines: Levers, Pulley, Wheel & Axles, Gear systems, Hydraulic systems

UNIT – IV (16 Hour)

Energy Applications

Forms of energy and conversion between different forms of energy.

Practical component –

Engineering Kitchen Activities [Laboratory]

- Concepts of measurement, error, precision, accuracy. Concept of scale. Understanding Measuring Instruments
- Understanding oscillation using simple and compound pendulums
- Mechanics system with 850 Universal Interface – understanding Newtonian Dynamics
- Measurement of Moment of inertia from rotational dynamics
- Roller coaster dynamics – computer simulation and physical verification
- Coupled pendulum motion – using webcam and image analysis
- Ballistic Pendulum
- Understanding physics of complex machines – one implementation of “Tod-Phod-Jod” concept.
- Visualization in 3D and understand how things work – Building a CAD model in 3D to trace the flow of power, energy, information and material.
- Innovation project – designing instruments, machines, prototypes, applets

Essential/recommended readings

1. *Classical Mechanics*. Herbert Goldstein, Pearson Education, 2011.
2. *A Textbook of Machine Design*. R. S. Khurmi, and J. K. Gupta, S. Chand Publishing, 2005.

GENERIC ELECTIVES (GE-2): Engineering Chemistry I

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical/ Practice			
Engineering Chemistry I, GE-2	04	2	0	2	Class XII pass	Science Till Class X	Chemistry Faculty of CIC

Learning Objectives

This course is designed in such way, so that it provides a flavor of interesting, innovative, programmable and multifunctional materials of chemistry. Students will be exposed to a lot of applications of materials from various walks of our day to day life. Different forms of materials (Biomolecules, drugs, nanomaterials, environment friendly materials etc.) will be discussed at length. Innovative applications of these extremely important materials for drug development, electronic material development, biosensing (like glucose monitoring / disease detection) and environmental remediation etc. will be elaborated, so that students become more aware of the useful materials, which may further be designed, developed and utilized by society as a whole.

Learning outcomes

- Students will be exposed to important aspects related to biomolecules, which are one of the most important constituents of our life.
- Students will get basic knowledge about programmable and multifunctional materials, which are being used in various walks of life nowadays.
- Students will be aware of the basic and advanced forms of nanomaterials and their applications in different fields.
- Importance of green chemistry will be understood through related examples.
- Students will be able to understand the importance of designing drugs and their development through various concepts of marketing.

SYLLABUS OF GE-2

UNIT – I (16 Hour)

Programmable and Multifunctional Materials

Basic features and properties of Biomolecules (Carbohydrates, Proteins, Nucleic Acids and Fats) along with their applications in our day to day life as food, medicine, drugs, enzymes for catalysis etc.; Programmable and Multifunctional DNA-Based Materials for various Applications; Chemical and Biological sensors.

UNIT – II (16 Hour)

Nanochemistry and Nanoscience in our day to day life

Synthesis of Nanoparticles (Green and Chemical Methods; Bottom up and Bottom down approach), Various kinds of nanomaterials and nanostructures (Nanoparticles, Nanoclusters, Nanorods, Quantum dots, Nanotubes, Nanorobots etc.) and their applications in various fields like biomedical, electronics, and environment etc.

UNIT – III (16 Hour)

Green Chemistry and it's applications in various fields

Green Chemistry, it's principles and applications in day to day life, Twelve Principles of Green Chemistry; Use of green chemistry for producing environmentally benign chemical products for varied applications.

UNIT – IV (16 Hour)

Designing of Drugs and their development

Discovery and designing of drugs (from concept to marketing); Organic therapeutic agents used in various diseases, their management and economics in market.

Practical component –

1. Three-dimensional modelling of DNA structure using various open access softwares available in public domain; Molecular Dynamics simulation of DNA (very simple and rudimentary coarse grained (CG) models, where DNA can be simulated as rods and proteins as ovoids/ spheres)
2. Understanding of principle, designing, fabrication and application of a nano-biosensor (Examples like glucose biosensors or diagnostic kits for COVID-19 etc. can be studied at length).
3. Simulation of a single nano-particle for understanding it's physical and chemical properties in solution
4. Practical assignments on computer-aided drug design/ In-silico drug designing using databases (like Pubchem, zinc database, drug bank etc.), ligand designing softwares, 2D and 3D structure making open access softwares like chem-draw, chimera, pymol etc. and ligand-target interaction (using various molecular docking softwares).

Essential/recommended readings

1. DNA Beyond Genes: From Data Storage and Computing to Nanobots, Nanomedicine, and Nanoelectronics by Vadim V. Demidov
2. Templated DNA Nanotechnology Functional DNA Nanoarchitectonics, 2019, by Govindraju, T.
3. DNA: The Secret of Life by James Watson
4. Structural DNA Nanotechnology by Nedrian Seeman
5. Nanotechnology: Importance and Applications, January 2019, by M.H. Fulekar
6. Scalable Green Chemistry: Case Studies from the Pharmaceutical Industry, by Stefan Koenig

AEC 01, SEC 01 and VAC 01 will be chosen from the pool of courses offered in CIC/University of Delhi as applicable from time to time.

Semester II

DISCIPLINE SPECIFIC CORE COURSE -4 (DSC-4): Engineering through Linear Algebra

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Engineering through Linear Algebra, DSC-4	4	3	0	1	Class XII pass	Mathematics till XII

Learning Objectives

Almost every area of modern science contains models where equations may be approximated by linear equations and linear algebra plays a vital role for finding their solution and interpreting them. This paper aims to enable the student to learn linear models for various physical problems such as traffic flow, electric-circuit flow etc. and to facilitate their solution using concepts of linear dependence, independence, rank, basis, eigenvalues, eigenvectors etc. This paper intends to provide geometrical interpretation of vectors, basis and vector operations in 2 & 3 dimensions and lays the groundwork for a more abstract, pure-mathematical treatment of vector spaces. Also, the importance and application of eigenvalues, eigenvectors in computer graphics, face recognition and many other fields is taught. Students will also learn how to use MATLAB for some simple matrix operations, for finding eigenvalues & eigenvectors, rank etc.

Learning outcomes

After completing this course, student should be able to;

- Understand graphical representation of vector and their operations in 2 and 3 dimensions
- Solve linear matrix system $AX=B$
- Understand the concept of Eigen values and Eigen vectors and their applications in computer graphics, face recognition algorithms & many other fields
- Conceptualize vector spaces, subspaces and their basis functions

- Understand inner product spaces, orthogonal sets, projection and orthogonal diagonalisation
- Learn basic arithmetic operations of matrices in MATLAB
- Implement basic loops (for, while, if else etc) of programming in MATLAB
- Write their own programs for solving system of linear equations

SYLLABUS OF DSC-4

Unit I: (16 Hour)

Algebra

Algebra of matrices – Review of Determinants - Hermitian, Skew-Hermitian and Unitary matrices - Vectors and vector operations in 2 and 3 dimensions - Solution and application of linear matrix system $AX = B$

Unit II: (16 Hour)

Eigenvalues and Eigenvectors

Eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton theorem and diagonalization

Unit III: (16 Hour)

Abstract vector spaces, subspaces

Finite dimensional vector spaces - Linear independence and dependence of vectors, bases, dimension of vector spaces - Finite dimensional inner product spaces

Unit IV: (16 Hour)

Orthogonality

Orthogonal sets and projections, Gram Schmidt process, orthogonal diagonalisation

Practical component –

Engineering Kitchen Activity (matrix based numerical mathematics software) [Laboratory]

- Basic arithmetic operations, hierarchy of arithmetic operations
- Declaration and assignment of variables
- Introduction to elementary mathematical functions
- Dealing with matrices and arrays
- Basic programming with loops (for, while, switch), if else statements
- Programs for solving system of linear equations, Orthogonalization
- Creating 2D, 3D plots
- Innovation project

Essential/recommended readings

1. *Linear Algebra and its Applications*, D. C. Lay, Addison Wesley, 2005.
2. *A Modern Introduction*, David Poole, *Linear Algebra*, Brooks Cole, 2011.

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

DISCIPLINE SPECIFIC CORE COURSE – 5 (DSC-5): Data Structure and Design

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		
Data Structure and Design, DSC-5	4	3	1	0	Class XII pass	Programming Languages

Learning Objectives

This course objective is to give an understanding of the real world data representation, organisation and structuring to the student while writing the programs and software. The course makes them familiar with the several types of data structures and their strengths and weaknesses, particularly in a real-world situation.

Learning outcomes

- Introduction to Data structure and their significance.
- Practical and theoretical understanding of Dynamic optimization
- Basics of Memory Hierarchy and implementation
- Understanding and implementation of Hashing, Networks and Graphs
- Understanding basics and practical aspects of Searching algorithms in the real world through implementation.
- Introduction and implementation of Heaps and Priority Queues and their comparison with other data structure

SYLLABUS OF DSC-5

Unit I: (16 Hour)

Program and data analysis

Introduction to Data structure, Basic concepts of Correctness, Efficiency and Application, Dynamic optimization Concept, Search Algorithms

Unit II: (16 Hour)

Data items arrangements and processing

Sorting Algorithms, Introduction to Linear Data Structures: Linked List, Stack and Queues

Unit III: (16 Hour)

Hierarchical arrangements and processing

Introduction to Hierarchical Data structure: Tree, Introduction to Heap, Priority Queues and Hashing

Unit IV: (16 Hour)

Network arrangements and analysis

Networks arrangements, Complex systems and real-world studies, Computational analysis

Practical component:

Engineering Kitchen Activity [Laboratory]:

- Implementation of Linked list in C/C++
- Implementation of Trees in C/C++
- Implementation of variant of Trees in C/C++
- Implementation of Heaps in C/C++
- Implementation of Hashing in C/C++
- Implementation of Priority Queues in C/C++
- Implementation of Graph and Network based approaches in C/C++
- Innovation Project

Essential/recommended readings

1. *Algorithms and Data Structures*, N. Wirth, Prentice-Hall of India, 2009
2. *Data Structures and Algorithms in C++*, A. Drozdek, Course Technology, 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– 6 (DSC-6): Object Oriented Programming

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		
Object	4	3	0	1	Class XII	Programming Languages

Oriented Programming, DSC-6					pass	
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Learning Objectives

The objective is to implement real-world entities like inheritance, hiding, polymorphism etc. in programming. To learn how to bind together the data and the functions that operate on them so that no other part of the code can access this data except that function.

Learning outcomes

Upon Completion of this course the students will be able to:

- Recognise features of object-oriented design such as encapsulation, polymorphism, inheritance, and composition of systems based on object identity.
- Use NetBeans, Eclipse, BlueJ as an Integrated Development Environment. Test a program and, if necessary, find mistakes in the program and correct them.
- Take a problem and develop the structures to represent objects and the algorithms to perform operations.
- Name and apply some object-oriented design patterns and give examples of their use.
- Apply standards and principles to write truly readable code.
- Design a class that serves as a program module or package.
- Design applications with an event-driven graphical user interface using java applets.
- Design different android applications such as web apps for the real-world problems.

SYLLABUS OF DSC-6

Unit I: (16 Hour)

Introduction to Java, Introduction to byte code, security and portability, Data Types, variables, operators, arrays, type conversion and casting, type promotion, Control statements, standard input-output, Designing Classes, constructors, methods. access specifiers - public, private, protected

Unit II: (16 Hour) Classes and Objects

Introduction, Class revisited, constant objects and constructor, static data members with constructors and destructors, constructor overloading, nested classes, objects as arguments, returning objects, constant parameters and member functions, static data and member functions

Unit III: (16 Hour)

Inheritance, packages and interfaces and Exception Handling Math, String, polymorphism - function overloading, function overriding, abstract classes, Dynamic objects - Introduction, array of objects, Exception types, nested try-catch, throw, throws and finally statements

Unit IV: (16 Hour)

Multi Thread Programming, Thread creation, synchronization and priorities

Practical component –

Engineering Kitchen Activities [Laboratory]

- Programs implying the use of Arrays, Linked Lists, Strings, Loops
- Programs on Object & Classes from Realistic Environment and Systems
- Programs demonstrating Constructors, Destructors, Methods & other concepts
- Programs Showcasing Inheritance, Polymorphism, Encapsulation & other OOPS features
- Programs on Exception Handling, Packages and Threading
- Reverse Engineering a Java Source/ project/Mobile Application and understanding the concepts
- Mapping the programs with Real life Systems and showcasing the implementation
- Innovation project

Essential/recommended readings

1. *Java: The Complete Reference*, 10th Edition. Herbert Schildt. McGraw-Hill, 2017.
2. *C++: The Complete Reference*, 4th Edition. Herbert Schildt. McGraw-Hill, 2012.
3. *Object Oriented Programming with C++*, 6th Edition. E Balagurusamy. Tata McGraw-Hill, 2001.
4. *C++ For Artists: The Art, Philosophy, and Science Of Object-Oriented Programming*. Rick Miller, Pulp Free Press, 2008
5. *Java For Artists: The Art, Philosophy, and Science Of Object-Oriented Programming*. Rick Miller , Pulp Free Press, 2008

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

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES

NOTE: The core papers offered in the B.Tech. Course at CIC are Mathematics and Information Technology. Therefore, the students will choose GE offered by Physics and Chemistry faculty members of CIC.

GENERIC ELECTIVES (GE-3): Engineering Physics II

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			
Engineering Physics II, GE-3	4	2	0	2	Class XII pass	Engineering Physics I	Physics Faculty of CIC

Learning Objectives

This module intends to provide an understanding of the basics of electrostatics and electrodynamics. It emphasizes on learning of concepts of electric circuits, electromagnets and induction mechanism. Further it gives a day-to-day knowledge of transformers, motors and generators. Also, it provides learning of solar energy usage and its technology. The lab activities provide a hand on experiments on electricity and solar energy. It provides understanding of working of utility devices. It intends to promote projects on robotics and solar energy.

Learning outcomes

- Understanding of physics principles in devices.
- Ability to conceptualize and build electrical devices for real life use.
- Reverse engineering of electrical devices and redesigning of such objects.
- Practical hands-on skills and understanding of simple engineering concepts derived from Electricity & Magnetism.

SYLLABUS OF GE-3

Unit I: (16 Hour) Electricity

Basics of Electrostatics and Electrodynamics - Electric Circuit elements and function - Current, voltage, capacitance, resistance - Power and efficiency in electrical appliances

Unit II: (16 Hour) Electromagnetism basics

Joule heating - Electrical safety devices - Basics of Electromagnetism - Electromagnets and induction - Transformers. DC motors and generators

Unit III: (16 Hour) Electromagnetism applications

AC motors - Using electromagnetic spectrum - Information transfer and broadcasting

Unit IV: (16 Hour) Alternate Energy

Use of Radiation energy and appliances - Photovoltaic cells and conversion of solar energy to electricity - Advantages, limitations and challenges of different solar cell technologies - Different forms of renewable energy and technology.

Practical component –

Engineering Kitchen Activities [Laboratory]

- Electric circuit, power requirement, cost of electricity, energy efficiency of sample appliances
- Potential divider, measurement of resistances of different scales
- Build a buzzer
- Conversion of solar power to electricity using photovoltaic cells: design, working principle, performance, application
- Build an autonomous robot
- Build a remote-controlled robot
- Understanding physics of devices – one implementation of “Tod-Phod-Jod” concept.
- Innovation project – designing instruments, devices, model & prototyping

Essential/recommended readings

1. *Introduction to Electrodynamics*. David. J. Griffiths, PHI Learning, 2012
2. *Textbook of Electrical Technology* – Volume I & II. B. L. Thareja, and A. K. Thareja, S. Chand Publishing, 2006

GENERIC ELECTIVES (GE-4): Engineering Chemistry II

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
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		Lecture	Tutorial	Practical/ Practice			
Engineering Chemistry II, GE-4	4	2	0	2	Class XII pass	Engineering Chemistry I	Chemistry Faculty of CIC

Learning Objectives

This course has an aim of making students aware of the structure and properties of engineering materials, polymers and composites, which are most commonly used around us for various applications daily. Also, an elaborative discussion will be done, on one of the most important constituents of life i.e. water, its properties, types, analysis etc., so that aspects related to water impurities and its different types of treatment methods become clear to them and they can further contribute towards the cause of providing this basic amenity to our society, as and when they get a chance, either by indulging themselves in research with academia or industry. At the end, students will be exposed to various characterization instrumentation techniques, through which they should be able to get a better understanding about various kinds of materials (biomolecules, drugs, nanomaterials etc.)

Learning outcomes

- Students will develop a good understanding about the engineering materials, polymers and composites which are used in our daily life.
- Knowledge about one of the basic amenities of life i.e. water will be enhanced, so that students can further contribute towards solving various related problems in due course of life.
- Further, through learning characterization techniques, students will be able to understand better about various kinds of materials like nanomaterials, drugs and biomolecules.

SYLLABUS OF GE-4

Unit-I. (16 Hour)

Engineering Materials, Polymers and composites

Glass, Ceramics, Magnetic materials, Classification, functionality, general properties and types of polymers; (addition polymerization, step polymerization, copolymerization) Different types of polymers; natural and synthetic polymers; Linear, branched and cross-linked polymers; Thermoplastic and thermosetting polymers, their applications; Plastics: Properties of Polyethylene Plastics; Vinyl Plastics, Nylons, Phenol-formaldehyde resins (Bakelite) and Glyptal; Speciality Polymers: Engineering thermoplastics, Conducting polymers, Electroluminescent

polymers, liquid crystalline polymers and biodegradable polymers.

Unit-II. (16 Hour)

Analysis of Water

Analytical aspects of water: Sources, conservation of water, impurities in water and their effects. WHO guideline and BIS guideline for drinking water. Water quality standards, physical, chemical and biological characteristics; hardness of water, disadvantages of hardness, determination of hardness (EDTA method). Alkalinity and its determination; Boiler problems with hard water and their prevention: Municipal water supply – its treatment and disinfection using break -point chlorination. Desalination, Reverse Osmosis, Electrodialysis and defluoridation of water.

Unit-III. (16 Hour)

Material characterization Techniques

Spectroscopy, General features of spectroscopy, Discussion on various kinds of spectra obtained using various spectroscopic techniques like UV-Visible spectroscopy, Fourier-Transform Infra- red spectroscopy, Fluorescence spectroscopy, Circular Dichroism spectroscopy etc.

Unit-IV. (16 Hour)

Nanomaterials and their Characterization

Characterization of Nanomaterials using UV-Visible Absorption spectroscopy, Fourier Transform Infra-red spectroscopy, Transmission electron microscopy (TEM), Scanning Electron Microscopy and FESEM etc.

Practical component –

1. Experimental demonstration of the synthesis of various types of polymers (like nylon, rayon fibre/ artificial silk etc.)
2. Molecular dynamics simulation of small molecules like water using softwares like LAAMPS
3. Demonstration of different experiments for determination of hardness of water

4. Interpretation and analysis of experimental data/ figures of various structures (biomolecules, and nano-structures) from some already published research papers/ reviews for understanding various spectroscopic and physicochemical techniques

Essential/recommended readings

1. Engineering Materials: Polymers, Ceramics and Composites, 2nd ed. Kindle Edition by A.K. Bhargava
2. Engineering Chemistry by O.G. Palanna, McGraw Hill, 2017.
3. Water Treatment (Hardness of Water) by Subodh Bhandarkar
4. Materials Science and Engineering: An Introduction, by Callister, 8th Edition, John Wiley and sons inc., Jan 2010.
5. Plastics Materials, Newness, Butterworths and Brydson, J.A., London, 1975
6. Spectroscopy and Characterization of Nanomaterials and Novel Materials: Experiments, Modelling, Simulations, and Applications, by Prabhakar Misra
7. Optical Properties and Spectroscopy of Nanomaterials, 2009 by Jin Zhong Zhang

Semester III

DISCIPLINE SPECIFIC CORE COURSE -7 (DSC-7): Modeling continuous changes through ordinary differential equations

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical / Practice		
DSC-7 Modeling continuous changes through ordinary differential equations	4	3	0	1	Class XII with Mathematics	NIL

Learning Objectives

Differential equations have the remarkable ability to translate the real-world problems in mathematical language. This course enables students to study many engineering systems, population dynamics in ecology and biology, mechanics of particles in physics, planetary models etc. involving differential equations. The main objective of the paper is to first analyze and understand the real-world problem through a mathematical lens and then develop the corresponding mathematical model with differential equations in the most realistic sense. Once governing equations are obtained, students should be able to solve them analytically and analyze the solution in physical situations. Students will use MATHEMATICA software for the purpose of simulation.

Learning outcomes

After completing this course, student will be able to:

- explain the fundamental concepts of ordinary differential equations (ODEs).
- use MATHEMATICA software to solve problems and applications of ordinary differential equations (ODEs) and complex analysis.
- formulate real life problems as ODEs.
- use concepts of ordinary differential equations to solve physical models such as mass spring, pendulum, alternating current circuits, etc.
- Use knowledge of ODEs, the general and particular structure of solutions and different methods for solutions.

SYLLABUS

Unit I: First Order Differential Equations

Review of first order differential equations - Variable separable, homogeneous, linear, exact differential equation - Integrating factors - Existence and uniqueness of solution [12 hours]

Unit II: Second and Higher Order Differential Equations

General solutions of second order differential equation - Homogeneous and non-homogeneous differential equations with constant coefficients - Method of variation of parameters - Method of undetermined coefficients, higher order differential equations with constant coefficients [12 hours]

Unit III: Planar Autonomous Systems

Planar autonomous linear systems with graphical representation - Determination of stability and classification of equilibrium of a planar nonlinear system by linearization [9 hours]

Unit IV: Power Series Solutions

Power series solution about a regular point of an analytic ordinary differential equation - Power series solution of Legendre and Bessel's equation - Laplace transform and its application to differential equations [12 hours]

Practical component – [30 hours]

The following explorations would be carried out on matrix based numerical mathematics software:

- Plotting of slope fields and solution curves of first order and higher order differential equations
- Graphical analysis of solution of Population model, Pollution Model, Acceleration – Velocity Models
- Projectile motion, Mechanical Vibrations – Motion of Simple Pendulum, Free undamped and damped motion, Forced undamped and damped motion
- Plotting of phase plane diagrams for predator – prey model, competing species, epidemic model and their analysis
- Innovation project

Essential/recommended readings

- Elementary differential equations and boundary value problems, W. E. Boyce and R. DiPrima, John Wiley, 2009.
- Differential equations and boundary value problems: Computing and modeling, C.H. Edwards and D.E. Penny, Pearson education (Singapore), Pte. Ltd., 2008.
- Advanced engineering mathematics, E. Kreyszig, John Wiley, 2015.

DISCIPLINE SPECIFIC CORE COURSE -8 (DSC-8): Operating 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		
DSC-8 Operating Systems	4	3	0	1	Class XII pass	Programming languages

Learning Objectives

The objective is to introduce students with basic concepts of Operating System, its functions and services and to familiarize the students with various views and management policies adopted by O.S. as pertaining with processes, Deadlock, memory, File and I/O operations. To brief the students about the functionality of various OS like Unix, Linux and Windows XP as pertaining to resource management and to provide the knowledge of basic concepts towards process synchronization and related issues.

Learning outcomes

After completing this course, student will be able to;

- Understand the Mutual exclusion, Deadlock detection and agreement protocols of Distributed operating system.
- Conceptualize the components involved in designing a contemporary OS.
- Analyze the structure of OS and basic architectural components involved in OS design.
- Analyze and design the applications to run in parallel either using process or thread models of different OS.
- Analyze the various device and resource management techniques for timesharing and distributed systems.

SYLLABUS

Unit I: Introduction

Overview: Operating systems – structure, operations, components, types, services, user interfaces. System calls, system programs, system boot. [12 hours]

Unit II: Process management

Processes: concept, scheduling, operations on processes, inter-process communications. Threads – single - and multi-threaded processes. CPU scheduling – criteria, algorithms, multiple-processor scheduling. [12 hours]

Unit III: Process synchronization

Critical-section problem, semaphores, classic synchronization problems, monitors. Deadlocks – characterization, deadlock prevention, deadlock avoidance, deadlock detection, recovery from deadlock. [12 hours]

Unit IV: Memory management

Main memory – memory allocation schemes.

[9 hours]

Practical component:

[30 hours]

- Write a program for implementation of Priority scheduling algorithms, Round Robin scheduling algorithms, FCFS scheduling algorithms, SJF scheduling algorithms.
- Write a program to implement the producer – consumer problem using semaphores, IPC using shared memory, banker's algorithm for deadlock avoidance, Threading and Synchronization Applications.
- Write a simple Unix commands.
- Innovation Projects

Essential/recommended readings

- Operating System Concepts, 10th Edition, Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, John Wiley & Sons, 2018.
- Manish Kumar Singh, Sachin Kumar, Saibal Kumar Pal, Operating Systems: Concept Building & Problem Solving Approach, Cengage Publication, 2022.
- John. Lions' Commentary on UNIX® 6th Edition with Source Code. John Lion, San Jose, CA: Peer-to-Peer Communications, 1996.
- Exokernel: An Operating System Architecture for Application-Level Resource Management., Engler, Dawson R., M. Frans Kaashoek, and James O'Toole Jr., ACM Press, 1995.

DISCIPLINE SPECIFIC CORE COURSE -9 (DSC-9): Computer Systems Architecture

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSC-9 Computer Systems Architecture	4	3	0	1	Class XII with Mathematics	NIL

Learning Objectives

The objective is to introduce students with the basic concepts of Computer and the principles underlying systems organization, issues in computer system design, and contrasting implementations of modern systems and to familiarize the students with a fundamental knowledge of computer hardware and computer systems, with an emphasis on system design and performance.

Learning outcomes

After completing this course, student will be able to;

- understand Computing Systems, Models & Logic, Organization & Architecture of Memory
- develop an understanding of CPU, I/O Devices, Distributed Computing, Parallel Architecture, Mobile Systems Architecture
- understand about Deconstructing Digital Architecture of a computing devices and study of components (Hardware/Software)
- get hands-on experience with Arduino/ARM Interface, Programming & interfacing with Sensors and Parallel Programming using OPENMP, OpenMPI & CUDA.

SYLLABUS

Unit I: Computer arithmetic:

Fixed point and floating-point representation and arithmetic, numbers conversion. Digitals circuits: Boolean algebra, logic gates, logical synthesis by minimization of Boolean functions
[12 hours]

Unit II: Input-Output Organisation

Combinational circuits, sequential circuits (synchronous and asynchronous). Construction of the computer: Von Neumann Architecture
[12 hours]

Unit III: Memory Organisation

Organization and architecture of memory systems, input/output systems
[12 hours]

Unit IV: Construction of the simple processor.
[9 hours]

Practical component:
[30 hours]

- Logic Gate Designs
- Deconstructing Digital Architecture of a computing devices and study of components (Hardware/Software)
- Hands on experiments with Arduino/ARM Interface
- Programming in Assembler: memory addressing, interrupts, operations on numbers bits and tables, conditional instructions, loops, input/output

Essential/recommended readings

- Computer System Architecture, Morris Mano, Pearson Education, 2008
- Computer Systems Architecture: a Networking Approach, Rob Williams, Pearson Education, 2011
- Advanced Computer Architecture: Parallelism, Scalability, Programmability, K. Hwang, McGraw Hill, 2017.

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES

NOTE: The core papers offered in the B.Tech. Course at CIC are Mathematics and Information Technology. Therefore, the students will choose GE offered by Physics, Chemistry, Management and Computational Biology faculty members of CIC.

GENERIC ELECTIVES (GE-3.1): Economic Behaviour

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 3.1; Economic Behaviour	4	3	1	0	Class XII pass	NIL	Management Faculty of CIC

Learning Objectives

The purpose of this course is to familiarize the student with the present day modern economics that is both intuitive and relevant to the students. The course introduces the generally accepted concepts of economics both at the micro and macro level. In addition to this, the purpose of this course is to analyse how individual decision-makers, both consumers and producers and the government policies, behave in a variety of economic environments.

Learning outcomes

After completing this course, student will be able to:

- understand the basic structure of the economic ecosystem.
- Conceptualize how individuals and firms allocate resources and how market prices are determined.
- understand shifts in supply and demand and their implications for price and quantity sold.
- analyse firms' decisions mathematically using a production function and calculate their optimal level of production, costs, and profits.
- Learn to model the decisions made by firm in a monopoly and an oligopoly, and the implications of these alternate structures for consumer welfare.
- Learn to perceive the nation's economy as a whole and compare the views of Keynes and the classical economists.
- Learn various techniques measuring and tracking macroeconomics using GDP and CPI.
- Analyse the model of full employment and use it to examine important macroeconomic issues, such as the extent to which taxes may depress economic activity and lower the level of GDP.

SYLLABUS

Unit I: The Economic Problem

Scarcity and Choice; Market economies and the price system; Variables, correlation and causation; Recommending appropriate policies [8 hours]

Unit II: The supply and demand model

Elasticity of supply and demand; Market equilibrium; Demand curve and behaviour of consumers; Supply curve and behaviour of firms [11 hours]

Unit III: Efficiency of markets

Rise and fall of industries; Monopoly; Antitrust policy; Taxes, transfers and income distributions [11 hours]

Unit IV: Macroeconomics

Unemployment, inflation and interest rates; Macroeconomic theory and policies; Measuring theoretical and actual GDP [15 hours]

Essential/recommended readings

- Principles of Economics, J.B. Taylor and A. Weerapana, Flatworld, 9th Edition, 2021.
- Principles of Economics, K. E. Case, R. C. Fair and S. C. Oster, Pearson Education, 13th Edition, 2019.
- Principles of Economics, N. G. Mankiw, Cengage, 9th Edition, 2021.

GENERIC ELECTIVES (GE-3.2.): Electronic Circuit elements and innovation lab

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 3.2.; Electronic Circuit Elements and Innovation Lab	4	2	0	2	Class XII pass	Mathematics till XII	Physics/ Electronics Faculty of CIC

Learning Objectives

This module involves interactive learning of A.C. fundamentals. It helps to understand the basic network analysis of electronic circuits. It also provides the interface to understand the working of various electronic devices and its characteristics. Working of electronic instruments will also be understood.

Learning Outcomes

After completing this course, student will be able to;

- understand the concepts of AC fundamentals
- gain good knowledge of Network Analysis
- understand the basics of Diodes and Transistor based devices
- knowledge about instruments like CRO, Function Generator, Multimeter, etc.

SYLLABUS

Unit I: AC Fundamentals

Concept of voltage and current sources - KVL and KCL - Node voltage analysis and method of mesh currents - Network theorems [8 hours]

Unit II: Transistors

PN Junction: variants and applications - Bipolar Junction Transistor (BJT) biasing and amplifier design - Field Effect Transistor (FET) variants – FET biasing and amplifier design [6 hours]

Unit III: Structure and working of SCR. Structure and operation of LDR, Photo voltaic cell, Photo diode, Photo transistors & LED [8 hours]

Unit IV: Operational Amplifiers basics and practical circuits - Feedback and oscillator circuits - Voltmeters-Multimeters-Function generator- Cathode ray oscilloscope - Cathode Ray Tube [8 hours]

Practical component –

[60 hours]

- Characteristics of PN junction and Zener diode filters
- Half wave rectifier.
- Full wave rectifier with 2 diodes.
- LC and Pi filters
- Full wave rectifier with 4 diodes (Bridge rectifier). Input, Output and Transfer characteristics of CE and CC Amplifier.
- Amplifiers and Oscillator characteristics.
- Characteristics of LDR, Photo-diode and Phototransistor.
- Transfer characteristics of JFET.
- Transfer characteristics of MOSFET (with depletion and enhancement mode)
- Characteristics of LED with three different wavelengths.
- Series voltage Regulator.
- Shunt voltage Regulator.
- Characteristics of Thermistor.

Essential/recommended readings

- Circuits and Networks - A. Sudhakar & Shyammohan S. Palli ,TMH, 2017
- Principles of Electronics- V.K. Mehta and Rohit Mehta, S Chand &Co, 2014
- Electronic Devices and Circuit Theory-R.L. Boylestad and L.Nashelsky, Pearson Education, 2009.

GENERIC ELECTIVES (GE-III.4.3.): Flow of information in 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 3.3.; Flow of Information in Living Systems	4	2	0	2	Class XII pass	NIL	Chemistry / Biology Faculty of CIC

Learning Objectives

This module is designed to:

- Introduce students to nuclear events such as replication, transcription, translation, condensation, repair and recombination etc.
- Introduce gene regulation in prokaryotes and eukaryotes
- Introduce various biophysical and biochemical techniques related to these nuclear events

Learning Outcomes

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

- Understand the structure and function of DNA and RNA
- Build concepts about the processes of the Central Dogma of the living systems (replication, transcription, translation, recombination etc.)
- Develop an understanding of prokaryotic and eukaryotic gene regulation

SYLLABUS

Unit I: Structure and properties of the nucleic acids

Structure and biophysical properties of the DNA and RNA, forms of DNA and RNA, DNA binding domains [8 hours]

Unit II: Replication, Transcription and Translation

DNA replication models, Enzymes of DNA replication, DNA replication in prokaryotes and eukaryotes, regulation of DNA replication; [8 hours]

RNA polymerases, Transcription in prokaryotes and eukaryotes, Regulation of transcription in Prokaryotes and Eukaryotes, Eukaryotic chromatin; Ribosomes; translation in prokaryotes and eukaryotes

Unit III: DNA repair and recombination

DNA damage and repair, Molecular recombination [8 hours]

Unit IV: DNA packaging and chromatin structure, regulation of gene expression in eukaryotes
[6 hours]

Practical Component

[60 hours]

- Agarose gel electrophoresis of DNA/ Proteins
- SDS-PAGE Electrophoresis
- Polymerase Chain Reaction (PCR)
- Primer design
- Spectrometry (Experiments based on DNA/ protein interactions with ligands)
- Modelling of DNA and RNA forms and motifs through computational tools
- Innovation Projects

Essential/recommended readings

- Nucleic acids in Chemistry and Biology; G. Michael Blackburn, Martin Egli, Michael J. Gait; RSC Publisher, 2022
- Molecular Biology of the Cell; Bruce Alberts, Rebecca Heald, Alexander Johnson, David Morgan, Martin Raff, Keith Robert, Peter Walter 2022
- Biology, Raven et al. Tata Mc Graw –Hill, 2016
- Biology: Global Approach. Reece et al., Pearson Educations, Global edition, 2020
-

GENERIC ELECTIVES (GE-3.4.): The Living world: Systems Approach

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.; The Living world: Systems Approach	4	2	0	2	Class XII pass	NIL	Chemistry / Biology Faculty of CIC

*This paper 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 hierarchical 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
- comprehend different fields within Bio-Sciences
- gain knowledge about experimental processes undertaken in Biology
- 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 [8 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 [8 hours]

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

Unit IV: Tools and materials for studying living systems [8 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.

Practical components [60 hours]

Basic equipment and techniques

- a. Observation of 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

Essential/recommended readings

- Biology, Raven et al., Tata McGraw-Hill, 2016.
- Biology: Global Approach. Reece et al., Pearson Educations, Global edition, 2020.

DISCIPLINE SPECIFIC ELECTIVE COURSE -1 (DSE-1) III. 4.5 Health Data Analysis

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		
Health Data Analysis [#] DSE-1,	4	0	0	4	12 th Pass	NIL

This course will also be available to the students in semester V

Learning Objectives

This is a practical based module is designed to:

- Introduce students to the complexity of data related to health and diseases.
- Introduce to the students the method of collection of data, their visualization and analysis

Learning outcomes

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

- Comprehend and handle complex data related to health and diseases, which are usually large.
- Do survey-based research for data collection, their visualization by different methods and their analysis including the statistical analysis

Syllabus

Practicals -

(120 Hours)

- Art and Science of preparation of questionnaire for collection of health data: types and ethical consideration
- Types of data: Likert scale data and quantitative data related to health and diseases their collection methods
- Understanding how data is organized to facilitate analysis in the healthcare setting.

- Data visualization through histograms and tables
- Data visualization through heat maps
- Integration, understanding and selection of appropriate data visualization techniques to effectively communicate results
- Identifying ways in which data quality can be compromised and applying remedies
- Evaluation of data from varying sources to create meaningful presentations.
- A survey-based research on epidemiology and public health by collecting real data from the field area. It will include study designing, data collection, visualization and analyses of the data
- The results will be used for the preparation of a project report/manuscript.

Essential/recommended readings

- Introduction to Data Science in Healthcare Reading:
<https://www.r2library.com/Resource/detail/1584265329/ch0007s0170>
- Analytics and (Precision Medicine) Decision Support Reading:
<https://www.r2library.com/Resource/detail/0128006811/ch0014s0163>
- Hype Cycle for Healthcare Providers, 2019 (Gartner) Reading: Pages 3-7
- <https://www.r2library.com/Resource/detail/0340950056/ch0004s0092>
- Principal components analysis
<https://www.r2library.com/resource/detail/0803625642/ch0006s0141>
- ANOVA <https://www.r2library.com/Resource/detail/0781781531/ch0015s0490>

DISCIPLINE SPECIFIC ELECTIVE COURSE -1 (DSE-1)

III. 4.6. Game Development using UNITY

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		
Game Development using UNITY [#] , DSE 1,	4	0	0	4	Class XII pass with Mathematics	C ⁺⁺

This course will also be available to the students in semester V

Learning Objectives

The Learning Objectives of this course are

- to introduce the students to the game engine platform UNITY

- to give a basic on how to develop a game using this game engine.
- to design, develop and finalize a game on either an Android or an IOS platform

Learning outcomes

This course gives students an insight into developing a game either on a mobile or a desktop platform. Upon completion of the course the students would be able to-

- Possess basic ability to convert game idea into a working prototype
- Learn basic techniques for animation and simulation
- Extend the concept of game development on Web, console or VR platforms
- Develop a creative and aesthetic mindset by creating a good-looking functional UI for the developed game

Practicals -

(120 Hours)

The course will be conducted completely on a hands-on mode. The basic concepts will be explained and each concept will be augmented by small tasks initially on UNITY before designing and developing a game. The following tasks will be performed in lab:

- Introduction to Unity's Interface and Unity's Basics
- Rigid Bodies and Colliders
- Audio Source and UI Elements
- Moving Character with Code
- Introduction to Variables; Operations with Variables; Functions; Conditional Statements; Loops; Coroutines; Classes
- Creating animations, simulations and background
- Designing, developing and finalizing a game

Essential/recommended readings

- *Learning C# by Developing Games with Unity 5.x*, G. Lukosek, Packt publishing Ltd, 2016
- *Developing 2D Games with Unity: Independent Game Programming with C#*, Jared Halpern, Apress, 1st Edition, 2018
- *Unity in Action: Multiplatform Game Development in C# with Unity 5*, Joe Hocking, Manning publications, 3rd Edition, 2022
- *Unity From Zero to Proficiency (Foundations)*, Patrick Felicia, LPF publishing, 4th Edition, 2015

DISCIPLINE SPECIFIC ELECTIVE COURSE -1 (DSE-1)

III. 4.7. 3D printing using Blender

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		
3D printing using Blender [#] , DSE 1,	4	0	0	4	Class XII pass with Mathematics	NIL

This course will also be available to the students in semester V

Learning Objectives

- To introduce the students to Blender
- to understand the basic concepts of 3D modelling and printing using Blender
- to identify the pitfalls in 3D printing
- to apply the slicing techniques and generate G code

Learning outcomes

This course gives students an insight into using the free and open source ware Blender for 3D printing. Upon the successful completion of the course the students are expected to generate 3D models of some simple objects like flower vase, geometrical figures, tessellation tiles, bottle lids, etc.

Practicals -

(120 Hours)

The course will be conducted completely on a hands-on mode. The basic concepts will be explained and each concept will be augmented by small tasks initially on Blender before moving on to 3D printing. The following tasks will be performed in lab:

- Introduction to the User Interface and navigation in blender
- Creating simple geometrical objects like planes, cube, cylinder, cone, spheres, spirals, etc. on blender
- Movement, scaling and rotation transformations
- Simulation, animation and rendering
- Polygonal modelling for 3D printing
- 3D printing of simple geometrical objects
- Moving on to more complex 3D printing

Essential/recommended/ suggested readings

1. *Blender 3D printing tutorials for beginners*,
<https://all3dp.com/2/blender-3d-printing-tutorial/>
2. *Blender for 3D printing design*

https://www.youtube.com/watch?v=5CyaeBBQIkc&list=PLvCZK2JGQINt8uEM5_J12Qj7eO5MqV03

3. *3D printing from zero to hero in Blender*

<https://www.udemy.com/course/learn-3d-printing/>

DISCIPLINE SPECIFIC ELECTIVE COURSE -1 (DSE-1)

III. 4.8. IT Project Leadership

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit-distribution of the course			Eligibility criteria	Prerequisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
IT Project Leadership [#] , DSE 1, III.4.8	4	0	0	4	12 th Pass	NIL

This course will also be available to the students in semester V

Learning Objectives

The key focus of this project-based course is to develop a deep understanding of facilitators and obstructions while developing and managing IT developments as a product and its life cycle. Innovations in IT have led some businesses to flourish, while others have faltered due

to massive changes brought by information technology. IT is hard to manage, therefore understanding its applications, planning and management are ensuring intended changes where innovations are realized and the unintended ones are kept under control. The course covers information system, information management, IT strategy, and IT governance

Learning outcomes

After completing this course, student should be able to;

- contribute to information system planning and strategy formulation in corporate enterprises and complex administrations.
- have a deeper understanding of a socio-technical approach to the deployment of IT in organisations
- understand frameworks for analysing strategic issues of IS deployment and a familiarity with the most relevant current issues.
- develop insight into cases of the strategic planning of information systems often demand

Syllabus

(120 Hours)

Practical -

- Understanding IT and software characteristics and applications. processes, methods and tools. Scenario based view of IT manager's role and KRA's.
- Understanding evolving IT landscape and dynamics, IT and networking as applied to enterprises in public and commercial sector.
- Software management, Software life cycle, Process and Project metrics, Software quality management and assurance, software cost estimation, the make or buy decision, Automated estimation tools.
- IT enabled products or services, ITIL service management model, software as a service, software as a platform, IT service strategy, new service designing and development process, common IT setups and Systems.
- Fundamental aspects of daily IT operations, human factors in organization, acquisition and procurement, research and Development, Logical planning.
Managing digital networks and security.
- Management Information Systems, Strategic planning in regulated and competitive IT industries, the management and marketing of a technology-based enterprise,
- Evaluating their legal constraints, responsibilities and ethics, Social and ethical aspects of IT, The principles and methods of asset valuation, Interpretation and measurement, financial statements risk assessment, Capital market, Capital budgeting and the effects of economic regulation on capital formation, IT Policy and Regulation

Essential/recommended readings

- Managing the Internet of Things: Architectures, Theories, and Applications Editors: Jun Huang & Kun Hua, Chongqing University, China & Lawrence Technological University, USA, ISBN9781785610288.
- "Management" by Stoner J A and Freeman R E, ISBN 10: 8131707040 / ISBN 3: 9788131707043
- "Management: Principles and Practice" by S K Mandal ISBN: 9788184952209, 8184952201 Edition: 1stEdition, 2011, Pages: 500.
- "Principles and Practices of Management" by Khusboo Manoj ISBN-10: 9380921128
ISBN-13: 978-9380921129.
- "Principles and Practice of Sport Management" by Carol A Barr, ISBN-13: 9781284034172 Product With Access Code, 606 pages.

DISCIPLINE SPECIFIC ELECTIVE COURSE -1 (DSE-1)
III.4.9. Fabrication of nanomaterials for devices

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		
Fabrication of nanomaterials for devices [#] , DSE-1,	4	1	0	3	Class XII pass	Basic knowledge of science

This course will also be available to the students in semester V

Learning Objectives

This course is designed to expose students regarding the fabrication and applications of various types of nanomaterials. Students will be performing hands-on experiments and will get themselves acquainted with the fascinating world of nanotechnology and its interdisciplinary applications.

Learning outcome

Through this paper, students would be learning:

- About the basics of nanomaterials and characterization techniques
- To fabricate nanomaterials using chemical or green synthesis
- To characterize nanomaterials using various physicochemical techniques
- To explore the interdisciplinary applications of fabricated nanomaterials in electronic devices, optical devices, computing devices, health devices, drug delivery, environmental remediation and energy etc.

Syllabus

Theory

(15 Hours)

Introduction of Nanoscience and nanomaterials; synthesis (Chemical as well green methods) and characterization techniques (including spectroscopic, X-RD, Zetasizer, electron micrography etc.); Discussion on basic, innovative and recent advancements in the field of nanostructures / Nano-formulations/ Nano-devices / Nano-sensors etc. for targeting various applications related to the interdisciplinary fields

Practicals -

(105 Hours)

- Identifying a research problem based on fabrication of devices using nanotechnology
- Identifying the requirement of type of nanomaterials (nanoparticles, quantum dots, nanostructures etc.) depending upon their physical and chemical properties as per the identified research problem
- Chemical or green synthesis of nanomaterials based on the selective, identified protocols, which may later be modified for the novel method of synthesis

- Characterization of nanomaterials using various physicochemical techniques like UV-absorption spectroscopy, FT-IT spectroscopy, X-ray diffraction, Zetasizer, Dynamic light scattering, Scanning electron microscope (SEM), HR-TEM, FESEM etc. for understanding their size, shape, charge, morphology etc.
- Exploring the role of fabricated nanomaterials in electronic devices, optical devices, computing devices, drug delivery, environmental remediation and energy etc.

Essential/recommended readings

- Nanotechnology For Dummies; By Richard D. Brooker, Earl Boysen (2011), Wiley Publisher
- Nanotechnology: An Introduction; By Jeremy Ramsden (2011), Elsevier Science Publisher
- Research papers and reviews from journals of international repute like Nanotechnology Reviews (NTREV) journal, NANO Reviews, Nature Nanotechnology

Semester IV

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	12 th 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
- Innovation Project

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.

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	0	1	Class XII pass	Programming Fundamentals

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 **[12 hours]**

Unit II: Sorting methods analysis – Randomization – NP Completeness – Advanced data structure **[12 hours]**

Unit III: Geometric algorithms – Graph algorithms – Linear Programming – Design paradigm such as Divide & conquer **[10 hours]**

Unit IV: Dynamic Programming – Greedy Approaches – Search heuristics – Approximation algorithms – Compression and streaming algorithms – Distributed and parallel algorithms. **[11 hours]**

Practicals - [30 Hours]

Write program to perform

- operation count for a given pseudo code

- Bubble sort for any given list of numbers.
- Insertion sort for any given list of numbers.
- Quick Sort for the given list of integer values.
- Merge Sort on the given two lists of integer values.
- Binary Search for a given set of integer values recursively and non-recursively.

Write program to find

- Maximum and Minimum of the given set of integer values.
- a solution for the knapsack problem using greedy methods.
- the minimum cost spanning tree using Prim's Algorithm.
- the minimum cost spanning tree using Kruskal's Algorithm.
- a solution for job sequencing with deadlines problem.

Write program

- for all pairs shortest path problems.
- to solve the N-QUEENS problem.
- to solve the Sum of subsets problem for a given set of distinct numbers.

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.

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	12 th 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 – MongoDB - 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, McGraw Hill, 2010

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES

NOTE: The core papers offered in the B.Tech. Course at CIC are Mathematics and Information Technology. Therefore, the students will choose GE offered by Physics, Chemistry, Management and Computational Biology faculty members of CIC.

Credit distribution, Eligibility and Pre-requisites of the Course

GENERIC ELECTIVES (GE-IV.4.1): Strategies and Concept for Innovation Management							
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 IV.4.1.	4	3	1	0	12 th 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. **[11 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 **[10 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. **[12 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 **[12 hours]**

Essential/recommended readings

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

GENERIC ELECTIVES (GE-IV4.2): 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 IV.4.2.	4	2	0	2	Class XII pass	Basic knowledge of science	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 basics of analog and digital electronics. The emphasis is on basic electronics components and devices and their application in real world.

Learning Outcomes

After the completion of the course, the students will be familiarized with

- concepts of Electronics.
- following analog electronic components and their identification: resistor, capacitor, inductor, power source, transducer, sensor, detector, switch, Potentiometer - Integrated Circuit – Transformer;
- 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
- following semiconductor devices, circuits and their identification: PN Junctions characteristics, Zener and Avalanche breakdown, diode applications, transistor & applications. Operational Amplifier (Op Amp): inverting and noninverting amplifier, integrator, differentiator, summing amplifier.
- practical and circuit simulations to understand basic electronics circuits used in everyday life.

SYLLABUS

Unit I: Analog World: resistor, capacitor, inductor, power source, transducer, sensor, detector, switch – Potentiometer - Integrated Circuit – Transformer. **[10 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. **[10 hours]**

Unit III: Semiconductor Devices: PN Junctions characteristics, Zener and Avalanche breakdown, diode applications, transistor & applications. Operational Amplifier (Op Amp): inverting and non-inverting amplifier, integrator, differentiator, summing amplifier. **[10 hours]**

Practicals -

[60 Hours]

- Design basic electric switch board used in home
- Simulation of rectifier circuit
- Designing device charging circuit
- Deconstructing mobile charger circuit
- Simulation of CE amplifier circuit
- Designing basic amplifier circuit using transistors
- Simulation of phase shift oscillator circuit
- Designing of oscillator circuit for frequencies in audio range
- Simulation of digital clock circuit
- Innovation Project: Deconstructing mobile phone circuit

Recommended/ Suggested Readings:

- Electronic Principles. Albert Paul Malvino, McGraw-Hill, 1998
- Electronic Devices & Circuit Theory. Robert L. Boylestad, and Louis Nashelsky, Pearson Education, 2009
- Digital Logic and Computer Design. M. Morris Mano, Pearson Education, 2008
- Signals and Systems. Alan V. Oppenheim, Alan S. Willsky, and Nawab S. Hamid, Prentice Hall, 1997
- Art of Electronics. Paul Horowitz, and Winfield Hill, Cambridge University Press, 2008
- Practical Electronics for Inventors, Fourth Edition – by Paul Scherz and Simon Monk, Mc Graw Hill Education, 2022

GENERIC ELECTIVES (GE-IV.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			
<i>In Silico</i> Biology, GE IV.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

- Bioinformatics: Sequence and genome analysis, David mount, Cold Spring Harbor Laboratory Press; 2nd edition, 2013.
- Introduction to Bioinformatics, Arthur M. Lesk, OUP Oxford, 4th edition, 2014.
- Bioinformatics and Functional Genomics, Jonathan Pevsner, Wiley-Blackwell, 3rd Edition, 2015.

GENERIC ELECTIVES (GE-IV.4.4): The Living world: Systems Approach

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 IV.4.4 The Living world: Systems Approach	4	2	0	2	Class XII pass	NIL	Chemistry/ Biology Faculty of CIC

***This paper 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 hierarchical 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 of 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

Essential/recommended readings

- Biology, Raven et al., Tata McGraw-Hill, 2016.
- Biology: Global Approach. Reece et al., Pearson Educations, Global edition, 2020.

DISCIPLINE SPECIFIC ELECTIVE COURSE -2 (DSE-2) IV.4.5. Mathematical modelling & 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 (if any)
		Lecture	Tutorial	Practical/ Practice		
Mathematical modeling & simulation[#] DSE-2, IV.4.5	4	0	0	4	12th pass with Maths	Linear Algebra, Differential Equations

This course will also be available to the students in semester VI

Learning Objectives

This interactive learning module intends to provide capabilities and basic understanding of system modelling and simulation performance. It will emphasis on analysis of dynamical behavior of physical, electrical, mechanical, social, biological, chemical, and financial systems along with applications in engineering and other applied sciences. The simulation will be done with the MATLAB software platform.

Learning outcomes

- After completing this course, student should be able to;
- Understand the mathematical and computational tools for modelling and simulation of various systems.
- Apply basic concepts of fractional calculus.
- Identify, model analyze, and simulate various systems using simulation tools.
- Know how the simulation help to analyze system graphically.
- Describe the behavior of different physical and virtual systems.

Syllabus

Practicals –

(120 Hours)

- Modeling of integer and non-integer systems
- Introduction to basic simulation tools
- Simulation performance of integer and non-integer systems
- Chaotic behavior of integer and non-integer systems

- Parameter optimization to improve the efficiency of the system
- Model validation and performance analysis with data
- Innovation Project

Essential/recommended readings

- Theory of modeling and simulation, Zeigler B.P., Praehofer. H., Kim I. G., 2nd Edition. Academic press, 2000.
- Theory of Fractional Dynamic Systems, Lakshmikantham, V., Leela, S., Vasundhara Devi, J. Cambridge Academic Publishers, Cambridge, 2009.
- Fractional-order nonlinear systems: modeling, analysis and simulation, Petras, I., SpringerVerlag Berlin Heidelberg, Germany, 2011.
- Chaos: An Introduction to Dynamical Systems, K.T. Alligood, Sauer, Tim D., Yorke James Springer, 1996.
- Nonlinear Dynamics and Chaos, Strogatz, S. Reading, MA: Addison-Wesley, 1994.
- Optimization and Dynamical Systems, Helmke U., Moore J. B, SpringerVerlag, 1993.

DISCIPLINE SPECIFIC ELECTIVE COURSE -2 (DSE-2) IV.4.6. Computational Fluid Dynamics (CFD)

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		
Computational Fluid Dynamics[#] (CFD), DSE-2, IV.4.6	4	0	0	4	12th Pass With Maths	Calculus, Linear Algebra & Differential Equations

#This course will also be available to the students in semester VI

Learning Objectives

This interactive practical paper aims to enable the students to visualize different types of problems of flow and heat transfer in various fields. Blood flow within arteries, biological tissues, heat transfer within biological tissues, flow within circular pipes, flow within an aquifer are some of the important application of CFD. In this paper, students will visualize CFD models, mathematical analysis of these visualizations, simulate them numerically using mathematical softwares such as ANSYS, COMSOL and post process the obtained numerical results.

Learning Outcome

After completing this paper, students will be able;

- Visualise and implement mathematical models of flow and heat transfer problems in different applications.
- Implement existing CFD based modules in ANSYS/COMSOL for simulation purpose.
- Design of UDF based problem specific modules in ANSYS/COMSOL
- Validate their numerical results with experimental data (if available) for suggesting new designs.

Syllabus

Practicals -

(120 Hours)

- Governing equations for CFD: The continuity, momentum and energy equations with their physical interpretation
- Interpretation of different set of flow conditions such as inflow, outflow, no slip boundary etc as per problem requirement.
- CFD mesh generations, structured and unstructured mesh, mesh refinement (local & global), adaptive mesh.
- Implementation of existing CFD based modules in ANSYS/COMSOL for simulation purpose.
- Design and modification of existing modules using UDF (User defined functions) in ANSYS/COMSOL as per the problem requirement.
- Post-processing of numerically simulated results

Essential/ Recommended Readings:

- Computational Fluid Dynamics: A practical Approach (2019) by Jiyuan Tu, Guan Yeoh, Chaoqun Liu, 2nd Edition, Publisher: Butterworth-Heinemann.
- Computational Fluid and Particle Dynamics in the Human Respiratory system (2012) by Jiyuan Tu, Kiao Inthavong, Goodarz Ahmadi, Biological and Medical Physics, Bio-medical Engineering, Publisher: Springer.
- Multiphysics Modelling using COMSOL: A First Principle Approach (2011), by Roger W. Pryor, Jones and Bartlett Publishers, London, Singapore.

DISCIPLINE SPECIFIC ELECTIVE COURSE -2 (DSE-2) IV.4.7. Technology based solutions of societal issues

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)
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		Lecture	Tutorial	Practical/ Practice		
Technology based solutions of societal issues, DSE-2, IV.4.7	4	0	0	4	12 th pass	Programming Fundamentals, Basic knowledge of biology.

#This course will also be available to the students in semester VI

Learning Objectives

This course is designed for students to give them hands-on experience of working on interdisciplinary research problems, which may have direct impact or relevance for the linkage of society and technology. This will broaden their horizon regarding the identification of an issue and then step by step way of solving the same, either theoretically or experimentally by acquiring the required technology-based skill-sets.

Learning outcomes

After completing this course, student should be able to;

- Identify a research problem related to a societal issue, which may be solved using technology
- Acquire the required technical skill-sets, which will be needed for solving such problems
- Get the hands-on training for working on real societal issues requiring technology-based interventions, so that students can become more sensitive and responsible for solving such issues

Syllabus

Practicals –

(120 hours)

- Developing an understanding related to societal issues specifically in the sectors of water, food, electricity, textiles, housing, energy, defense and human health etc., which may require a technology-based intervention
- Identification of a problem as per interest of the student, and solving it using innovative and interdisciplinary approaches
- Working on problems based on artificial intelligence-based biosensors, Electrochemical biosensors, wearable biosensors etc. for various applications related to society
- Building machine learning models on various datasets specially related to health issues for the identification, diagnosis or prediction of the disease
- Computational modeling/ simulation of nanoparticles and their usage in drug delivery applications for various diseases. Examples can be like neuro-simulation of drug-loaded nanoparticles for understanding the pathway for diseases like mental depressive disorders.

Essential/recommended readings

- Sensing and Artificial Intelligence Solutions for Food Manufacturing; Editors: Charles Oluwaseun Adetunji, Daniel Hefft, CRC Press
- Mathematical Modeling of Biosensors by Romas Baronas, Felikas Ivanauskas, Juozas Kulys, (2021); Springer International publishing
- Biosensors and Nanotechnology: Applications in Health Care Diagnostics (2017), Editor: Zeynep Altintas; Wiley Publishers
- Research papers/ Reviews from peer reviewed reputed journals, related to the identified problem/ issue

DISCIPLINE SPECIFIC ELECTIVE COURSE -2 (DSE-2)

IV.4.8. Medical Imaging Techniques

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		
Medical Imaging Techniques#, DSE-2, IV.4.8	4	0	0	4	12 th Pass	Basic knowledge of python

#This course will also be available to the students in semester VI

Learning Objectives

This practical paper is designed to provide hands on experience to build data driven module for computer vision, with applications in medical image analysis. This practical paper enables the students to build deep learning architecture, such as filters, activation functions, loss functions; regularization techniques such as e.g. batch normalization and dropout. Student can implement different non-linear optimization algorithms that are used when training the medical imaging networks on different imaging tools.

Learning outcomes

- Training and validation of image dataset, classification and regression, supervised and unsupervised learning, bias and variance, loss function, generalization error, accuracy, precision, to medical image dataset.
- Can implement deep learning parameters, such as e.g. depth, learning rate, hyper parameter, overtraining and regularization in softwares.
- Implementation of different deep learning architecture for classification and segmentation of diagnosis of various diseases.
- Can simulate hybrid deep learning architecture and models used in medical imaging.

Syllabus

Practicals -

(120 Hours)

- Implementation of basic Medical imaging tools.
- Feature extraction, segmentation, systematic evaluation and validation on medical image datasets using data driven architectures.
- Designing different machine learning and deep learning based models for segmentation and classification of medical imaging datasets.
- Performance analysis of different deep learning architecture in terms of statistical parameters.
- Case studies on some recent advances in analysis of retinal, CT, MRI, ultrasound and histology images.

Essential/recommended readings

1. The Handbook of Medical Image Perception and Techniques, by Ehsan Samei and Elizabeth A. Krupinski, second edition, Publisher Cambridge University Press.
2. Medical Imaging by DS Guru, K.C. Santosh, Nilanjan Dey, Sameer Antani, Publisher CRC Press.

DISCIPLINE SPECIFIC ELECTIVE COURSE -2 (DSE-2)

IV.4.9. Virtual Reality

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		
Virtual Reality#, DSE 2, IV.4.9	4	0	0	4	Class XII pass with Maths	C ⁺⁺

#This course will also be available to the students in semester VI

Learning Objectives

The objective of this course is to provide a detailed understanding of the concepts of Virtual Reality and its applications

Learning outcomes

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

- Understand geometric modelling and Virtual environment.
- Be able to do 2D and 3D geometrical modelling
- Develop Virtual Reality applications.

Practicals -

(120 Hours)

The course will be conducted completely on a hands-on mode and project-based learning. The basic concepts will be explained and each concept will be augmented by small tasks in UNITY.

Animations and physical simulations will be introduced to the students through an appropriate Virtual environment. Following tasks will be covered in the lab:

- Introduction to the Virtual environment
- Introducing frame of reference and modelling transformations
- Animation in virtual environment – projectile motion, flight/ car simulation, Ferris wheel, pendulums, etc.
- Visualising Human Anatomy/ geographical regions/ environment/ monuments in the VR environment
- Modelling a store/ classroom/ office/ mall in VR

Essential/recommended/ suggested readings

- Virtual Reality Systems, John Vince, Pearson Education India, 2002.
<https://all3dp.com/2/blender-3d-printing-tutorial/>
- Understanding Virtual Reality: Interface, Application and Design, William R Sherman and Alan B Craig, Morgan Kaufmann, 2018
- Virtual Reality, Samuel Greengard, MIT Press, 2019.
- Virtual and Augmented Reality, Paul Mealy, Wiley, 2018.

Semester V

DISCIPLINE SPECIFIC CORE COURSE – 13 (DSC-13) V.1. Linear Programming and Game Theory

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
<i>Linear Programming and Game Theory, DSC 13, V.1</i>	4	3	0	1	12 th Pass	NIL

Learning Objectives

To provide an understanding of the optimization of linear models in the many areas. This course starts with the definition of LPP, underlying assumptions and modeling of problems. Illustration of graphical methods will help to conceive the idea behind the solution of LPP. This will also help the reader to visualize the overall concept though explained for only two decision variables. Once the concept becomes clear, the theoretical as well as logical approach of the most popularly used simplex method will be explained.

Learning outcomes

After completing this course, student should be able to

- Formulate linear programming models for given real situations
- Learn simplex method and its computational efficiency
- Formulate dual problems and understand economical interpretation of primal dual relationship
- Analyze post optimality and its economical interpretation
- Solve Transportation problems and assignment problems
- Learn some basic concepts of game theory
- Learn linear programming solution of games with mixed strategies

Syllabus

Unit I: Formulation of Linear Programming Models - Theory of simplex method - optimality and unboundedness - the simplex algorithm - simplex method in tableau format - Computational efficiency of the technique **(10 hours)**

Unit II: Introduction to artificial variables – two-phase method, Big-M method and their comparison - Formulation of the dual problem, Primal-dual relationships, Economic interpretation of the dual **(10 Hours)**

Unit III: Introduction to Post optimality analysis - Dual Simplex Method and its application - Formulation of the Transportation problem - Algorithm for solving transportation problem - Northwest - corner method, least cost method and Vogel approximation method for determining the starting basic solution **(10 hours)**

Unit IV: Assignment problem and its mathematical formulation, Hungarian method for solving assignment problem - Formulation of two person zero sum games - Solving two person zero sum games - Games with mixed strategies - Graphical solution procedure -Linear programming solution of games **(15 hours)**

Practicals -

(30 Hours)

Program with Solver and its application to simple models

- Formulation of the model in Solver
- Solution of LPP with Solver
- Sensitivity analysis with Solver
- Solution of Transportation and Assignment problem with Solver
- Innovation Project

Essential/recommended readings

- Linear Programming and Network Flows, Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, (2nd edition), John Wiley and Sons, India, 2004.
- Introduction to Operations Research, F. S. Hillier and G. J. Lieberman, (9th Edition), Tata McGrawHill, Singapore, 2009.
- Operations Research, An Introduction, Hamdy A. Taha, (8th edition), Prentice-Hall India, 2006.

DISCIPLINE SPECIFIC CORE COURSE – 14 (DSC-14)

V.2. Data Communication and Networking

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		

Data Communication and Networking DSC 14, V.2	4	3	0	1	12th Pass	Programming, Data Structure, Design and Analysis of Algorithms
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Learning Objectives

This course introduces to the students, fundamentals of data communication and computer networks, organization of network architecture, its components and functions. The course gives them a practical understanding of client-server programming and also introduces the basics of network security.

Learning outcomes

Through this course, students:

- Will understand Data communication, Communication Channels, Topologies and Networking Applications.
- Will have knowledge of Layered Architecture & Models, Network Devices, Error Management, and Network Protocols.
- Will have exposure to Network Architectures of Enterprise Applications.
- Will be able to understand the Routing Mechanism and TCP/UDP applications on Network Devices, Socket Programming, and Web/Server Based Applications.

Syllabus

Unit I: Introduction to Data Communication; Components and Basics-Communication Channels – Topologies

(15 Hours)

Unit II: Networking Applications - Layered Architecture & Models – Network Devices

(10

Hours)

Unit III: Introduction to Data Link - Error Management

(10

Hours)

Unit IV: Network Protocols – Network Security – Network Architectures of Enterprise Applications

(10

Hours)

Practical Component-

(30

Hours)

- Simulate Cyclic Redundancy Check (CRC) error detection algorithm for noisy channels.
- Simulate and implement stop and wait protocol for noisy channels.
- Simulate and implement go-back n sliding window protocol.
- Simulate and implement selective repeat sliding window protocol.
- Simulate and implement the Dijkstra algorithm for shortest-path routing.
- Implementation of socket programming.

Essential/recommended readings

- Data Communication and Networking, Forouzan, B.A., Tata McGraw-Hill. 2013
- Computer Networking: A Top-Down Approach Featuring the Internet, Kurose, .F. and Ross, K.W., 3rd Ed., Addison Wesley, 2004
- Computer Networks, A S Tanenbaum, PHI, IV Ed, 2003
- Computer Communication Networks, W. Stallings, PHI, 1999

**DISCIPLINE SPECIFIC CORE COURSE – 15 (DSC-15)
V.3. Software Engineering****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		
Software Engineering, DSC-15, V.3	4	3	0	1	12th Pass	NIL

Learning Objectives

This course objective is to train students in developing software and large scale software products in a systematic manner through requirement analysis, design principles, quality assurance, software process models, and estimation of schedules, productivity and cost.

Learning outcomes

After completing this course, student should be able to understand:

- Software Engineering basics, Software Process Models, Software Requirement Process.
- System Design and Testing Approaches.
- Scheduling, Productivity and Cost Estimation.
- Risk Management.

Syllabus

Unit I: Introduction to software Engineering – Software Engineering Principles – Software metrics – Software development life-cycle. **(10 Hours)**

Unit II: Software Process Models – Software Requirement Process — System Design – Testing. **(10 Hours)**

Unit III: Scheduling Estimation Models. **(10 Hours)**

Unit IV: Productivity Estimation – Cost Estimation – Schedule Estimation – Risk Management – Case Study **(15 Hours)**

Practicals - (30 Hours)

- Analysis of a desktop/enterprise Software Applications under lens of software design fundamentals
- Requirement gathering, verification and specification of a new Software Project
- Creating Prototypes and outlines of problems in the frame of Software engineering aligned with design methodologies
- Reverse engineering management aspects any Open Source Software Project and identify Software
- Software Projects sign off with Project Charter and management of project plans
- Hands on Experiment on Requirement Management, Deliverable attributes of Software projects
- Design a Software Application, Product, and Service and integrate with existing system
- Estimation of Costing of Software, Time sheet management in estimation of Effort, Resource Management
- Design of User Guides, Software Manuals, Update Documentation, Release Guides, Deployment Guides, FAQs
- Basic Understanding on use of Agile & Scrum
- Innovation Project

Essential/recommended readings

- Requirements Risks Can Drown Software Projects, Leishman and Cook, Computer (November 2001).
- Software Engineering: A Look Back and A Path to the Future. Leveson, Nancy, December 14, 1996.
- Applied Software Project Management, Andrew Stallman & Jennifer Greene, O'Reilly, 2005.
- R . S. Pressman, “Software Engineering – A practitioner’s approach”, 5th Ed., McGraw Hill Int. Ed., 2001.
- K. K. Aggarwal & Yogesh Singh, “Software Engineering”, 2nd Ed., New Age International, 2005.

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES

NOTE: The core papers offered in the B.Tech. Course at CIC are Mathematics and Information Technology. Therefore, the students will choose GE offered by Physics, Chemistry, Management and Computational Biology faculty members of CIC.

GENERIC ELECTIVES (GE-5) V.4.1. Consumer Behaviour and Marketing Research

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			
Consumer Behavior and Marketing Research, GE-5, V.4.1	4	2	0	2	12th Pass	NIL	Management Faculty of CIC

Learning Objectives:

The success of business depends on a thorough understanding of how consumers behave and why they behave in a way they do to any business actions such as change in any of the 4 P's of marketing. This course provides the useful insights into consumer psychology with special focus on how consumers think, feel and react to marketing stimuli. Effective marketing research reduces the percentage of product or service failures. It is important for the participants to know the fundamental concepts in the field of marketing research.

Learning Outcomes

After completing the course, student should be able to:

- Understand factors important for consumer buying behaviour
- Understand various consumer behaviour models
- Understand basis of marketing decisions on consumer insights
- Understanding nature and scope of marketing research
- Different methods of data collection, sampling techniques
- Learning various univariate and multivariate data analysis techniques
- Ethical issues in MR

SYLLABUS:

UNIT I: Consumer mind mapping and Consumer behaviour models

(6 Hours)

Manager and Consumer perspectives, Mapping consumer mind, Deterministic and probabilistic approaches, Howard and Sheth model, Nicosia and Engle and Blackwell model.

Unit II: Consumer knowledge and perception (6 Hours)

Types of thresholds, consumer memory networks, Consumer engagement, Perceived risk, antecedents and consequences of consumer decision making, Learning and motivation theories

Unit III: Marketing Research & Types of Research Design (8 Hours)

Nature and Scope of Marketing Research, Marketing Research process, Exploratory, Descriptive and Conclusive Research

Unit IV: Data collection & Ethical Research (10 Hours)

Sample design and field work, Data coding, Data analysis, Use of statistical software for hypotheses testing, Ethical considerations.

Practicals -

(60 Hours)

- Data collection and Coding
- Marketing Research Case studies
- Data analysis of the already existing products based on surveys
- Innovation projects based on data collection and marketing research

Essential/ recommended readings:

- Assael, H. (2009). *Consumer behaviour and marketing action*. New Delhi: Cengage Learning.
- Blackwell, R. D., Miniard, P. D., & Engle, J. F. (2009). *Consumer behaviour*. USA: Thomson-South Western.
- Evans, M., Jamal, A., & Foxall, G. (2009). *Consumer behaviour* (2nd ed.). New Jersey: John Wiley & Sons.
- Malhotra, N., & Dash, S. (2015). *Marketing Research: An Applied Orientation* (6th ed.). New Delhi: Pearson.
- Burns, A. C., Veeck, A.F. & Bush, R. F. (2017). *Marketing Research* (8th ed.). New Delhi: Pearson.
- Churchill, G., Iacobucci, D., & Israel, D. (2010). *Marketing Research: A South Asian Perspective*. Delhi: Cengage

GENERIC ELECTIVES (GE-5)

V. 4.2. Circuit Analysis and Synthesis

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)	Department offering the course
		Lecture	Tutorial	Practical/ Practice			
Circuit Analysis and Synthesis, GE 5, V. 4.2	4	2	0	2	12 th Pass	NIL	Physics/ Electronics Faculty of CIC

Learning Objectives

This module is designed to enable the students with skills (i) for analyzing an electronic circuit and (ii) to synthesis a circuit based on practical needs. All necessary theoretical inputs are explained in details to achieve the said objective. Module also explains the calculation methods to determine voltages, currents, power factors and other attributes of electrical circuits.

Learning Outcomes

After completing the course the students will be able to

- understand difference between various types of electric circuits like DC and AC Circuits with Resistors in series and parallel and understanding related basic laws like Ohm's Law, Kirchhoff's laws
- understand various circuit analysis methods like Mesh current and node voltage method of analysis for D.C and A.C. circuits, Network reduction and network theorems for dc and ac circuits, voltage and current division, source transformation, star delta conversion, Thevenins and Norton's Theorem, Superposition Theorem, Maximum power transfer theorem, Reciprocity Theorem
- learn about resonance and coupled L, C, R circuits: Series, parallel resonance and their frequency response, Quality factor and Bandwidth, Tuned circuits, Single tuned circuits- Transient response for DC circuits, Transient response of RL, RC and RLC Circuits
- learn about characterization of two port networks in terms of Z, Y and h parameters.

Syllabus

Unit I: Basic circuits analysis - Ohm's Law - Kirchoffs laws - DC and AC Circuits - Resistors in series and parallel circuits -Mesh current and node voltage method of analysis for D.C and A.C. circuits - Phasor Diagram - Power, Power Factor and Energy **(10 Hours)**

Unit II: Network reduction and network theorems for dc circuits - voltage and current division, source transformation - star delta conversion - Thevenins and Nortons Theorem – Superposition Theorem - Maximum power transfer theorem - Reciprocity Theorem - Resonance and coupled circuits – Series, parallel resonance and their frequency response - Quality factor and Bandwidth, Characterization of two port networks in terms of Z,Y and h parameters. **(10 Hours)**

Unit III: Tuned circuits - Single tuned circuits, Transient response for DC circuits - Transient response of RL, RC and RLC Circuits **(10 Hours)**

Practicals -

(60 Hours)

- Verification of nodal voltage and mesh current methods for solving circuits.
- Verification of important network theorems.
- Study of the response of the first order R-C and R-L circuits.

- Study of the response of a series and a parallel RLC circuits.

Essential/recommended readings

- Linear circuits: analysis and synthesis - Ayyagari Ramakalyan, Oxford University Press, 2005,
- Linear circuit analysis - Chi Kong Tse, Addison-Wesley, 1998

GENERIC ELECTIVES (GE-5)

V. 4.3. Genes to Genomes

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)	Department offering the course
		Lecture	Tutorial	Practical/ Practice			
Genes to Genomes, GE-5, V.4.3.	4	2	0	2	12th Pass	NIL	Biology Faculty of CIC

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Learning Objectives

This module is designed to:

- Introduce students to the basics of genetics and genome biology
- Introduce students to genome sequencing analysis.
- Introduce students to population genetics.

Learning outcomes

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

- Comprehend the basis of the inheritance of characters from simple to complex
- Understand and analyze population-based inheritance patterns
- Generate and analyze Pedigree charts and family trees for inherited diseases

Syllabus

Unit I: Discovery of the gene concept and beyond (8 Hours)

Mendelian and non-Mendelian inheritance, Gene interaction, Epistasis, Linkage pedigree and recombination

Unit II: Population genetics (7 Hours)

Hardy Weinberg Principle and equilibrium, deviations and role of evolution in the equilibrium, metabolic and other diseases

Unit III: Eukaryotic genome complexity**(7 Hours)**

Junk DNA, Characteristics, Genome mapping techniques, Genome evolution, Transposable elements, Coding and noncoding RNA,

Practicals -**(60 Hours)**

- Punnett square, T-test
- Analysis of gene mapping
- Pedigree analysis
- Calculations to understand genome evolution
- Mathematical equations and models for prediction of inheritance

Essential/recommended readings

1. *Biology*, Raven et al., Tata McGraw-Hill, 2013.
2. *Biology: Global Approach*. Reece et al., Pearson Educations, Global edition, 2014.

DISCIPLINE SPECIFIC ELECTIVE COURSE -3 (DSE-3)
V.5.1 Health Data Analysis

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		
Health Data Analysis[#] DSE-3, V.5.1	4	0	0	4	12th Pass	NIL

This course will also be available to the students in semester III

Learning Objectives

This is a practical based module is designed to:

- Introduce students to the complexity of data related to health and diseases.
- Introduce to the students the method of collection of data, their visualization and analysis

Learning outcomes

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

- Comprehend and handle complex data related to health and diseases, which are usually large.

- Do survey-based research for data collection, their visualization by different methods and their analysis including the statistical analysis

Syllabus

Practicals -

(120 Hours)

- Art and Science of preparation of questionnaire for collection of health data: types and ethical consideration
- Types of data: Likert scale data and quantitative data related to health and diseases their collection methods
- Understanding how data is organized to facilitate analysis in the healthcare setting.
- Data visualization through histograms and tables
- Data visualization through heat maps
- Integration, understanding and selection of appropriate data visualization techniques to effectively communicate results
- Identifying ways in which data quality can be compromised and applying remedies
- Evaluation of data from varying sources to create meaningful presentations.
- A survey-based research on epidemiology and public health by collecting real data from the field area. It will include study designing, data collection, visualization and analyses of the data
- The results will be used for the preparation of a project report/manuscript.

Essential/recommended readings

- Introduction to Data Science in Healthcare Reading:
<https://www.r2library.com/Resource/detail/1584265329/ch0007s0170>
- Analytics and (Precision Medicine) Decision Support Reading:
<https://www.r2library.com/Resource/detail/0128006811/ch0014s0163>
- Hype Cycle for Healthcare Providers, 2019 (Gartner) Reading: Pages 3-7
- <https://www.r2library.com/Resource/detail/0340950056/ch0004s0092>
- Principal components analysis
<https://www.r2library.com/resource/detail/0803625642/ch0006s0141>
- ANOVA <https://www.r2library.com/Resource/detail/0781781531/ch0015s0490>

DISCIPLINE SPECIFIC ELECTIVE COURSE -3 (DSE-3)

V. 5.2. Game Development using UNITY

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		

Game Development using UNITY[#], DSE 3, V. 5.2	4	0	0	4	Class XII pass with Mathematics	C++
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This course will also be available to the students in semester III

Learning Objectives

The Learning Objectives of this course are

- to introduce the students to the game engine platform UNITY
- to give a basic on how to develop a game using this game engine.
- to design, develop and finalize a game on either an Android or an IOS platform

Learning outcomes

This course gives students an insight into developing a game either on a mobile or a desktop platform. Upon completion of the course the students would be able to-

- Possess basic ability to convert game idea into a working prototype
- Learn basic techniques for animation and simulation
- Extend the concept of game development on Web, console or VR platforms
- Develop a creative and aesthetic mindset by creating a good looking functional UI for the developed game

Practicals -

(120 Hours)

The course will be conducted completely on a hands- on mode. The basic concepts will be explained and each concept will be augmented by small tasks initially on UNITY before designing and developing a game. The following tasks will be performed in lab:

- Introduction to Unity's Interface and Unity's Basics
- Rigid Bodies and Colliders
- Audio Source and UI Elements
- Moving Character with Code
- Introduction to Variables; Operations with Variables; Functions; Conditional Statements; Loops; Coroutines; Classes
- Creating animations, simulations and background
- Designing, developing and finalizing a game

Essential/recommended readings

- *Learning C# by Developing Games with Unity 5.x*, G. Lukosek, Packt publishing Ltd, 2016
- *Developing 2D Games with Unity: Independent Game Programming with C#*, Jared Halpern, Apress, 1st Edition, 2018
- *Unity in Action: Multiplatform Game Development in C# with Unity 5*, Joe Hocking, Manning publications, 3rd Edition, 2022
- *Unity From Zero to Proficiency (Foundations)*, Patrick Felicia, LPF publishing, 4th Edition, 2015

DISCIPLINE SPECIFIC ELECTIVE COURSE -3 (DSE-3)
V. 5.3. 3D printing using Blender

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		
3D printing using Blender [#] , DSE 3, V. 5.3	4	0	0	4	Class XII pass with Mathematics	NIL

This course will also be available to the students in semester III

Learning Objectives

The Learning Objectives of this course are

- to introduce the students to Blender
- to understand the basic concepts of 3D modelling and printing using Blender
- to identify the pitfalls in 3D printing
- to apply the slicing techniques and generate G code

Learning outcomes

This course gives students an insight into using the free and open source ware Blender for 3D printing. Upon the successful completion of the course the students are expected to generate 3D models of some simple objects like flower vase, geometrical figures, tessellation tiles, bottle lids, etc.

Practicals -

(120 Hours)

The course will be conducted completely on a hands- on mode. The basic concepts will be explained and each concept will be augmented by small tasks initially on Blender before moving on to 3D printing. The following tasks will be performed in lab:

- Introduction to the User Interface and navigation in blender
- Creating simple geometrical objects like planes, cube, cylinder, cone, spheres, spirals, etc. on blender
- Movement, scaling and rotation transformations
- Simulation, animation and rendering
- Polygonal modelling for 3D printing
- 3D printing of simple geometrical objects
- Moving on to more complex 3D printing

Essential/recommended/ suggested readings

1. *Blender 3D printing tutorials for beginners*,
<https://all3dp.com/2/blender-3d-printing-tutorial/>
2. *Blender for 3D printing design*
https://www.youtube.com/watch?v=5CyaeBBQIkc&list=PLvCZK2JKGQINt8uEM5_J12Qj7eO5MqV03
3. *3D printing from zero to hero in Blender*
<https://www.udemy.com/course/learn-3d-printing/>

DISCIPLINE SPECIFIC ELECTIVE COURSE -3 (DSE-3)
V. 5.4. Applications of Data Science: A Case Study Approach

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		
Application of Data Science: A Case Study Approach, DSE 3, V. 5.4.	4	0	0	4	Class XII pass with Mathematics	Linear Algebra; Probability and Statistics; Basic programming

Learning Objectives

- Introduce the students to Python based toolkits
- Understand the application of mathematics concepts to data science
- Formulate hypothesis for the case study under consideration
- Inculcate problem solving mind-set among students

Learning outcomes

The students will be enabled to identify a case study (for e.g. weather forecasting, stock market prediction, sentimental analysis, crime prediction, etc) and apply the fundamentals of mathematics and programming languages. The students will also understand the use of various Python tools such as NumPy, Matplotlib, etc.

Practicals -

(120 Hours)

The course will be conducted completely on a hands- on mode. The basic concepts will be explained and each concept will be augmented by small exercises on lab either using Python/

MATLAB or R. A case study would be identified to implement all the concepts. Following tasks will be done in the computer lab

- Introduction to programming tools (Python/ MATLAB/ R)
- Visualising Data through Bar Charts, Line Charts, Box Plots, Histogram
- Scrapping web for data (Eg, Various social media sites)
- Cleaning the data
- Using models like K nearest neighbours; Naïve Bayes, Linear and Logistic Regression, Decision Trees, Neural Network, Clustering., Random forest to analyse the data
- Identifying a case study (for e.g. weather forecasting, stock market prediction, sentimental analysis, crime prediction, health data analytics etc) for a mini project

Essential/recommended/ suggested readings

- Data Science from Scratch: First principles with Python, Joel Grus, 2nd Edition, O’Rielly Media Inc, 2019. <https://all3dp.com/2/blender-3d-printing-tutorial/>
- Python Data Science Handbook: Essential Tools for working with Data, 2nd Edition, O’Rielly Media Inc, 2022
- Practical Statistics for Data Scientist, Peter Bruce, Andrew Bruce and Peter Gedeck, 2nd Edition, O’Rielly Media Inc, 2020
- Python for Data Science, L.M. John Paul Mueller, Wiley, 2019.

DISCIPLINE SPECIFIC ELECTIVE COURSE -3 (DSE-3) V. 5.5. Urban Computing

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit-distribution of the course			Eligibility criteria	Prerequisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Urban Computing [#] DSE 3, V.5.5	4	0	0	4	Pass 12 th	Programming languages, data Structure, Algorithm design and analysis

Learning Objectives:

This course introduces an interdisciplinary field, is the science of using computing technology in solving urban challenges such as crowds, traffic, and pollution, governance issues etc. Urban computing research also focuses on acquiring an understanding of the nature of urban phenomena, predict the future of cities, and plan their development.

Learning Outcomes:

- Learn to formulate challenges urban problems.
- Understand ways of data acquisitions, integration, and modeling skills necessary for urban computing research.
- Learn to model cities, develop large-scale statistical models, and use visualization technologies to pose and answer questions.
- Solve issues related to public health, sustainable use of limited energy resources, emergency preparedness, and societal stability etc
- Work in blended project teams with people from a variety of disciplines.
- Understand ways to solve practical hands-on problems faced by urban spaces/cities. activities.

Practicals -

(120 Hours)

The course will be conducted completely on a hands- on mode and project based learning. The basic concepts of Urban Computing will be explained and associated real world challenging problems will be identified.

- Problem solving on Urban context text analytics including Smart mobility and smart environments.
- Acquisition and processing of high resolution remotely sensed data for urban applications;
- Practical work on Location-based service in smart cities
- Experiments on Data acquisition, storage, management, analysis, sharing
- Agent-based simulation for urban dynamics
- Hands on working on Urban sensor network data and applications.
- Students will be exposed to the practical application of Urban Computing concepts and learn how to solve real world urban problems.

Essential/recommended readings

- Zheng, Y. (2019). *Urban computing*. MIT Press.
- Yin, H. (2023). An overview of urban data variety and respective value to urban computing. *Handbook of Mobility Data Mining*, 1-13.
- Haldorai, A., Ramu, A., & Murugan, S. (2019). *Computing and Communication Systems in Urban Development: A Detailed Perspective*. Springer Nature.
- Zheng, Y., Capra, L., Wolfson, O., & Yang, H. (2014). Urban computing: concepts, methodologies, and applications. *ACM Transactions on Intelligent Systems and Technology (TIST)*, 5(3), 1-55.

DISCIPLINE SPECIFIC ELECTIVE COURSE -3 (DSE-3)

V. 5.6. IT Project Leadership

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit-distribution of the course			Eligibility criteria	Prerequisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
IT Project Leadership[#], DSE 3, V.5.6	4	0	0	4	12th Pass	NIL

This course will also be available to the students in semester III

Learning Objectives

The key focus of this project-based course is to develop a deep understanding of facilitators and obstructions while developing and managing IT developments as a product and its life cycle. Innovations in IT have led some businesses to flourish, while others have faltered due

to massive changes brought by information technology. IT is hard to manage, therefore understanding its applications, planning and management are ensuring intended changes where innovations are realized and the unintended ones are kept under control. The course covers information system, information management, IT strategy, and IT governance

Learning outcomes

After completing this course, student should be able to;

- contribute to information system planning and strategy formulation in corporate enterprises and complex administrations.
- have a deeper understanding of a socio-technical approach to the deployment of IT in organisations
- understand frameworks for analysing strategic issues of IS deployment and a familiarity with the most relevant current issues.
- develop insight into cases of the strategic planning of information systems often demand

Syllabus

(120 Hours)

Practical -

- Understanding IT and software characteristics and applications. processes, methods and tools. Scenario based view of IT manager's role and KRA's.
- Understanding evolving IT landscape and dynamics, IT and networking as applied to enterprises in public and commercial sector.
- Software management, Software life cycle, Process and Project metrics, Software quality management and assurance, software cost estimation, the make or buy decision, Automated estimation tools.

- IT enabled products or services, ITIL service management model, software as a service, software as a platform, IT service strategy, new service designing and development process, common IT setups and Systems.
- Fundamental aspects of daily IT operations, human factors in organization, acquisition and procurement, research and Development, Logical planning.
Managing digital networks and security.
- Management Information Systems, Strategic planning in regulated and competitive IT industries, the management and marketing of a technology-based enterprise,
- Evaluating their legal constraints, responsibilities and ethics, Social and ethical aspects of IT, The principles and methods of asset valuation, Interpretation and measurement, financial statements risk assessment, Capital market, Capital budgeting and the effects of economic regulation on capital formation, IT Policy and Regulation

Essential/recommended readings

- Managing the Internet of Things: Architectures, Theories, and Applications Editors: Jun Huang & Kun Hua, Chongqing University, China & Lawrence Technological University, USA, ISBN9781785610288.
- “Management” by Stoner J A and Freeman R E, ISBN 10: 8131707040 / ISBN 3: 9788131707043
- “Management: Principles and Practice” by S K Mandal ISBN: 9788184952209, 8184952201 Edition: 1stEdition, 2011, Pages: 500.
- “Principles and Practices of Management” by Khusboo Manoj ISBN-10: 9380921128
ISBN-13: 978-9380921129.
- “Principles and Practice of Sport Management” by Carol A Barr, ISBN-13: 9781284034172 Product With Access Code, 606 pages.
- “Better Software Practice for Business Benefit: Principles and Experiences” by Colin Tully and Richard Messnarz, ISBN-10: 0769500498 ISBN-13: 978-0769500492.

V.5.7. Fabrication of nanomaterials for devices

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		
Fabrication of nanomaterials for devices[#], DSE-3, V.5.7	4	1	0	3	Class XII pass	Basic knowledge of science

This course will also be available to the students in semester III

Learning Objectives

This course is designed to expose students regarding the fabrication and applications of various types of nanomaterials. Students will be performing hands-on experiments and will get themselves acquainted with the fascinating world of nanotechnology and its interdisciplinary applications.

Learning outcome

Through this paper, students would be learning:

- About the basics of nanomaterials and characterization techniques
- To fabricate nanomaterials using chemical or green synthesis
- To characterize nanomaterials using various physicochemical techniques
- To explore the interdisciplinary applications of fabricated nanomaterials in electronic devices, optical devices, computing devices, health devices, drug delivery, environmental remediation and energy etc.

Syllabus

Theory

(15 Hours)

Introduction of Nanoscience and nanomaterials; synthesis (Chemical as well green methods) and characterization techniques (including spectroscopic, X-RD, Zetasizer, electron micrography etc.); Discussion on basic, innovative and recent advancements in the field of nanostructures / Nano-formulations/ Nano-devices / Nano-sensors etc. for targeting various applications related to the interdisciplinary fields

Practicals -

(105 Hours)

- Identifying a research problem based on fabrication of devices using nanotechnology
- Identifying the requirement of type of nanomaterials (nanoparticles, quantum dots, nanostructures etc.) depending upon their physical and chemical properties as per the identified research problem
- Chemical or green synthesis of nanomaterials based on the selective, identified protocols, which may later be modified for the novel method of synthesis

- Characterization of nanomaterials using various physicochemical techniques like UV-absorption spectroscopy, FT-IT spectroscopy, X-ray diffraction, Zetasizer, Dynamic light scattering, Scanning electron microscope (SEM), HR-TEM, FESEM etc. for understanding their size, shape, charge, morphology etc.
- Exploring the role of fabricated nanomaterials in electronic devices, optical devices, computing devices, drug delivery, environmental remediation and energy etc.

Essential/recommended readings

- Nanotechnology For Dummies; By Richard D. Brooker, Earl Boysen (2011), Wiley Publisher
- Nanotechnology: An Introduction; By Jeremy Ramsden (2011), Elsevier Science Publisher
- Research papers and reviews from journals of international repute like Nanotechnology Reviews (NTREV) journal, NANO Reviews, Nature Nanotechnology

DISCIPLINE SPECIFIC ELECTIVE COURSE -3 (DSE-3) V. 5.8. IoT, Security and Machine Learning

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit-distribution of the course			Eligibility criteria	Prerequisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
IoT, Security and Machine Learning, DSE 3, V.5.8	4	1	0	3	12 th pass with Physics and Mathematic	Programming Fundamentals, Probability and statistics, Computer System Architecture

Learning Objectives

This course introduces students to the field of machine learning, deep learning, security with python and its interaction with the Internet of Things (IoT) devices/ sensors. The course will cover topics such as security models, attacks, concept of privacy preservation, threats to machine learning models, and IoT devices. Students will be implementing various privacy preserving machine learning techniques with Python/ C or in MATLAB. The students will also learn to use various IoT devices in real applications.

Learning Outcomes

- Understand the fundamental concepts of machine learning, security and IoT.
- Identify deep learning and privacy preserving machine learning models, IoT platforms.
- Implement various security techniques for IoT and machine learning applications
- Understand current research trends and developments in the field of machine learning, security and IoT
- Explore on Interacting with digital outputs with C/ Python.

Syllabus

Theory

(15 Hours)

Basic introduction to IoT, IoT- devices and related security, IoT communication protocols, principles of security, Vulnerability in IoT, CIA triad, Viruses and their types, Machine learning principles, Deep learning, CNN and other models. Concepts of privacy preservation, privacy preserving machine learning models.

Practicals:

(105 Hours)

- Implementing IoT devices for various sensing applications
- Training deep learning models on sensed data
- Implementing IoT communication protocols
- Designing and testing IoT based systems
- Implementing IoT in wearables/ healthcare systems
- Using Python based application for IoT device control.
- Implementing basic deep learning models
- Implementing Privacy Preserving Machine Learning (PPML) models on available data

Essential/ recommended Readings:

- "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things" by David Hanes, Gonzalo Salgueiro, Patrick Grossetete
- "Building IoT Projects with Raspberry Pi and Python" by Matthew Poole
- "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron
- "Machine Learning Yearning" by Andrew Ng
- Adrian McEwen, Hakim Cassimally, —Designing the Internet of Things, John Wiley and Sons, 1st Edition, 2014
- Matt Richardson, Shawn Wallace, —Getting Started with Raspberry Pi, O'Reilly (SPD), 3rd Edition, 2014.

DISCIPLINE SPECIFIC ELECTIVE COURSE -3 (DSE-3)
V.5.9. Integral Transform: Applications to Digital Signal Processing

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		
Integral Transforms: Applications to Digital Signal Processing, DSE 3, V. 5.9	4	1	0	3	12th Pass with Maths	Calculus, Linear Algebra, Differential equations

Learning Objectives

Signal processing is, in a sense, application of various mathematical tools that primarily consist of Fourier Transforms, Laplace Transforms and z – Transforms. This is a practical-based course and students will :

- learn to utilize integral transformations to solve and analyze problems in digital signal processing
- comprehend and deploy signal processing techniques in an applied environment
- be able to design different types of filters

Learning outcomes

- Identification, understanding and differentiation between discrete time system and continuous time system
- Be able to apply mathematical tools – Laplace transform, Z transform and Fourier transform to various signals
- Implementation different signal types on matrix based numerical based software
- Designing different low pass, band pass and high pass filters
- Reconstruction of signal from its samples using natural sampling

Syllabus

Theory –

(15 Hours)

LTI system; Convolution; Impulse response representation of LTI system; Fourier Series and Fourier coefficients; Complex exponential function; Fourier Transforms and their basic properties; Some Fourier transform pairs, Nyquist Sampling theorem

Practicals –

(105 Hours)

- Representation of elementary signals (periodic and non-periodic)
- Basic operations on signals
- MATLAB implementation of different signal types
- Output of convolution of two signals
- Impulse response of an LTI system
- Simulations of difference equations

- Frequency response of LTI system from impulse response
- Representation of DTFS and FS of a signal
- Frequency response of LTI system described by a differential or difference equation
- Relating DTFS to DTFT
- Transform analysis of LTI system
- Computational structures for implementing discrete time LTI systems
- FIR & IIR Filter Implementation using the DSP Processors.
- Sampling theorem and reconstruction of signal from its samples using natural sampling

Essential/ Recommended readings:

- C. L. Byrne, "Signal Processing: A Mathematical Approach", 2 Ed., CRC Press, 2015.
- Haykin, S. and Van Been, B., "Signals and Systems" 2 Ed., John Wiley & Sons, 2003.
- Sundararajan, D., "A Practical Approach to Signals and Systems", Wiley, 2008.
- Padmanabhan, K., Ananthi, S. and Vijayarajeswaran, R., "A Practical Approach to Digital Signal Processing", New Ag International, 2003.

Semester VI

DISCIPLINE SPECIFIC CORE COURSE – 16 (DSC-16) VI.1. Numerical Methods for Computational Mathematics

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		
Numerical Methods for Computational Mathematics DSC 16, VI.1	4	2	0	2	12th Pass with Mathematics	Linear Algebra, Programming Language, Ordinary Differential Equations

Learning Objectives

In practical scenarios, the governing mathematical models are usually too complex to be solved analytically and numerical techniques become the only way out to approximate the solutions. This paper aims to teach the student solutions of nonlinear equations in one variable with error analysis, interpolation and approximation, numerical differentiation and integration, direct methods for solving linear systems, numerical solution of ordinary differential equations. By the end of this paper, students should have the ability to compare the computational methods for advantages and drawbacks and choose the suitable computational method among several existing methods for underlying physical problems. In this paper, students will write codes in MATLAB/C/C++ for implementation of numerical methods.

Learning outcomes

After completing this course, student should be able to;

- Understand the need of numerical techniques and their importance in real situations
- Learn different techniques of solving non-linear equations such as Bisection method, Newton Raphson method, Regula Falsi method, Secant method & Iterative methods
- Analyze errors associated with these methods and their rate of convergence
- Learn Gauss elimination, Gauss seidel, LU decomposition methods for solving system of linear equations with pivoting concepts

- Learn polynomial interpolation, linear and cubic spline interpolations, analyze errors of interpolation
- Conceptualize numerical integration and errors associated with it.
- Learn Euler's method and Runge-Kutta method for numerical solution of differential equations
- Write programs of all these numerical methods in MATLAB/C/C++

SYLLABUS

Unit I: Solving Nonlinear Equations - Graphical method - Bracketing and Non-bracketing approach. - Bisection, Method of false position, Iterative method, Newton-Raphson method and Secant method - Errors and rate of convergence **(8 Hours)**

Unit II: Matrix notation of a system of linear equations - Gaussian elimination and Gauss-seidel method - Pivoting - Row-echelon form - LU factorization **(6 Hours)**

Unit III: Polynomial interpolation - Forward, Backward and Divided differences - Piecewise linear and Cubic Spline interpolation - Errors in interpolation **(6 Hours)**

Unit IV: Newton-Cotes Integration Formula - Trapezoidal and Simpson's rules - Gaussian quadrature, Euler, Modified Euler and Runge-Kutta methods for solution of differential equations - Power method, QR method for Eigen Value problems **(10 Hours)**

Practicals- **(60 Hours)**

- Writing MATLAB/C/C++ programs for finding root of the equations using Bisection, Newton-Raphson, Iterative and Secant methods
- Writing MATLAB/C/C++ programs for solving system of linear equations (Gaussian Eliminations, Gauss Jacobi & Gauss Seidel Method)
- Writing MATLAB/C/C++ programs for interpolation, forward, backward and divided difference
- Writing MATLAB/C/C++ programs for methods of numerical integration
- Writing MATLAB/C/C++ programs for Euler and Runge-Kutta methods.

Essential/recommended readings

- Applied Numerical Analysis, C. F. Gerald and P. O. Wheatly, Pearson Education India, 2007.
- Introduction to Applied Numerical Analysis, R. W. Hamming, Dover Publications, 2012.
- Elementary Numerical Analysis- An Algorithmic Approach, S. D. Conte and Carl de Boor, McGraw-Hill, 1980.
- Numerical Recipes: The Art of Scientific Computing, 3rd Edition, William H. Press, Saul A. Teukolsky, William T. Vetterling, Brian P. Flannery, Cambridge University Press, 2007

DISCIPLINE SPECIFIC CORE COURSE – 17 (DSC-17)
VI.2. Information Security

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		
Information Security, DSC-17, VI.2.	4	3	0	1	12th Pass with Mathematics	Programming Language

Learning Objectives

This course will discuss the fundamentals of cryptography and its application to network security. Understand network security threats, security services, and countermeasures. Understand vulnerability analysis of network security. Acquire background on hash functions; authentication; firewalls; intrusion detection techniques. Gain hands-on experience with programming and simulation techniques for security protocols. Understand the tradeoffs and criteria/concerns for security countermeasure development. Apply methods for authentication, access control, intrusion detection and prevention. Identify and mitigate software security vulnerabilities in existing systems.

Learning outcomes

After completing this course, student should be able to;

- Understand and explain the risks faced by computer systems and networks.
- Identify and analyze security problems in computer systems and networks.
- Explain how standard security mechanisms work.
- Develop security mechanisms to protect computer systems and networks.
- Write programs that are more secure.
- Use cryptography algorithms and protocols to achieve computer security.

SYLLABUS

Unit I: Introduction to Information Security, CIA, Conventional Cryptographic Techniques: Substitution and transposition ciphers, One Time Pad. **(12 Hours)**

Unit II: Block cipher and Stream Cipher, Steganography: Symmetric and Asymmetric Cryptographic Techniques: DES, AES, RSA algorithms, Authentication and Digital Signatures, Secure Hash function. **(13 Hours)**

Unit III: Program Security: Nonmalicious Program errors – Buffer overflow, Incomplete mediation, Time-of-check to Time-of-use Errors, Viruses, Trapdoors, Salami attack, Man-in-the-middle attacks, **(10 Hours)**

Unit IV: Threats in networks, Network Security Controls – Architecture, Wireless Security, Honeypots, Traffic flow security, Firewalls, Types of Firewalls, Personal Firewalls, IDS, Email Security – PGP/S/MIME **(10 Hours)**

Practicals:

(30 Hours)

- Implementing trans-positional ciphers.
- Implementing substitution ciphers
- Using block and stream ciphers from various available libraries
- Implementing Al-Gamal Key sharing algorithm
- Implementing and using AES/DES and RSA algorithm
- Understanding authentication practically
- Simulating attacks on system

Essential/recommended readings

- Security in Computing, Fourth Edition, by Charles P. Pfleeger, Pearson Education
- Cryptography And Network Security Principles And Practice, Fourth or Fifth Edition, William Stallings, Pearson
- Modern Cryptography: Theory and Practice, by Wenbo Mao, Prentice Hall
- Network Security Essentials: Applications and Standards, by William Stallings. Prentice Hall

DISCIPLINE SPECIFIC COURSE -18 (DSC 18)
VI. 3: Artificial Intelligence

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		
Artificial Intelligence DSC 18, VI.3	4	3	1	0	12th Pass with Mathematics	Programming, Data Structure, Design and Analysis of Algorithms

Learning Objectives

The objective is to introduce the basic principles and techniques of Artificial Intelligence. The course provides a theoretical foundation for variety of concepts in the field of artificial intelligence. To enhance the practical understanding of AI concepts, the course expects problem-solving projects as a ‘hands-on’ approach and avenue for exploration and creativity.

Learning outcomes

Upon completion of this course, the student will be able to:

- Learn the fundamentals of artificial intelligence.
- Learn to problematize the problems and solve them.
- Understand and implement search and adversarial (game) algorithms.
- Understand mathematical models such as belief networks and apply them to a range of AI problems.
- Have a glance at machine learning algorithms and extracting knowledge models from data.
- Understand the fundamentals of Machine learning and Reinforcement learning.

SYLLABUS

Unit I: Philosophy of Artificial Intelligence, Intelligent Agents **(9 Hours)**

UNIT II: Problem-solving, Search techniques, Constraint satisfaction, Game playing, Automated Planning **(9 Hours)**

UNIT III: Knowledge Representation and Reasoning through Logic, Bayesian Networks, Markov Decision Processes **(12 Hours)**

UNIT IV: Machine Learning, and Reinforcement Learning **(15 Hours)**

Practicals- (30 Hours)

- Implementation of problem-solving and search techniques.
- Implementation of hill climbing and its variations.
- Implementation of genetic algorithm search.
- Implementation of heuristics search techniques.
- Implementation of machine learning algorithms and their applications.
- Development of artificial intelligence projects.

Essential/recommended readings

- Russell, S., & Norvig, P. (2021). Artificial intelligence: A modern approach, global edition 4th. Foundations, 19, 23.
- Poole, D. L., & Mackworth, A. K. (2010). Artificial Intelligence: foundations of computational agents. Cambridge University Press.
- Kulkarni, P., & Joshi, P. (2015). Artificial intelligence: Building intelligent systems. PHI Learning Pvt. Ltd.
- Artificial Intelligence, 3rd Edition. R. Elaine, K. Knight, S. Nair, Tata McGraw-Hill, 2009.
- Bishop, C. M., & Nasrabadi, N. M. (2006). *Pattern recognition and machine learning* (Vol. 4, No. 4, p. 738). New York: Springer.
- Winston, Patrick Henry, Artificial Intelligence. 3rd ed. Addison-Wesley, 1992.
- Kevin P. Murphy and Robert R. Reitano, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES

NOTE: The core papers offered in the B.Tech. Course at CIC are Mathematics and Information Technology. Therefore, the students will choose GE offered by Physics, Chemistry, Management and Computational Biology faculty members of CIC.

GENERIC ELECTIVES (GE-6) VI-4.1. e-Business Organization and Strategy

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			
e-Business: Organization and Strategy, GE-6, VI. 4.1.	4	2	0	2	12th Pass	Basic understanding of consumer behaviour	Management Faculty of CIC

Learning Objectives

The core objective of this subject is to provide students with a comprehensive understanding of the managerial as well as technical aspects of e-business, i.e., what is e-business and how it works? The contemporary theories and new business models will be discussed as a theory to form a strong basis for practice. The participants will develop insights for the effective designing and development of e-business strategy as a channel of communication or channel of distribution or both. The analytical ability of students will be enhanced via analytical tool for understanding customer behaviour towards E- business.

Learning Outcomes

After completing this course, student should be able to:

- Understand the dynamic business environment and its elements
- Understand different business models and their application.
- E-commerce architecture and its platforms.
- Understand the dynamics of E-brand trust via ICT.
- Plan e- marketing tools and Web analytics through KPI's.

- Analyse important strategic elements of e- supply chain management, e-customer relations management, e-procurement.
- Perform predictive analysis, customer analysis, pricing, marketing, and over-all retail analytics application in different online retail sectors.
- Envision financial dynamics and cost analysis in website management for a start-up.

SYLLABUS

Unit I: Evolution of e-business and transitions-E-commerce and internet penetration, Web 1.0, Web 2.0, Web 3.0, E-business models & organisation structure- Indian and Global trends, Business responsiveness during crisis, supply chain disruptions and management, Opportunities for Innovations. **[10 hours]**

Unit II: E-business and consumer behaviour- Consumer complex buying behaviour patterns, sentiment analysis, consumer online engagement tools for reviews and managing UGC (User generated content), E-Brand Trust, and Security and role of Information Systems and various approaches in ICT Systems **[10 hours]**

Unit III: Perspectives and requirements for starting online business: Revenue and resources, Processes associated with managing website development, ICT in types of businesses such as B2B and B2C. SEO's, measuring success, On page and off page search engine optimisation, Customer acquisition, customer experience, conversion and retention. **[10 hours]**

Practical Component: (60 Hours)

- Hands on training will be provided by experts from academia and industry regarding different E-business tools for analysing consumer behaviour and building robust advertising strategies
- Predictive analysis using Python, performing (Recency-frequency-monitory) RFM analysis for creating customer clusters.
- Churn Prediction analysis
- Market Basket analysis
- Web analytics- Sentiment analysis via social media such as Google ads, twitter, Facebook and Instagram.
- Case study discussion on real life cases of the companies that exploited the competitive advantage of IT to leverage their growth and expansion.
- Case study discussion on innovative e-business evolved such as online grocery stores, fashion retail which emerged out of market space and other concepts.

Essential/ recommended readings:

- Internet Business Models and Strategies: Text and Cases, A. Afuah and C. L. Tucci, McGraw-Hill., 2003.
- Information Technology and the Corporation of the 1990s: Research Studies, T. J. Allen and M.S. Morton, Oxford University Press, New York 1994.
- Strategies for e-Business: Creating Value through Electronic and Mobile Commerce, T. Jelassi and A. Enders, Prentice Hall, 2005.

- Competitive Advantage: Creating and Sustaining Superior, Performance, Michael E. Porter, The Free Press, New York, 1985.
- E-Learning Tools and Technologies, Horton and Horton, Wiley Publishing, 2003

GENERIC ELECTIVES (GE-6)
VI. 4.2. Control 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)	Department offering the course
		Lecture	Tutorial	Practical/ Practice			
Control Systems GE-6, VI. 4.2	4	2	0	2	12th Pass with Mathematics	Linear Algebra, Differential equations	Physics/ Electronics Faculty of CIC

Learning Objectives

This interactive learning module intends to provide capabilities and basic understanding of functionality and control of a system or a device. It will emphasize on the conceptual know-how of the behavioral aspects and mechanism of different machines, equipment or a system, their manageability, efficiency and performance as per controlled parameters.

Learning outcomes

After completing this course, student should be able to;

- Understand the building blocks of basic and modern control systems.
- Understand the concept of stability analysis of control systems in both time and frequency domain.
- Understand the concept of MATLAB and SIMULINK toolbox to simulate the control systems.
- Perform comparative study of electrical systems using simulation software - Multisim, Eagle, LTSpice and experimental set-up.
- Understand the complex mathematical operations associated with building blocks of various control systems.

SYLLABUS

Unit I: Introduction to Control Systems - Analysis and design objectives - The design process - Classification and modeling of control systems **(6 Hours)**

Unit II: Modeling in the frequency domain - Modeling in the time domain - Time response - Reduction of multiple subsystems **(6 Hours)**

Unit III: Signal flow graphs - Mason's rule - Routh Hurwitz Criterion - Steady state errors - Root locus techniques - Frequency Response Techniques **(8 Hours)**

Unit IV: Root Locus and its Applications — Design via state space — Non-linear analysis — Controller and its applications — Case Studies **(10 Hours)**

Practicals – (60 Hours)

The following explorations would be carried out on matrix based numerical mathematics software:

- Designing the model of a DC motor
- Design of controllers for speed and position control
- Compensator design
- Realization of logic gates through diodes and resistors
- Verification of Boolean algebraic functions through digital IC gates
- Design of half/full adder and subtractor circuits
- Design of shift registers using flip-flops
- Circuit simulation
- State space model design
- Design of temperature controller
- Hands on experiments with PID controller
- Innovation Project

Essential/recommended readings

- Control Systems Engineering, 6th Edition, Norman S Nise, Wiley, 2011.
- Linear Control Systems with MATLAB Applications, 11th Edition, B. S. Manke, Khanna Publishers, 2013
- Discrete-Time Control Systems, K. Ogata, Prentice Hall, 1995.
- Control Tutorials for MATLAB and Simulink, W. Messner and D. Tilbury, Addison-Wesley, 1998.

GENERIC ELECTIVES (GE-6)
VI. 4.3. Genomics and Proteomics

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Prerequisite of the course (if any)	Dept. offering the course
		Lecture	Tutorial	Practical/ Practice			
Genomics and Proteomics GE-6, VI.4.3	4	2	0	2	12th Pass	Basic knowledge of biological sciences	Chemistry / Biology Faculty of CIC

Learning Objectives

This module is designed to:

- Introduce students to basic RDT techniques
- Introduce students to basic tools of genomics and proteomics
- Introduce students to building and analyzing networks involving complex biological data.

Learning outcomes

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

- Design primers for PCR
- Well-versed in gene cloning techniques
- Will develop skills in understanding the advancement of the genomic and proteomics branches of Sciences and their importance in manipulating genome and proteome.

SYLLABUS

Unit I: Basics of gene cloning

(8 Hours)

Introduction to Recombinant DNA technology, Isolation of DNA, PCR amplification, Types of PCR, Restriction digestion, Cloning and expression vectors, Cloning, Expression, Purification of expressed proteins, DNA libraries and Screening

Unit II: Genome analysis (8 Hours)

Genome sequences and database, Discovery of new genes and function, Early DNA sequencing efforts: Maxam & Gilbert Method, Sanger Di-deoxy method, Fluorescence method, shot-gun approach, NGS: different methods and principles, Genome libraries, expressed sequenced tags (ESTs)

Unit III: Applied Genomics (8 Hours)

Genotyping tools: DNA Chips, Diagnostic assays, Diagnostic services. Functional genomic studies with model systems such as Drosophila, Yeast and C. elegans, Interference RNA, RNA silencing, SiRNA: Applications in Functional genomics, Medicine and Gene Knockdown. Gene Editing - Crispr Cas9

Unit IV: Applied Proteomics (6 Hours)

Large-scale preparation of proteins and peptides, Synthesis of peptides, Use of peptides as probes Two-hybrid interaction screens, Mass-spec based analysis of protein expression. "Protein Chip" - interactions and detection techniques, Two-dimensional PAGE for proteome analysis, Detection of proteins on SDS gels, Protein cleavage, Edman protein micro-sequencing, Automation in proteomics, Applications of proteome analysis to drug development and toxicology, Phage antibodies as tools for proteomics.

Practicals- (60 Hours)

- Isolation and analysis of plasmids
- Expression of proteins as inclusion bodies
- Isolation and refolding of the inclusion bodies
- Agarose Gel Electrophoresis
- SDS PAGE analysis
- Primer design
- Polymerase Chain Reaction (PCR)
- Restriction Digestion
- Cloning Strategy (Introductory Gene Cloning)

Essential Readings

- Principles and Techniques of Biochemistry and Molecular Biology, Wilson & Walker, Cambridge University Press, 2010
- Principles of Gene Manipulation and Genomics, Primrose and Twyman, Wiley-Blackwell 2013

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		
Mathematical modeling & simulation# DSE-4, VI.5.1	4	0	0	4	12 th pass with Maths	Linear Algebra, Differential Equations

This course will also be available to the students in semester IV

Learning Objectives

This interactive learning module intends to provide capabilities and basic understanding of system modelling and simulation performance. It will emphasis on analysis of dynamical behavior of physical, electrical, mechanical, social, biological, chemical, and financial systems along with applications in engineering and other applied sciences. The simulation will be done with the MATLAB software platform.

Learning outcomes

- After completing this course, student should be able to;
- Understand the mathematical and computational tools for modelling and simulation of various systems.
- Apply basic concepts of fractional calculus.
- Identify, model analyze, and simulate various systems using simulation tools.
- Know how the simulation help to analyze system graphically.
- Describe the behavior of different physical and virtual systems.

Syllabus

Practicals –

(120 Hours)

- Modeling of integer and non-integer systems
- Introduction to basic simulation tools
- Simulation performance of integer and non-integer systems
- Chaotic behavior of integer and non-integer systems
- Parameter optimization to improve the efficiency of the system
- Model validation and performance analysis with data
- Innovation Project

Essential/recommended readings

- Theory of modeling and simulation, Zeigler B.P., Praehofer. H., Kim I. G., 2nd Edition. Academic press, 2000.
- Theory of Fractional Dynamic Systems, Lakshmikantham, V., Leela, S., Vasundhara Devi, J. Cambridge Academic Publishers, Cambridge, 2009.

- Fractional-order nonlinear systems: modeling, analysis and simulation, Petras, I., SpringerVerlag Berlin Heidelberg, Germany, 2011.
- Chaos: An Introduction to Dynamical Systems, K.T. Alligood, Sauer, Tim D., Yorke James Springer, 1996.
- Nonlinear Dynamics and Chaos, Strogatz, S. Reading, MA: Addison-Wesley, 1994.
- Optimization and Dynamical Systems, Helmke U., Moore J. B, SpringerVerlag, 1993.

DISCIPLINE SPECIFIC ELECTIVE COURSE -4 (DSE-4)
VI.5.2. Computational Fluid Dynamics (CFD)

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		
Computational Fluid Dynamics[#] (CFD), DSE-4, VI.5.2	4	0	0	4	12th Pass With Maths	Calculus, Linear Algebra & Differential Equations

#This course will also be available to the students in semester IV

Learning Objectives

This interactive practical paper aims to enable the students to visualize different types of problems of flow and heat transfer in various fields. Blood flow within arteries, biological tissues, heat transfer within biological tissues, flow within circular pipes, flow within an aquifer are some of the important application of CFD. In this paper, students will visualize CFD models, mathematical analysis of these visualizations, simulate them numerically using mathematical softwares such as ANSYS, COMSOL and post process the obtained numerical results.

Learning Outcome

After completing this paper, students will be able;

- Visualise and implement mathematical models of flow and heat transfer problems in different applications.
- Implement existing CFD based modules in ANSYS/COMSOL for simulation purpose.
- Design of UDF based problem specific modules in ANSYS/COMSOL
- Validate their numerical results with experimental data (if available) for suggesting new designs.

Syllabus

Practicals -

(120 Hours)

- Governing equations for CFD: The continuity, momentum and energy equations with their physical interpretation
- Interpretation of different set of flow conditions such as inflow, outflow, no slip boundary etc as per problem requirement.
- CFD mesh generations, structured and unstructured mesh, mesh refinement (local & global), adaptive mesh.
- Implementation of existing CFD based modules in ANSYS/COMSOL for simulation purpose.
- Design and modification of existing modules using UDF (User defined functions) in ANSYS/COMSOL as per the problem requirement.
- Post-processing of numerically simulated results

Essential/ Recommended Readings:

- Computational Fluid Dynamics: A practical Approach (2019) by Jiyuan Tu, Guan Yeoh, Chaoqun Liu, 2nd Edition, Publisher: Butterworth-Heinemann.
- Computational Fluid and Particle Dynamics in the Human Respiratory system (2012) by Jiyuan Tu, Kiao Inthavong, Goodarz Ahmadi, Biological and Medical Physics, Bio-medical Engineering, Publisher: Springer.
- Multiphysics Modelling using COMSOL: A First Principle Approach (2011), by Roger W. Pryor, Jones and Bartlett Publishers, London, Singapore.

DISCIPLINE SPECIFIC ELECTIVE COURSE -4 (DSE-4) VI.5.3. Technology based solutions of societal issues

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		
Technology based solutions of societal issues, DSE-4, VI.5.3.	4	0	0	4	12 th pass	Programming Fundamentals, Basic knowledge of biology.

#This course will also be available to the students in semester IV

Learning Objectives

This course is designed for students to give them hands-on experience of working on interdisciplinary research problems, which may have direct impact or relevance for the linkage of society and technology. This will broaden their horizon regarding the identification of an issue and then step by step way of solving the same, either theoretically or experimentally by acquiring the required technology-based skill-sets.

Learning outcomes

After completing this course, student should be able to;

- Identify a research problem related to a societal issue, which may be solved using technology
- Acquire the required technical skill-sets, which will be needed for solving such problems
- Get the hands-on training for working on real societal issues requiring technology-based interventions, so that students can become more sensitive and responsible for solving such issues

Syllabus

Practicals –

(120 hours)

- Developing an understanding related to societal issues specifically in the sectors of water, food, electricity, textiles, housing, energy, defense and human health etc., which may require a technology-based intervention
- Identification of a problem as per interest of the student, and solving it using innovative and interdisciplinary approaches
- Working on problems based on artificial intelligence-based biosensors, Electrochemical biosensors, wearable biosensors etc. for various applications related to society
- Building machine learning models on various datasets specially related to health issues for the identification, diagnosis or prediction of the disease
- Computational modeling/ simulation of nanoparticles and their usage in drug delivery applications for various diseases. Examples can be like neuro-simulation of drug-loaded nanoparticles for understanding the pathway for diseases like mental depressive disorders.

Essential/recommended readings

- Sensing and Artificial Intelligence Solutions for Food Manufacturing; Editors: Charles Oluwaseun Adetunji, Daniel Hefft, CRC Press
- Mathematical Modeling of Biosensors by Romas Baronas, Felikas Ivanauskas, Juozas Kulys, (2021); Springer International publishing
- Biosensors and Nanotechnology: Applications in Health Care Diagnostics (2017), Editor: Zeynep Altintas; Wiley Publishers
- Research papers/ Reviews from peer reviewed reputed journals, related to the identified problem/ issue

DISCIPLINE SPECIFIC ELECTIVE COURSE -4 (DSE-4)**VI.5.4. Medical Imaging Techniques****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		
Medical Imaging Techniques#, DSE-4, VI.5.4	4	0	0	4	12 th Pass	Basic knowledge of python

#This course will also be available to the students in semester IV

Learning Objectives

This practical paper is designed to provide hands on experience to build data driven module for computer vision, with applications in medical image analysis. This practical paper enables the students to build deep learning architecture, such as filters, activation functions, loss functions; regularization techniques such as e.g. batch normalization and dropout. Student can implement different non-linear optimization algorithms that are used when training the medical imaging networks on different imaging tools.

Learning outcomes

- Training and validation of image dataset, classification and regression, supervised and unsupervised learning, bias and variance, loss function, generalization error, accuracy, precision, to medical image dataset.
- Can implement deep learning parameters, such as e.g. depth, learning rate, hyper parameter, overtraining and regularization in softwares.
- Implementation of different deep learning architecture for classification and segmentation of diagnosis of various diseases.
- Can simulate hybrid deep learning architecture and models used in medical imaging.

Syllabus**Practicals -****(120 Hours)**

- Implementation of basic Medical imaging tools.
- Feature extraction, segmentation, systematic evaluation and validation on medical image datasets using data driven architectures.
- Designing different machine learning and deep learning based models for segmentation and classification of medical imaging datasets.
- Performance analysis of different deep learning architecture in terms of statistical parameters.

- Case studies on some recent advances in analysis of retinal, CT, MRI, ultrasound and histology images.

Essential/recommended readings

1. The Handbook of Medical Image Perception and Techniques, by Ehsan Samei and Elizabeth A. Krupinski, second edition, Publisher Cambridge University Press.
2. Medical Imaging by DS Guru, K.C. Santosh, Nilanjan Dey, Sameer Antani, Publisher CRC Press.

DISCIPLINE SPECIFIC ELECTIVE COURSE -4 (DSE-4) VI.5.5. Computational Analysis of OMICS data

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		
Computational Analysis of OMICS data DSE 4, VI. 5.5.	4	0	0	4	12 th Pass	One programming language, Basic knowledge of statistics and biology.

Learning Objectives

This module is designed to:

- Introduce students the basic tools and processes of genetic engineering
- Introduce students to basic tools of genomics and proteomics
- Introduce students to building and analyzing networks involving complex biological data.

Learning outcomes

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

- develop skills in understanding the advancement of the genomic and proteomics branches of Sciences and their importance in manipulating genome and proteome.
- handle genome and proteome data.
- do mathematical prediction of high throughput data

SYLLABUS

(120 hours)

Practicals-

1. Computational analysis of genomics / proteomics / Metabolomics data

2. Large scale genome sequencing strategies and interpretation of results
3. Handling microarray data, SNPs and OMIMs
4. Transcriptome Analysis: Databases and basic tools: Gene Expression Omnibus (GEO)
5. Array Express, SAGE databases
6. RNA Sequencing
7. Active site prediction
8. Machine learning tools, such as Neural network, SVM etc.
9. Protein MS applications: Identifying unknown proteins by peptide mass fingerprinting; de novo sequencing of peptides from fragment ion spectra obtained by tandem MS; Protein arrays: basic principles.
10. Using bioinformatics tools for proteomics: SEQUEST, MASCOT etc.

Essential Readings

- Gary Hardiman, Ed, Systems Analytics and Integration of Big Omics Data, 2020, SBN 978-3-03928-744-4, <https://doi.org/10.3390/books978-3-03928-745-1>
- Bioinformatics for Omics Data Methods and Protocols, Edited by Bernd Mayer, emergentec biodevelopment GmbH, Vienna, Austria, Humana Totowa, NJ, 2011, 978-1-61779-027-0 Published: 03 March 2011
- Omics Approaches, Technologies and Applications, Integrative Approaches For Understanding OMICS Data, Edited by Preeti Arivaradarajan, Gauri Misra, 2018, Springer Nature, <https://doi.org/10.1007/978-981-13-2925-8>
- Big data in OMICS and Imaging, Momiao Xiong, Chapman and Hall/CRC, 2017.

DISCIPLINE SPECIFIC ELECTIVE COURSE -4 (DSE-4)

VI.5.6. Virtual Reality

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		
Virtual Reality#, DSE 4, VI. 5.6	4	0	0	4	Class XII pass with Maths	C ⁺⁺

#This course will also be available to the students in semester IV

Learning Objectives

The objective of this course is to provide a detailed understanding of the concepts of Virtual Reality and its applications

Learning outcomes

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

- Understand geometric modelling and Virtual environment.
- Be able to do 2D and 3D geometrical modelling
- Develop Virtual Reality applications.

Practicals -

(120 Hours)

The course will be conducted completely on a hands-on mode and project-based learning. The basic concepts will be explained and each concept will be augmented by small tasks in UNITY. Animations and physical simulations will be introduced to the students through an appropriate Virtual environment. Following tasks will be covered in the lab:

- Introduction to the Virtual environment
- Introducing frame of reference and modelling transformations
- Animation in virtual environment – projectile motion, flight/ car simulation, Ferris wheel, pendulums, etc.
- Visualising Human Anatomy/ geographical regions/ environment/ monuments in the VR environment
- Modelling a store/ classroom/ office/ mall in VR

Essential/recommended/ suggested readings

- Virtual Reality Systems, John Vince, Pearson Education India, 2002.
<https://all3dp.com/2/blender-3d-printing-tutorial/>
- Understanding Virtual Reality: Interface, Application and Design, William R Sherman and Alan B Craig, Morgan Kaufmann, 2018
- Virtual Reality, Samuel Greengard, MIT Press, 2019.
- Virtual and Augmented Reality, Paul Mealy, Wiley, 2018.

DISCIPLINE SPECIFIC ELECTIVE COURSE -4 (DSE-4)

VI.5.7. Complex 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		
Complex Systems, DSE 4, VI. 5.7	4	0	0	4	12 th Pass with Maths	Programming languages, data Structure, Algorithm design and analysis, Computer Networks, Discrete Mathematics

Learning Objectives

The objective of this course is to provide a practical and detailed understanding of the complex systems which can be found in various fields and disciplines, like sociology, political systems, biology, and economics etc.

Learning outcomes

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

- to understand the basics of complex systems and their importance.
- to recognise complex systems related to societal, environmental, engineering and scientific problems and to learn their basic features;
- to introduce a problem-solving approaches for complex systems.
- to get hands-on experience in studying and solving complex systems problems.

Syllabus

Practicals-

(120 Hours)

The course will be conducted completely on a hands-on mode and project based learning. The basic concepts will be explained and associated real world challenging problems will be identified.

- Practical exposure to complex systems in domains like global climate, organisms, the human brain, infrastructure such as power grid, transportation or communication systems, complex software and electronic systems, social and economic organizations (like cities).
- Experiment to model dependencies, competitions, relationships, or other types of interactions between their parts or between a given system and its environment.
- Practicals on problem solving on nonlinearity, emergence, spontaneous order, adaptation, and feedback loops, among others.
- Practical on network approach a solution to complex problems where the nodes represent the components and links to their interactions.
- Students will be exposed to the practical application of complex systems concepts and problem-solving approaches on such real world problems.

Essential/recommended/ suggested readings

- Bar-Yam, Y. (2019). Dynamics of complex systems. CRC Press.
- Cilliers, P. (2002). Complexity and postmodernism: Understanding complex systems. Routledge.
- Dekker, S. (2016). Drift into failure: From hunting broken components to understanding complex systems. CRC Press.

DISCIPLINE SPECIFIC ELECTIVE COURSE -4 (DSE-4)

VI.5.8. Research Methodology

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		
Research Methodology, DSE 4, VI. 5.8	4	0	0	4	12th Pass	NIL

Learning Objectives:

The course is designed to make students understand about what, why and how to conduct research includes nature and purpose of research, identifying research problems, building research design, appropriate selection of research tools and methods for data analysis and also developing the base of future researches

Learning Outcomes

After completing the course, student should be able to

- Identify a research problem
- Formulate hypotheses
- In depth literature review
- Plan research design
- Use research tools and techniques, methods of analysis
- Ethics in research
- Communication skills

Practicals –

(120 Hours)

- Art of reviewing research articles, identification of research gap and finding research problems, framing research objectives, Outline for research proposal.
- How to conduct an exploratory study, Experiments, Quantitative and qualitative study based on research questions and objectives, Data coding and entry to the software, Analysis of data through various tools, applications and research techniques such as regression and correlation, Hypothesis testing and inferences
- Familiarity with data collection software, E-resource library system with journals, books and publications, Usage of the data analysis and software.
- Directing students to follow report writing conventions, citations, acknowledgements, checking originality of the work vis plagiarism software and abiding research ethics, Presentation of work, how to get the research work published in a reputed journal.

Suggested Readings:

- Kitsakorn Locharoenrat, Research Methodologies for Beginners, Pan Stanford Publishing Pte. Ltd., Singapore, 2017.
- C. R. Kothari, Research Methodology: Methods and Techniques, New Age International, 2004, ISBN 8122415229, 978812241522.

- Kumar R. Research Methodology: A step by step Guide for Beginners (2010) 3rd ed., Pearson Education. (ISBN-13: 978-1849203012)
- Relevant study material from ACM, IEEE, Elsevier, Springer
- Levin, R. I and D.S. Rubin, Statistics for Management, Prentice Hall of India.
- Aczel, Amir D., and Sounderpandian, J., Complete Business Statistics, Tata McGraw Hill Publishing

Semester VII

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		
Data Mining and Data Warehousing DSC-19	4	3	1	0	Class XII pass	Database Management system

Learning Objectives

This course objective is to introduce data mining principles and techniques. Introduce data mining as a cutting edge business intelligence tool. Develop and apply critical thinking, problem solving and decision making skills. Introduce the concepts of Data Warehousing, difference between database and data warehousing. Describe and demonstrate basic data mining algorithms, methods, and tools.

Learning outcomes

After completing this course, student should be able to;

- Design a data warehouse to present information needed by the end can be utilized for managing clients.
- Design and implement a quality data warehouse effectively and administer the data resources in such a way that it will truly meet management's requirements.
- Evaluate standards and new technologies to determine their potential impact on your information resource for a large complex data warehouse/data mart.
- Use data mining tools for projects and to build reliable products as per demand.

SYLLABUS OF DSC-19

Unit I: Overview: The process of knowledge discovery in databases, predictive and descriptive data mining techniques, supervised and unsupervised learning techniques. Data preprocessing: Data cleaning, Data transformation, Data reduction, Discretization. (9 hours)

Unit II: Classification: Supervised learning for predictive data mining, Basic issues in predictive data mining Decision trees, Decision rules, Statistical classification, Instance-based methods (nearest neighbor), Evaluation and Validation methods.

- (9 hours)
- Unit III: Clustering: Unsupervised learning for descriptive data mining, Basic issues in clustering, Partitioning methods, Hierarchical methods for clustering, Density-based methods, Cluster Validation methods and metrics. Association Rule Mining: Frequent item set, Maximal and Closed itemsets, Apriori property, Apriori algorithm. (12 hours)
- Unit IV: Data Warehousing: Overview, Definition, Delivery Process, Difference between Database System and Data Warehouse, Multi-Dimensional Data Model, Data Cubes, Stars, Snow Flakes, Fact Constellations, Concept hierarchy, Process Architecture, 3 Tier Architecture, Data Marting. (12 hours)

Essential/recommended readings

1. Jiawei Han, Micheline Kamber, "Data Mining Concepts & Techniques" Elsevier.
2. Mallach,"Data Warehousing System",McGraw –Hill.
3. H.Dunham,"Data Mining:Introductory and Advanced Topics" Pearson Education.
4. Sam Anahory, Dennis Murray, "Data Warehousing in the Real World : A Practical Guide for Building Decision Support Systems, Pearson Education.
5. Charu C Agrawal, Data Mining: The Textbook, Springer, 2015.
6. J Zaki Mohammed and Wagner Meira, Data Mining and Analysis: Fundamental Concepts and Algorithms, Cambridge University Press, 2014.
7. P. Tan, M. Steinbach, A Karpatne, and V. Kumar, Introduction to Data Mining, 2nd Ed., Pearson Education, 2018.

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

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE):

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Theory of Computation (DSE)	4	3	1	0	Class XII pass	Programming languages and linear algebra

Learning Objectives

The objective is to introduce students to the mathematical foundations of computation including automata theory; the theory of formal languages and grammars; the notions of algorithm, decidability, complexity, and computability.

Learning outcomes

After completing this course, student should be able to;

- Understanding of Sets and Graphs
- Understanding and implementation of Digital abstraction
- Philosophy of automata and machine
- Exposure to the Combinatorial Logic
- Exposure to turing machine
- Introduction to Context-free languages and their significance

SYLLABUS

Unit 1 : Need for automata theory - Introduction to formal proof – Finite Automata (FA) – Deterministic Finite Automata (DFA) – Non-deterministic Finite Automata (NFA) – Equivalence between NFA and DFA – Finite Automata with Epsilon transitions – Equivalence of NFA and DFA- Equivalence of NFAs with and without ϵ -moves- Conversion of NFA into DFA – Minimization of DFAs. (12 hours)

Unit 2 : Regular expression – Regular Languages- Equivalence of Finite Automata and regular expressions – Pumping Lemma – Closure properties of regular languages. (9 hours)

Unit 3: Types of Grammar - Chomsky's hierarchy of languages -Context-Free Grammar (CFG) and Languages – Derivations and Parse trees – Ambiguity in grammars and languages – Push Down Automata (PDA) (9 hours)

Unit 4: Normal forms for CFG – Simplification of CFG- Chomsky Normal Form (CNF) and Greibach Normal Form (GNF) – Pumping lemma for CFL – Closure properties of Context Free Languages –Turing Machine : Basic model – definition and representation , Recursive and recursively enumerable languages – Properties (12 hours)

Essential/recommended readings

1. Introduction to Automata Theory, Languages, and Computation, John E. Hopcroft, Rajeev Motwani, Jeffrey D Ullman, 3rd Edition, 2013
2. Introduction To Computer Theory, Daniel I. A. Cohen, 2nd Edition, 2007
3. Computation Structures. Stephen Ward & Robert Halstead, MIT Electrical Engineering and Computer Science, 1989.
4. Discrete computational structures, Robert R. Korfhage, Academic Press, 1974
5. Peter Linz, "An Introduction to Formal Language and Automata", 6th Edition, Jones & Bartlett, 2016.
6. K.L.P.Mishra and N.Chandrasekaran, "Theory of Computer Science: Automata Languages and Computation", 3rd Edition, Prentice Hall of India, 2006.

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

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		
Computational Social Systems (DSE)	4	3	1	0	Class XII pass	Programming languages and Artificial intelligence

Learning Objectives

This interdisciplinary course encompasses the recent groundbreaking research and its applications to the interface of machines, society, and human beings. The course uses present-day digital technologies, data science, and artificial intelligence techniques and approaches in several fields. The course also deals with making data-driven processes more efficient and productive, primarily through urban computing, innovative governance, and smart cities to contribute toward sustainable development goals (SDGs).

Learning outcomes

The course will have the following Course Learning Outcomes.

- Will have understanding of Computational Social Sciences
- Will have understanding of the important aspects of digital humanities.
- Will have understanding of Privacy and Security related issues.
- Will have understanding of applying intelligent approaches to problems in urban computing, Smart Governance, and Smart Cities.
- Will have understanding of Intelligent transportation systems.
- Will have understanding of the analysis of social/ economic phenomena or structures using computational approaches

SYLLABUS

Unit I: Foundations of Computational Social Science: Overview of Computational Social Systems(CSS) and Digital Humanities, Evolution of computational approaches in social sciences and humanities, Collection of web and social media data, Web scraping, Text and image data extraction from social platforms (9 hours)

Unit II: Networks, Society, and Computational Methods: Social Network Analysis (SNA), Basics of graph theory: nodes, edges, centrality, and clustering Network metrics: degree distribution, modularity, and connectedness Community detection algorithms, Agent-based modelling, Natural language processing (NLP) for sentiment and discourse analysis, Predictive modelling and causal inference in societal studies, Role of networks in shaping opinions and behaviours (e.g., polarization, echo chambers), Computational propaganda and misinformation. (15 hours)

Unit III: Advanced Research Topics and Case Studies Behavioral and Cultural Analysis: Social behaviour modelling, Cultural analytics through multimedia and text mining, Social Impact Measurement (e.g., climate activism, public health initiatives), Social influence and diffusion modelling, CSS for sustainable development goals (SDGs) (10 hours)

Unit IV: Applications of Computational Social Systems and AI Ethical Issues: Urban Governance Challenges and Solutions, Consumer behaviour modelling and recommendation, Smart information systems and their role in governance, Digital Ethics in Computational Social Systems, Responsible AI for public systems, Algorithmic Bias and Challenges, Fairness and Accountability of algorithms, Governance frameworks for AI. (9 hours)

Essential/recommended readings

1. Bit by Bit: Social Research in the Digital Age, Matthew Salganik, 2013
2. Cioffi-Revilla, Claudio. "Introduction to computational social science." London and Heidelberg: Springer (2014).
3. Lazer, D. M., Pentland, A., Watts, D. J., Aral, S., Athey, S., Contractor, N., ... & Wagner, C. (2020). Computational social science: Obstacles and opportunities. *Science*, 369(6507), 1060-1062.
4. Zheng, Y., Capra, L., Wolfson, O., & Yang, H. (2014). Urban computing: concepts, methodologies, and applications. *ACM Transactions on Intelligent Systems and Technology (TIST)*, 5(3), 1-55.
5. Zheng, Yixian, Wenchao Wu, Yuanzhe Chen, Huamin Qu, and Lionel M. Ni. "Visual analytics in urban computing: An overview." *IEEE Transactions on Big Data* 2, no. 3 (2016): 276-296.
6. Lo Piano, S. (2020). Ethical principles in machine learning and artificial intelligence: cases from the field and possible ways forward. *Humanities and Social Sciences Communications*, 7(1), 1-7.
7. Schönberger, D. (2019). Artificial intelligence in healthcare: a critical analysis of the legal and ethical implications. *International Journal of Law and Information Technology*, 27(2), 171-203.

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE):

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		
Network Science (DSE)	4	3	1	0	Class XII pass	Programming languages and Artificial intelligence, Data structure and design

Learning Objectives

This is an interdisciplinary course encompassing the recent groundbreaking research and its applications in complex problems and issues faced by humans and communities. It will explore the digital spaces and their entities from a network point of view.

Keywords: Social networks analysis; Communities; Network Dynamics; Complex issues.

Learning Outcomes

The course will have the following Course Learning Outcomes.

- Will have understanding of Network science concepts
- Will have understanding of Graphs and Networks
- Will have understanding of network dynamics and the practical problems associated with it.
- Will have an understanding of Intelligent transportation systems.
- Solve real-world problems modelled as complex networks

SYLLABUS

Unit I: Foundations of Network Science: Introduction to Network Science, Historical evolution and interdisciplinary nature of network science, Real-world examples: biological, technological, social, and economic networks, Basic Concepts Types of networks: undirected, directed, weighted, and bipartite networks, Representation of networks: adjacency matrix and edge list Network motifs and substructures. (10 hours)

Unit II: Graph Theory and Social Network Analysis: Graph Theory Fundamentals Key concepts: paths, cycles, connectivity, cliques, and components, Properties of networks: degree distribution, clustering coefficient, and shortest path, Centrality measures: degree, betweenness, closeness, and eigenvector centrality Identifying influential nodes and authorities (e.g., PageRank), Social Network Analysis (SNA): Structural analysis of social systems and applications (10 hours)

Unit III: Communities, Spreading Phenomena, and Societal Impacts: Community Detection Modularity optimization and algorithms: Louvain, Girvan-Newman, and spectral clustering, Overlapping and hierarchical communities and applications, Spreading Phenomena in Networks Epidemic models, Measuring and mitigating polarization Case studies: social media platforms and political discourse. (15 hours)

Unit IV: Network Dynamics and Temporal Evolution: Network Dynamics Cascading behaviours: threshold and tipping-point models Influence maximization: greedy algorithms and heuristics Information diffusion models: independent cascade and linear threshold models, Applications: tracking disease spread, communication networks, and transportation systems. (15 hours)

References

1. Albert-László Barabási, Márton Pósfai, Network Science, Cambridge University Press, 2021
2. Borgatti, Stephen P., Ajay Mehra, Daniel J. Brass, and Giuseppe Labianca. "Network analysis in the social sciences." *Science* 323, no. 5916 (2009): 892-895.
3. Easley, D., & Kleinberg, J. (2010). *Networks, crowds, and markets: Reasoning about a highly connected world*. Cambridge University Press.

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE):

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)
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		Lecture	Tutorial	Practical / Practice		
Deep Learning and Applications (DSE)	4	3	1	0	Class XII pass	Programming languages and Artificial intelligence, Data structure and design

Learning Objectives

It is an introductory course on deep learning methods with applications to computer vision and natural language processing in several fields. Students will gain foundational knowledge of deep learning algorithms and practical experience building deep neural networks.

Learning outcomes

- Will have understanding of deep neural networks
- Will have understanding of the design of single and multi-layer feed-forward deep networks and tune various hyper-parameters.
- Will have an understanding of the practical aspects of Deep Learning.

SYLLABUS

Unit I: Introduction to Machine Learning and Deep Learning: Overview of learning paradigms: supervised, unsupervised, and reinforcement learning, Fundamentals of machine learning (ML) and deep learning (DL), and the distinctions between the two, Introduction to deep neural networks and their role in modern AI applications. (9 hours)

Unit II: Deep Learning Architectures and Optimization: Deep feedforward networks and their implementation for real-world problems, Techniques for regularization and optimization to improve deep learning model performance, Key strategies for training deep models effectively, including backpropagation and gradient descent. (9 hours)

Unit III: Advanced Deep Learning Models: Convolutional neural networks (CNNs) for image processing and computer vision tasks, Sequence modeling with recurrent neural networks (RNNs) and recursive nets for time-series and language data. (15 hours)

Unit IV: Practical Applications and Advanced Models: Methodologies for applying deep learning to real-world problems in various domains, Exploration of autoencoders, representation learning, and deep generative models like GANs, Introduction to linear factor models and their use in data compression and anomaly detection. (9 hours)

Essential/recommended readings

1. Ian Goodfellow, Deep Learning, MIT Press, 2016.
2. Jeff Heaton, Deep Learning and Neural Networks, Heaton Research Inc, 2015.
3. Mindy L Hall, Deep Learning, VDM Verlag, 2011.
4. Li Deng (Author), Dong Yu, Deep Learning: Methods and Applications (Foundations and Trends in Signal Processing), Now Publishers Inc, 2009.

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE):

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		
Business Intelligence and Advance Data Analytics (DSE)	4	3	1	0	Class XII pass	Programming languages and Artificial intelligence

Learning Objectives

Data analytics and business intelligence (BI) are of great importance in today's world. Data analysis is required to understand organisational problems and to explore data. At the same time, business intelligence helps companies make better decisions by showing current and historical data within their business context. Course aims of leveraging Data Analysis and Business Intelligence skills to help understand trends and derive actionable insights from data, thus allowing us to make data-driven, strategic and tactical business decisions.

Keywords: Data Analytics, Machine Learning, Management, Social Media, Business Intelligence

Learning Outcomes

- Develops business analytics foundation through machine learning for data analysis.
- the students will be able to enhance their skills in data analysis, python programming for machine learning and Python/ R programming for statistical methods.
- They will also be able to find answers to the questions they don't know the answers to.
- will help them to adapt themselves to the automated future of business intelligence.

SYLLABUS

Unit I: Fundamentals of Data and Analytics Overview of data types, sources, and collection methods for business applications, Basics of data analytics: descriptive, diagnostic, predictive, and prescriptive analytics, Role of data in driving business intelligence and decision-making. (9 hours)

Unit II: Machine Learning for Business Intelligence: Introduction to machine learning concepts and algorithms for business, Building predictive and classification models for business decision

support, Applications of machine learning in forecasting, optimization, and customer insights. (15 hours)

Unit III: Data Analytics for Business Functions: Applications in product strategy, sales, marketing, and consumer behaviour analysis, Financial decision-making using advanced data analytics techniques, Leveraging analytics to optimize pricing, segmentation, and customer experience. (9 hours)

Unit IV: Advanced Applications of Business Analytics: Data analytics for digital and social media strategy, including content optimization, Innovation and entrepreneurship supported by analytics-driven insights, Operational analytics for supply chain management, logistics, and resource allocation. (9 hours)

Essential/recommended readings

1. Sherman, R. (2014). Business intelligence guidebook: From data integration to analytics. Newnes.
2. Negash, S., & Gray, P. (2008). Business intelligence. *Handbook on decision support systems 2*, 175-193.
3. Moss, L. T., & Atre, S. (2003). Business intelligence roadmap: the complete project lifecycle for decision-support applications. Addison-Wesley Professional.
4. Chaudhuri, S., Dayal, U., & Narasayya, V. (2011). An overview of business intelligence technology. *Communications of the ACM*, 54(8), 88-98.
5. Minelli, M., Chambers, M., & Dhiraj, A. (2013). *Big data, big analytics: emerging business intelligence and analytic trends for today's businesses* (Vol. 578). John Wiley & Sons.

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE):

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		
Natural Language Processing (DSE)	4	3	1	0	Class XII pass	Database management system and Artificial intelligence

Learning Objectives

This course objective is to train students in advanced understanding of NLP, Deep learning approaches and their implementation. In addition, the course introduces deep learning

frameworks such as TensorFlow and solves real-world problems through projects on sentiment analysis, sentence classification, and speech recognition.

Learning outcomes

After completing this course, students should be able to;

- Will have a deep and advanced understanding of Natural Language Processing concepts.
- Will have experiment-level knowledge of Deep learning approaches.
- Will have understanding of real-world projects on NLP in text, audio or video.
- Will have understanding of NLP applications in Emotional recognition, Speech recognition, translation, etc.

SYLLABUS

Unit I: Advanced Concepts in NLP – Deep Learning Approaches: Exploration of deep learning methods for Natural Language Processing (NLP), Overview of key techniques and models, including word embeddings and neural network architectures for NLP tasks. (9 hours)

Unit II: Word Representations and Named Entity Recognition: Simple and advanced word vector representations, such as Word2Vec and GloVe, Introduction to named entity recognition (NER) and its applications in text processing, Basic overview of TensorFlow and its use in language modelling and NLP tasks. (15 hours)

Unit III: Machine Translation, Parsing, and Sentiment Analysis: Deep learning techniques for machine translation and syntactic parsing, Implementing sentiment analysis using neural networks for text classification. (10 hours)

Unit IV: Sentence Classification, Speech Recognition, and Advanced Translation: Methods for sentence classification tasks, including text categorization, Introduction to speech recognition models and applications, and Advanced techniques for improving machine translation systems. (9 hours)

Essential/recommended readings

1. Foundations of statistical natural language processing, Manning, C. D., Manning, C. D., & Schütze, MIT Press, 1999.
2. Speech and language processing: An introduction to natural language processing. Computational linguistics, and speech recognition, Jurafsky, D, 2010.
3. Deep Learning (Adaptive Computation and Machine Learning), Ian Goodfellow, Yoshua Bengio , Aaron Courville, Francis Bach, 2016.
4. Deep Learning for Computer Vision with Python, Adrian Rosebrock, 2018.

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

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE):

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		
Operation Research (DSE)	4	3	1	0		Linear Algebra, Linear Programming

Learning Objectives

This course should help the students to understand the nature and scope of decision making affairs and apply different operation research techniques to industrial problems. This course provides understanding to formulate shortest route problems, network modal and various dynamic programming applications. Also it provides students to choose a suitable operation research technique to solve many real life problems.

Learning outcomes

- Formulate various operation research models
- Learn to relate OR modals with many real life situations.
- Learn network models using CPM and PERT.
- Formulate integer programming algorithms for nonlinear models.
- Able to simulate various optimization problems using OR techniques

SYLLABUS

Unit I Introduction of OR, Formulation of basic OR modals: traveling salesman problem, inventory models, shortest route algorithm (9 hours)

Unit II Network Modal, Shortest route problems, CPM and PERT, Critical Path Computation, Construction of time schedule, Linear programming formulation of CPM, PERT calculations (12 hours)

Unit III Integer linear programming, applications of integer programming: Capital Budgeting, Fixed Charge Problem, Branch & Bound Method to traveling salesman problem, cutting plane algorithm (12 hours)

Unit IV Deterministic Dynamic Programming, DP Applications: Investment Modal, Inventory Modal, Static Economic order quantity EOQ models. (10 hours)

Essential/recommended readings

1. *Introduction to Operations Research*, F. S. Hillier and G. J. Lieberman, (9th Edition), Tata McGrawHill, Singapore, 2009.
2. *Operations Research, An Introduction*, Hamdy A. Taha, (8th edition), Prentice-Hall India, 2006.

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

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE):

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Mathematical Modeling with emphasis on Robotics (DSE)	4	3	1	0		Calculus, Linear Algebra, Ordinary Differential Equations

Learning Objectives

This interactive learning module intends to provide capabilities and basic theoretical understanding of kinematics and dynamics with special emphasis on learning how these concepts are applied in designing robotic systems. It will also provide an insight of the technology that deals with the design, construction, and operation and its application in manufacturing and automation processes.

Learning outcomes

After completing this course, student should be able to;

- understand the mathematical model of different types of robot
- describe the architecture of robots
- explain kinematics and dynamics modeling of robots
- understand the motion analysis and control of robot
- understand the application of robot in different fields

SYLLABUS

Unit I:

Introduction to Robotics and its Applications, Links, Joints, Degrees of Freedom, Position and Force/Torque, Workspace, Robot Transformations, Robot Parameters, D-H Algorithm. (9 hours)

Unit II:

Forward and Inverse Kinematics, Cartesian and Joints Space, Velocity Mapping, Forward Kinematics of n Degrees of Freedom Robotic Arm, Inverse Kinematics of 3 Degrees of Freedom Robotic Arm. (12 hours)

Unit III:

Redundant Robot Manipulators, Mobile Robots, Dynamic Analysis of Robots, Trajectory Generators, Motion analysis, Error Dynamics Model. (12 hours)

Unit IV:

Trajectory Tracking Control, Robust Control, Sliding Mode Control, Model-Based Control, Feedback Control, Lyapunov Stability Analysis and Performance Evaluations. (10 hours)

Essential/recommended readings

1. *Introduction to Robotics*, J. J. Craig, Prentice Hall, 2003.
2. *Introduction to Robotics, Analysis, Systems, Applications*, S. B. Niku, Prentice Hall, 2001.
3. *Fundamentals of Robotics Analysis and Control*, R. J. Schilling, PHI Learning, 2009.
4. *Robot Modeling and Control*, M. W. Spong, S. Hutchinson, M. Vidyasagar, John Wiley and Sons, Inc., 2005.
5. *Handbook of Robotics*, B. Siciliano, O. Khatib, Springer 2008.

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

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE):

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		
Biological Networks and Data Analysis (DSE)	4	2	0	2	12th Pass	Programming languages

Learning Objectives

This module is designed to:

- Introduce students to the complexity of biochemical pathways in living systems
- Introduce students to building and analyzing networks involving complex biological data.

Learning outcomes

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

- Comprehend the complexity of biochemical pathways and will be able to build and analyze biological networks
- Handle biological network-building databases such as STRING, Cytoscape and many more.

SYLLABUS

- Unit I: Complex biochemical pathways (6 hours)
 Importance of pathways and networks in biological systems, Examples of networks from biological systems, Inter and intra-cellular networks
- Unit II: Types and Examples of Biological Networks (8 hours)
 Ecological network, Circulatory network, Neurological network, Metabolic network, Cellular networks and Gene regulation networks, Protein interaction networks
- Unit III: Building and analysis of networks (8 hours)
 Building gene and protein networks using STRING and Cytoscape and other databases and determination of master regulator genes
- Unit IV: Applications of Biological Networks (8 hours)
 Tree of life and macroevolution

Practical components (30 hours)

- o Practical exposure to STRING and Cytoscape for building and analysis of protein and gene networks
- o Microarray Analysis
- o Building Ecological Models
- o Neural Networks
- o Energy calculations in complex ecological food webs
- o Analysis of models related to gene regulation, epigenetic and other networks
- o Networks as filters and integrators of biological information
- o network diffusion methodology
- o Network prediction of gene function
- o Network distance between two samples
- o Inference of disease and patient networks

Essential/recommended readings

1. Molecular Biology of the Cell, Alberts et al., Garland Science, 5 edition 2007.
2. Molecular Cell Biology, Lodish et al., W. H. Freeman & Company, 7 edition, 2012.
3. Cline, M.S. et al. Integration of Biological Networks and Gene Expression Data Using Cytoscape. Nature protocols 2, 2366 (2007).
4. Hagberg, A., Swart, P. & S Chult, D. Exploring Network Structure, Dynamics, and Function Using Networkx. (Los Alamos National Lab.(LANL), Los Alamos, NM (United States), 2008).
5. Maere, S., Heymans, K. & Kuiper, M. Bingo: A Cytoscape Plugin to Assess Overrepresentation of Gene Ontology Categories in Biological Networks. Bioinformatics 21, 3448-3449 (2005).
6. Saito, R. et al. A Travel Guide to Cytoscape Plugins. Nature methods 9, 1069 (2012).
7. Shannon, P. et al. Cytoscape: A Software Environment for Integrated Models of Biomolecular Interaction Networks. Genome research 13, 2498-2504 (2003).
8. Subramanian, A. et al. Gene Set Enrichment Analysis: A Knowledge-Based Approach for Interpreting Genome-Wide Expression Profiles. Proceedings of the National Academy of Sciences 102, 15545-15550 (2005).

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE):

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		
A mathematical approach to signal processing DSE	4	3	1	0		Calculus, Linear Algebra, Ordinary Differential Equations

Learning Objectives

Signal processing is, in a sense, application of various mathematical tools that primarily consist of Fourier Transforms, Laplace Transforms and z – Transforms. Through this course a student would learn the necessary mathematical background and tools in order to comprehend and deploy signal processing techniques in an applied environment. The emphasis would be on some fundamental problems and essential tools, as well as on their applications to digital signal processing.

Learning outcomes

After completing this course, student should be able to:

- Identify, understand and differentiate between discrete time system and continuous time system
- Apply mathematical tools – Laplace transform, Z transform and Fourier transform to various signals
- Implement different signal types on matrix based numerical based software

SYLLABUS

Unit I: Fourier Series and Fourier coefficients; Complex exponential function; Fourier Transforms and their basic properties; Some Fourier transform pairs; Dirac delta; Inverse Fourier transforms (12 hour)

Unit II: Classification of Signals; LTI system; Convolution; Impulse response representation of LTI system and its properties; Differential and Difference equation representation of LTI system; Application of Fourier Series and Fourier transforms to Discrete and Continuous periodic and non-periodic signals (12 hour)

Unit III: Laplace Transform; Inverse Laplace Transform; Solving Differential equation with initial conditions using Laplace Transform, Representing signals by using continuous time complex exponentials (10 hours)

Unit IV: z -Transform; Properties of z -Transform; Inverse of z -Transform; Representing signals by using discrete time complex exponentials (9 hours)

Essential/recommended readings

1. C. L. Byrne, "Signal Processing: A Mathematical Approach", 2 Ed., CRC Press, 2015.
2. Haykin, S. and Van Been, B., "Signals and Systems" 2 Ed., John Wiley & Sons, 2003.
3. Oppenheim, Alan, and Alan Willsky. Signals and Systems. 2nd ed. Prentice Hall, 1996.

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

Generic Elective: (GE)**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		
Environment Management (GE)	4	2	0	2	Class XII pass.	Nil

Learning Objectives

Course Objective: Provides an understanding of how to identify and evaluate the environmental impacts of developmental projects or product/service. Understanding the nature of environmental impact and minimizing the impact within the context of Environmental management. It demonstrates the types of information required for assessing the impacts of a proposal on specific environmental parameters. To impart knowledge of geospatial modelling in evaluating and mitigating the environmental impacts.

Learning outcomes

After completing this course, student should be able to;

- o to evaluate the Environmental Impact Assessment (EIA) &
- o to understand the legal frameworks associated with Environment in India.
- o to use Geospatial and environmental information through opensource.
- o to prepare basic maps e.g., elevation, vegetation etc.
- o to classify Land use and Land cover information and maps.
- o to assess urbanization through spectral band index.

- o to quantify the complex environmental impacts through GIS.

SYLLABUS

Unit I: Introduction to Environmental Impact Assessment (EIA) and Environmental Management (EM). EIA: Scoping, Public consultation, Expert appraisal committee and Environmental clearance of various projects; Introduction to Satellite remote sensing and Geographical information system (8 hours)

Unit II: Satellite image processing: Land use Land cover, Spectral bands of vegetation through Normalized difference vegetation index (NDVI), Ecosystem modelling: Satellite topographical data) and NDVI, Urbanization, Urban Planning and Growth - Central Place Theory (8 hours)

Unit III: Geometry and Ordering, Burgess Model for City Planning, Growth Pole and Growth Centre Theory and Demographic Transition Mode, Waste Management; Municipal Solid Waste Management, Hazardous Waste Management & Radioactive Waste Management, Waste Management: Physicochemical Treatment of Solid and Hazardous Waste, Biological Treatment of Solid and Hazardous Waste & landfill design (8 hours)

Unit IV: Environmental management tools and techniques of sustainable development. Environmental Law (6 hours)

Practical component – (30 hours)

- Environmental Impact modelling
- Environmental Index modelling
- Environmental Impact assessment using spatial database.
- Urbanization and urban sprawl assessment using satellite data.

Essential/recommended readings

1. Environmental Management: Principles and Practice (Routledge Environmental Management Series), Chris Barrow, Routledge, 2003.
2. Environmental Management in Organizations: The IEMA Handbook, John Brady, Alison Ebbage and Ruth Lunn, Earthscan, Washington, DC., 2011.
3. Essentials of Environmental Management, Paul Hyde and Paul Reeve, IOSH Services Ltd. (U. K.), 2004.
4. Textbook of Environmental Studies, Erach Bharucha, UGC 5. Fundamental Concepts in Environmental Studies, D D Mishra, S Chand & Co Ltd

Generic Elective: (GE)

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/ Practise			
Principles of Financial Decision Making	4	3	1	0	Class XII pass	Basic knowledge of business and management concepts	Management Faculty of CIC

Learning Objectives

1. To provide students with foundational knowledge of financial principles.
2. To enable students to understand the role of finance in technology-driven businesses.
3. To develop analytical skills for financial decision-making in IT projects.
4. To bridge the gap between technical expertise and business acumen.

Learning outcomes

By the end of the course, students will:

1. Understand the fundamental principles of financial management.
2. Evaluate investment opportunities and assess project feasibility.
3. Manage the financial aspects of IT operations and projects effectively.
4. Apply financial tools and techniques to optimize decision-making in technology-based enterprises.

SYLLABUS OF GE-7

Unit I- Introduction to Financial Management: Definition, Scope, and Objectives of Financial Management, Financial Management in Technology-Oriented Businesses, Role of IT in Modern Financial systems. Financial Statements and Analysis: Understanding Financial Statements: Balance Sheet, Profit & Loss Statement, and Cash Flow Statement, Ratio Analysis and Its Application in IT Projects, Importance of Financial Metrics for IT Firms (e.g., Return on Investment (ROI), Payback Period, Net Present Value (NPV)). **(13 hours)**

Unit II- Time Value of Money and Investment Decisions: Concept of Time Value of Money: Present and Future Value, Evaluation of Investment Decisions: Payback Method, NPV, Internal Rate of Return (IRR), Risk Analysis in IT Investments. **(10 hours)**

Unit III- Financing and Capital Structure: Sources of Finance for IT Companies (Venture Capital, Private Equity, Debt). Optimal Capital Structure and Cost of Capital. Impact of Technology Trends on Financing. Budgeting and Cost Control: Principles of Budgeting in IT

Projects, Types of Budgets: Operating, Capital, and Cash Budgets, Techniques for Cost Control in IT Systems and Infrastructure. **(9 hours)**

Unit IV- Working Capital Management: Definition and Components of Working Capital, Managing Receivables, Inventory, and Payables, Working Capital Challenges in IT Companies. Emerging Trends in Financial Management: FinTech and Its Applications in Financial Management, Financial Impact of AI, Big Data, and Cloud Computing, ESG (Environmental, Social, and Governance) Factors in Financial Decision-Making. **(10 hours)**

Essential/recommended readings

Pandey, I. M. (2021). *Financial management* (12th ed.). McGraw-Hill Education.

Chandra, P. (2022). *Financial management: Theory & practice* (11th ed.). McGraw Hill.

Generic Elective: (GE)

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)	Department offering the course
		Lecture	Tutorial	Practical/ Practice			
Biodefense and Bioengineering	4	2	0	2	12 th Pass	Nil	Biology faculty of CIC

Learning Objectives

This module is designed to:

- Introduce students to the complexity of the immune system, infections
- Introduce students to tools and techniques related to immunity including the development of vaccines and immunological tests.

Learning outcomes

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

- Comprehend the complexity of the immune system
- Develop an understanding of the basis of functioning the immune system against infections and cancer
- Develop skills in immunological techniques such as ELISA, DOPE test, simulated pregnancy test etc.

SYLLABUS

Unit I: Overview of Immune system

(6 hours)

Immune system and its classifications, types of immunity, cells and organ of the immune system

Unit II: Mechanisms of immunity (8 hours)

Humoral and cell-mediated immunity, antigen and antibody interaction, antibody structure and classification, Ag-Ab complex and clearing

Unit III: Tools and Techniques related to Immunology (8 hours)

Western blotting, Immunoprecipitation, Immunolocalization, ELISA, Immunodiffusion, Rocket Electrophoresis, DOPE test, production and purification of monoclonal and polyclonal antibodies, applications.

Unit IV: Emerging pathogens and host-pathogen interactions (8 hours)

New pathogens and diseases, single chain antibody engineering, AIDS, cancer and other disease immunity

Practical components (30 hours)

1. Blood smear preparation and staining
2. Immunodiffusion demonstration
3. ELISA test
4. Western blotting
5. Immunoprecipitation
6. Pregnancy test (Simulation experiment)

Essential/recommended readings

1. *Kuby Immunology*, Owen and Punt, W. H. Freeman & Company, 7 edition, 2013.
2. *Microbiology: an introduction*, Tortora et al., Benjamin Cummings, 11 edition 2012.
3. *Immunology and Immunotechnology*, Ashim K Chakravarty, , O.U. P, 1 edition, 2006.
4. *The Biology of Cancer*, Robert Weinberg, Garland Science

Generic Elective: (GE)

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)	Department offering the course
		Lecture	Tutorial	Practical/ Practice			
Devices and Nanotechnology (GE)	4	3	1	0	Class XII pass	Functional knowledge on electronic	Physics/Electronics faculty of CIC

						s and circuit analysis	
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Course Objective

This module provides interactive learning of nano-science and its applications. It emphasizes learning in material science, medical, photonics, optical, electronic and magnetic devices at nanoscale. It intends to enlighten about identification, fabrication and characterization of nano based devices.

Course Learning Outcomes:

- For students, this course on devices and nanotechnology becomes very important, as this exposes them to the most versatile and interdisciplinary world of nanotechnology, which is emerging as a branch having its relevance in various fields like medical, biotechnological, industrial, forensic science, material science etc.
- Students would be exposed to the relevant concepts of nanomaterials, their identification and characterization along with studying their applications in optical, electronic and magnetic devices.
- Nano based devices and sensors are a major attraction for students, because this not only makes them understand about the basic principles related to them, but it also inculcates the skills among students, which are required to develop nano-based formulations or devices as a whole.

Keywords: Optical devices; Nanoscale photonic devices; Sensor Technology; Nanoscale CMOS design

Unit I: Optical devices, electronic devices, liquid crystal and magnetic devices and their functionality Spintronic devices (including spin valves and MRAM devices) - Nanoscale semiconductor electronic devices - CMOS at sub-15nm gate length, Carbon nanotubes, III-V and wide-bandgap devices - Devices for quantum computing **(12 hours)**

Unit II: Nanoscale photonic devices - Basic properties of liquid crystals - Molecular properties of the organic materials and their use in current production and research level electronic devices - Thin Films Growth and Epitaxy, Characterization of Nanomaterials **(9 hours)**

Unit III: Introduction to Sensor Technology - CMOS scaling challenges at nanoscale regimes - Device technologies for sub 100nm CMOS - Device scaling and ballistic MOSFET **(12 hours)**

Unit IV: Nanoscale CMOS design, Nanoscale circuits - Non classical CMOS **(9 hours)**

References

1. Nanotechnology for Electronic Materials and Devices, Korkin, A.; Gusev, E.; Labanowski, J.K.; Luryi, S. Springer, 2007
2. Electronics Composite -Modeling, Characterization, Processing, and MEMS Applications-Minoru Taya, Cambridge University Press, 2008
3. Nanotechnologies for Future Mobile Devices - Tapani Ryhänen, Mikko A. Uusitalo, Olli Ikkala, Asta Kärkkäinen, Cambridge University press, 2010
4. High-Speed Heterostructure Devices From Device Concepts to Circuit Modeling - Patrick Roblin, Hans Rohdin, Cambridge University press, 2006

Semester VIII

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		
Complex Analysis and Algebra DSC-20	4	3	1	0	12 th Pass	Calculus, Linear Algebra

Learning Objectives

This interactive learning module intends to provide capabilities and basic understanding of complex analysis and algebra. The primary objective of this course is to introduce the basic tools of complex numbers, analytic functions, Laurent expansions and complex integration to understand their connection with the real-world problems. The second part of this course deals with introduction to group theory and its applications.

Learning outcomes

- Understanding the significance of limit, continuity and differentiability of complex numbers
- Evaluate integrals along a given path and functions.
- An introduction to the fundamentals of group theory
- Visualization of the applications of group theory

SYLLABUS

Unit I: Functions of complex variable - Derivatives, differentiation formulas - Cauchy- Riemann equations - sufficient conditions for differentiability - Analytic functions of a complex variable: Power- series expansions, Laurent expansions and Liouville's theorem. **(12 hours)**

Unit II: Complex integration - Cauchy Integral Theorem - Residue Theorem and applications to evaluate real integral **(12 hours)**

Unit III: Sets, relations, functions - Groups, subgroups - Permutations – Cyclic notation of permutation – Even and odd permutations - Permutation groups – Alternating groups – Subgroups **(12 hours)**

Unit IV: Lagrange's theorem and its consequences – Cyclic and Abelian groups – Centralizer and normalizer of a group
(12 hours)

Essential/recommended readings

1. Complex Variables and Applications, J.W. Brown and R. V. Churchill, McGraw Hill (8th Edition), 2009.
2. Contemporary Abstract Algebra, J. A. Gallian, (8th Edition), Cengage Learning, 2013.
3. An Introduction to Theory of Groups, J. J. Rotman, (4th Edition), Springer, 1995.

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

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE):

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		
Computer Art and Design Techniques (DSE)	4	1	0	3	Class XII pass	Programming languages

Learning Objectives

This course provides an introduction to the principles of computer graphics. In particular, the course will consider methods for modeling 3-dimensional objects and efficiently generating photorealistic renderings on color raster graphics devices. The emphasis of the course will be placed on understanding how the various elements that underlie computer graphics (algebra, geometry, algorithms and data structures, optics, and photometry) interact in the design of graphics software systems.

Learning outcomes

After completing this course, student should be able to;

- Understand all Display devices and their background
- Understand and implement the Transformation algorithms
- Understand basics of Ray Tracing and shading.
- Understand the process of Camera and image formation and

- implementation Understand the concept of 2D and 3D transformation modeling
- have the basics of the Animations and Motion Pictures
- Have basic understanding of video databases and understanding indexing and retrieval of video.

SYLLABUS

Theory

Unit I: Basic Introduction, Overview of Graphics systems - Refreshing display devices, Random and raster scan display devices, Colour Models: RGB, HSV, etc., coordinates systems, Devices, plotters, Drawing techniques, projections, 2D & 3D Transformations, clipping, viewing curves and shading basics. (15 hours)

Practice /LAB

Unit II: Implementation of DDA Line drawing algorithm, Bresenham's Line Drawing Algorithm, Midpoint circle algorithm, Mid-point Ellipse algorithms. Performing basic Transformation, Matrix representations, Composite Transformations, reflection and shear transformations. (30 hours)

Unit III: Implementing Bary line clipping algorithm, Algorithm for polygon clipping, Sutherland-Hodgeman polygon clipping, Curves - Bezier Curves, 4 point and 5 point Bezier curves using Bernstein Polynomials (30 hours)

Unit IV: Perform Shading and Hidden Surface Removal - Shading, Guard Shading, Phong Model, Back Face Detection, Depth Buffer (Z-Buffer, A-Buffer) Method (30 hours)

Essential/recommended readings

1. Watt, Alan, 3D Computer Graphics. Addison-Wesley, 1999.
2. Shirley, Peter, Michael Ashikhmin, Steve Marschner, Fundamentals of Computer Graphics. 3rd ed. A K Peters/CRC Press, 2009.
3. The Illusion of Life – Disney Animations, Frank Thomas, Ollie Johnston, Walt Disney, 1981
4. Computer Graphics, C Version, 2nd Edition, Hearn & Baker, Pearson Education, 1997
5. Computer Graphics: Principles and Practice in C, 2nd Edition, J. Foley, Addison Wesley, 1995

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

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE):

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		
Machine Learning for Business Intelligence (DSE)	4	1	0	3	Class XII pass	Programming languages, AI/ML Basic Concepts, and Linear Algebra

Learning Objectives

Data analytics and business intelligence (BI) are very important in today's world. Data analysis is required to understand organisational problems and to explore data. At the same time, business intelligence helps companies make better decisions by showing current and historical data within their business context. Course aims to leverage Data Analysis and Business Intelligence skills to help understand trends and derive actionable insights from data, thus allowing us to make data-driven, strategic and tactical business decisions.

Keywords: Data Analytics, Machine Learning, Management, Social Media, Business Intelligence

Learning Outcomes

- Develops business analytics foundation through machine learning for data analysis.
- Students will be able to enhance their skills in data analysis, Python programming for machine learning and Python/ R programming for statistical methods.
- They will also be able to find answers to the questions they don't know the answers to.
- It will help them to adapt to the automated future of business intelligence.

SYLLABUS

Theory and Practice

Unit I: Fundamentals of Data and Analytics, Overview of data types, sources, and collection methods for business applications, Basics of data analytics, Role of data in driving business intelligence and decision-making. (12 hours)

Unit II: Machine Learning for Business Intelligence: Introduction to machine learning concepts and algorithms for business, Building predictive and classification models for business decision support, Applications of machine learning in forecasting, optimisation, and customer insights. (15 hours)

Unit III: Data Analytics for Business Functions: Applications in product strategy, sales, marketing, consumer behaviour analysis, Financial decision-making using advanced data analytics techniques, (12 hours)

Unit IV: Advanced Applications of Business Analytics: Data analytics for digital and social media strategy, including content optimisation, Innovation and entrepreneurship supported by analytics-driven insights, Operational analytics for supply chain management, logistics, and resource allocation. (12 hours)

Practical Component

(60 hours)

1. Collect data from open business datasets (e.g., Kaggle, UCI) and perform data cleaning and preprocessing using Python (Pandas).
2. Perform basic descriptive statistics and data visualisation to understand business trends.
3. Use regression algorithms to predict future sales based on historical data. Apply classification models (e.g., Decision Trees, Logistic Regression) to segment customers.
4. Forecast product demand using time series data and ARIMA/exponential smoothing.
5. Use association rule mining (Apriori algorithm) for cross-selling and product bundling.
6. Perform customer segmentation using K-means clustering for targeted marketing.
7. Analyze financial statements and build a model to predict credit risk.
8. Analyze Twitter or YouTube comments to assess public sentiment towards a brand or product.
9. Supply Chain Optimisation Using Analytics through real-world problems.

Essential/recommended readings

1. Sherman, R. (2014). Business intelligence guidebook: From data integration to analytics. Newnes.
2. Negash, S., & Gray, P. (2008). Business intelligence. *Handbook on decision support systems 2*, 175-193.
3. Moss, L. T., & Atre, S. (2003). Business intelligence roadmap: the complete project lifecycle for decision-support applications. Addison-Wesley Professional.
4. Chaudhuri, S., Dayal, U., & Narasayya, V. (2011). An overview of business intelligence technology. *Communications of the ACM*, 54(8), 88-98.
5. Minelli, M., Chambers, M., & Dhiraj, A. (2013). *Big data, big analytics: emerging business intelligence and analytic trends for today's businesses* (Vol. 578). John Wiley & Sons.

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

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE):

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		
Crafting Digital Experiences: A Practical Approach to Web Design and Programming (DSE)	4	0	0	4	Class XII pass	Database Management System, Data Communication and Networking

Learning Objectives

The objective is to introduce with the fundamentals of how the Internet and the Web function, a basic understanding of graphic production with specific stress on creating graphics for the Web, and a general grounding introduction to more advanced topics such as programming and scripting. This will also expose students to the basic tools and applications used in Web publishing.

Learning outcomes

After completing this course, student should be able to;

- Acquire knowledge of web protocols and develop understanding of concepts of Internet security.
- Able to implement studied technologies in systematically developing a website with due regard to ethical and environmental issues.
- Understand the significance of emerging web technologies for the advancement of society.

Syllabus

Practice/Labs -

(120 hours)

The course will be conducted completely in a hands-on mode and project-based learning. The following tasks will be covered in the lab:

- Exercise based on developing websites and portals using HTML.
- Exercise based on developing websites and portals using CSS.
- Exercise based on developing websites and portals using JavaScript.

- Projects based on PHP and MySQL to be implemented.
- Domains: Healthcare, Criminal, resource management projects, etc.

Essential/recommended readings

1. Data Communication and Networking, Forouzan, B.A., Tata McGraw-Hill. 2013
2. Internet and World Wide Web: How to Program, 5th Edition, Deitel and Deitel, Pearson Education. 2008
3. List of Web links prescribed by instructor

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

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE):

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		
Partial Differential Equations (DSE)	4	3	1	0	Class XII pass	Ordinary differential equations

Learning Objectives

This course helps to develop Partial differential equation models, in the context of modeling heat and mass transport and, in particular, wave phenomena, such as sound and water waves. This course develops students' skills in the formulation; find a solution, understanding and interpretation of PDE models. As well as developing analytic solutions, this course establishes general structures and characterizations of PDEs. The course will also expose the students to various applications of the partial differential equations.

Learning outcomes

- Understand how partial differential equations (PDEs) represent real-world problems.
- Able to use computational tools to solve problems and applications of PDEs.
- Understand the importance of Laplace's equation, heat equation, wave equation,

conduction of heat, gravitational potential, telegraph equation, dispersion of contaminants, Fourier series, Fourier transforms, etc. in the theory of PDEs.

SYLLABUS

Theory

Unit I: Familiarities with different type of first order linear and non-linear PDEs - Examples of PDEs arising in transport equation, conservation laws, spread of epidemic cholera - Cauchy problem for first order PDE (12 hours)

Unit II: Method of characteristics, Classical methods for simple PDE models (12 hours)

Unit III: Second order PDE arising in wave equations, conduction of heat, gravitational potential, telegraph equation, dispersion of contaminants - classification of second order PDE and their solution (12 hours)

Unit IV: Fourier Series and Fourier transforms - Boundary Value Problem: Dirichlet and Neumann Problems (12 hours)

Essential/recommended readings

1. *Partial Differential Equations*, E.DiBenedetto, Birkhauser, Boston, 1995.
2. *Partial Differential Equations*, Fritz John, Narosa Publ.Co., New Delhi, 1979.
3. *Linear Partial Differential Equation for Scientists and Engineers*, TynMyint-U and Lokenath Debnath, Springer, Indian reprint, 2006.
4. *Partial Differential Equations: An Introduction with Mathematica and MAPLE*, Ioannis P Stavroulakis and Stepan A Tersian, World Scientific, 2004

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

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE):

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		
Brain and Cognition: Computational Neuroscience (DSE)	4	1	0	3	12th Pass	Understanding in Python, Networks

Learning Objectives

This module is designed to:

- o Introduce students to the field of neuroscience
- o Introduce students to the components of Learning, Memory and Neuroplasticity
- o Differentiate between Neural Network and Artificial Neural Network
- o Understand Neurological Disorders, Neural Coding and Neuroimaging

Learning outcomes

- After studying this course, the students will be able to:
 - o Comprehend Neural Network of the Brain and Artificial Neural Network
 - o Understand the different aspects of Neurosciences and its applications
 - o Develop knowledge about Neuroplasticity, Learning, Memory
 - o Understand Different Neurological Disorders,

Phobia SYLLABUS

Theory:

Unit I: Introduction to Neuroscience (15 hours)

Introduction to Neurobiology; Brain, Synapse and Neurons; Gut-Brain Connection; Recent developments in Neurosciences

Practice/Labs/Projects:

Unit II: Networks (Neural, Artificial Networks) (30 hours)

Networks and Patterns; Feedback and Feed Forward Loops; Artificial neural Network; Perceptrons, Multilayer Feed Forward Neural Networks; Neuro Dynamics

Unit III: Learning, Memory, Neuroplasticity (30 hours)

Learning and Memory; Short term and Long term memory; Associative and Dissociative Learning; Memory based Learning, Neural plasticity; Cognitive and Neural modeling

Unit IV: Sleep, Neurological Disorders, Neural Imaging (30 hours)

Different stages of sleep, Sleep Disorders, Coma; Phobia; Common Neurological Disorders; NeuroImaging, Functional Magnetic Resonance Imaging (fMRI), Computed Tomography (CT), Positron Emission Tomography (PET)

Essential/recommended readings

1. *Neuroscience: Exploring The Brain, Enhanced Edition*, Bear M et al., Jones and Bartlett Publishers, 2020.
2. *Fundamentals of Computational Neuroscience*, Thomas Trappenberg, Oxford University Press, 2010.

3. *Theoretical Neuroscience: Computational and Mathematical Modeling of Neural Systems*, Peter Dayan and Larry Abbott, MIT Press, 2005.

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

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE):

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		
Systems Biology (DSE)	4	1	0	3	12 th Pass	Network Biology, Python

Learning Objectives

This module is designed to:

- Develop an understanding of the biological equations and events as a whole and combines different streams of biosciences to get a bigger picture
- Explore cutting-edge technologies of biosciences to novel findings that travel to hitherto unexplored fields

Learning outcomes

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

- Comprehend biological networks and organization of biological systems
- Develop an understanding of designing simple organisms
- Perform biological data analysis, protein-protein interaction networks etc.

SYLLABUS

Unit I: Introduction to Systems Biology

(9 hours)

Biological complexity, Biological circuits, Bio-physical properties of macromolecules, Biomolecular interaction analysis, Developmental biology, Data integration and hypothesis generation, Reversible reactions and feedback loops

Unit II: Network and Modelling

(9 hours)

Transient networks, Behavioral networks, Cognitive and neural modelling, Memory and Learning, Neural models (vision, memory function, rhythm), Synapse and networks, Neural plasticity and computational learning, Artificial intelligence, Neural imaging

Practical components/Projects

(90 hours)

Interaction studies

Biological complexity, biological circuits - Biophysical properties of macromolecules - Biomolecular interaction analysis

1. Building Gene Regulation/Interaction networks models.
2. Intercellular signalling network analysis using relevant software's and data bases.
3. Creating biological databases and software.
4. Small projects integrating different biological parameters.

Essential/recommended readings

1. *An Introduction to Systems Biology: Design Principles of Biological Circuits*, Uri Alon, Chapman & Hall
2. *Fundamentals of Computational Neuroscience*, Thomas Trappenberg, Oxford University edition, 2010.
3. *Handbook of Systems Biology: Concepts and Insights*, Marian Walhout, Marc Vidal, Job Dekker (Edited), Academic Press; 1 edition, 2012.

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

Generic Electives (GE):

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical / Practice		
Contribution of Indian Knowledge System to Science, Engineering and Technology	4	3	1	0	NIL	NIL

Learning Objectives

The course presents a gainful insight to some of the areas of application of IKS in science, engineering and technology. The course presents to the students the origin of science and technology that they can relate, appreciate and explore further as per their interest.

Learning Outcomes

- Get used to the foundation of Sanskrit language in NLP
- Understand the important aspects of Indian Numeral Systems
- Understand the use of time, length and weight measurements in ancient India
- Identify the origin of modern day binary number system used in modern day computers
- Develop an awareness of contribution of Indian astronomy
- Develop familiarity of ancient Indian pursuits in various areas of science and technology

SYLLABUS

Theory:

Unit I: Natural language processing

Components of a language; Panini's work on Sanskrit Grammar; Phonetics in Sanskrit; Patterns in Sanskrit vocabulary; Computational concept is *Astadhyayi*; Logic for sentence construction; Importance of verbs; Role of Sanskrit in NLP (12 hours)

Unit II: Units of Measurements

The concept of zero and its importance; Large numbers and their representations; Place values of numerals; Decimal system; Different approaches to represent numbers; Measurements for time, distance and weights; Pingala's Binary mathematics (9 hours)

Unit III: Contributions in Astronomy

Historical developments of astronomy in India; Elements of Indian calendar; *Pancanga*- the Indian calendar system; *Aryabhatiya Sidhanta*; Distance and velocity of a planet; Apparent motions of the stars due to earth's motion; Parallax in solar eclipse; Visibility corrections; Eclipses of the sun and the moon; Astronomical instruments (12 hours)

Unit IV: Science and Engineering

Metal extraction processes of Au, Zn, Cu and its alloys, Fe, Hg, Pb, Ag; Apparatus used for extraction; Lost wax casting of artefacts; Irrigation and water management; Dyes and painting technology; surgical techniques; shipbuilding (9 hours)

References:

1. *Introduction to Indian Knowledge System: Concepts and Applications*, B. Mahadevan, V R Bhat, Nagendra Pavan R N, PHI Learning Pvt Limited, 2022.
2. *Ancient Hindu Science: Its impact on the Ancient and Modern worlds*, Alok Kumar; Jaico Publishing House, 2019.
3. *Aryabhatiya of Aryabhat* by K.S. Shukla and K.V. Sarma, Indian National Science Academy, New Delhi (1976)

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Generic Electives (GE):**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		
Understanding Public Health: Infection to Informatics (GE)	4	2	0	2	12th Pass	Nil

Learning Objectives

The course introduces students to the fundamentals of Public Health with reference to Infectious Diseases and Informatics. The Covid-19 pandemic has taught us the importance of having a good public health system and this course will prepare the future generation for a better understanding of the threats of zoonotic diseases and corresponding public health measures. Apart from theoretical background in Zoonotic diseases, infectious diseases prevalent in our country, this course will delve into the fundamentals of outbreaks and infection through case studies, data analysis and health informatics.

Learning Outcomes

This course enables students to become responsible and aware citizens and to act promptly and systematically in future outbreaks and epidemics. Upon completion of the course the students would be able to:

- Understand the differences of Outbreak, Endemic, Epidemic and Pandemic
- Prepare themselves and the society for better awareness of Public Health system and Disaster Management responses
- Understand how Drugs and Vaccines are created and Clinical Trials are designed
- Learn the basics of health informatics and analysis of public health data
- Access and Analyse Public Health datasets
- Create relevant Citizen Science projects on Public Health
- Create Posters, fliers and Advertisements for Awareness and preventing misinformation.

Keywords: Public Health, Zoonotic Disease, Drugs and Vaccines, Endemic, Epidemic, Pandemic, Epidemiology, Pathogens, Clinical Trial, Personalized Medicine.

SYLLABUS

Unit I: Understanding Outbreak, Endemic, Epidemic, Pandemic. Infectious Diseases and Lifestyle Diseases. (4 hours)

Unit II: Zoonotic diseases, Pathogens (viruses, bacteria, parasites and fungi) and Infection Process, Epidemiology, Disaster Management, Biohazard and Bioweapons. (12 hours)

Unit III: Medicine and Vaccine, Introduction to Drug designing, Vaccine types, Clinical Trials, Trial Design, Personalized Medicine and Precision Medicine, Medical Terminology & Medical Ethics (8 hours)

Unit IV: Introduction to Public Health, Public Health Data Analysis, International Health Issues, Institutes of Public Health, Public health policy (8 hours)

Practical Components/Projects (60 hours)

- Case Studies of Outbreak, Pandemic. Designing Public Awareness Posters, fliers and Advertisement, Engaging with social media misinformation.
- Designing Health Survey and Disaster Management Awareness Survey. Creating Citizen Science Projects related to Public health and Zoonotic Diseases.
- Public Health dataset analysis, Searching and curating Databases, Experimental design for vaccine Preparation and Clinical trials.

References:

1. *Introduction To Public Health* Mary Jane Schneider, Jones and Bartlett Publishers, Inc; 6th edition, 2020.

2. *Oxford Handbook of Infectious Diseases and Microbiology* (Oxford Medical Handbooks) OUP Oxford; 2nd edition, 2016.
3. *Kuby Immunology*, WH Freeman; 8th ed. 2018.
4. *Spillover – Animal Infections and the Next Human Pandemic*. David Quammen, W. W. Norton & Company; 2012.
5. *Emergence of Zoonotic Diseases in India: A Systematic Review*. Dhiman RC, Tiwari A *Med Rep Case Stud* 3: 163. doi: 10.4172/2572-5130.1000163, 2018.
6. Changing patterns of infectious disease, Cohen, Mitchell L. *Nature*, Volume 406, pages 762–767, 2000.
7. *Manual on Zoonotic Diseases of Public Health Importance*. National Centre for Disease Control (<https://ncdc.gov.in/WriteReadData/1892s/File618.pdf>), 2016.
8. *Exploring the relationship between the emergence of zoonotic diseases and the inhuman touch of habitat loss and wildlife trade*. Tiwary, N. K., Singh, G., & Bhaduri, A. in *Multidimensional Approaches to Impacts of Changing Environment on Human Health* CRC Press, Taylor & Francis Group, 2022.
9. *Citizen Science Comes of Age*, Aisle Irvine, *Nature* 562, 480-482 (2018) doi: <https://doi.org/10.1038/d41586-018-07106-5>
10. *Citizen Science for Public Health*, Lea Den Broeder et al., *Health Promotion International*, Volume 33, Issue 3, Pages 505–514, 2018.

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Generic Electives (GE):

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Income Tax and Law Practice	4	3	0	1	PASS IN XII	NIL

Learning Objectives

This course aims to provide comprehensive knowledge of various heads of income and focuses on the computation of the total income and tax liability of an individual as per the Income Tax Act 1961.

Learning outcomes

After completion of the course the student will be able to;

- Explain the basic concepts, residential status of the assessee and incidence of tax.
- Develop an understanding of the nuances of the salaries, various allowances and perquisites available under the head income from Salaries.
- Develop an understanding of the concept of self-occupied and let out property under the head income from house property.
- Compute the income under the head profits and gains of business or profession and capital gains.
- Compute incomes covered under the head income from other sources.
- Explore the concept of including the income of other persons in the assessee's income.
- Compute the total tax liability of an individual after allowing for permissible deductions and exemptions.

Syllabus

Theory

Unit 1: Basic concepts and Residential Status (12 hours)

Basic concepts: person, assessee, income, previous year, assessment year and PAN; structure to compute tax liability; residential status and tax incidence.

Unit 2: Income under the head Salaries and House Property (12 hours)

Computation of income under the head salaries including various allowances and perquisites, computation of income of self-occupied and let out property.

Unit 3: Income under the head Profits and Gains of Business or Profession (6 hours)

Computation of income from business or profession, expenses specified and disallowed while computing such income.

Unit 4: Income under the head of Capital Gains and Other Sources (6 hours)

Meaning of capital assets, long term and short-term capital gains; computation of capital gains. Computation of taxable income from other sources.

Unit 5: Computation of Total Income and Tax Liability of an Individual (6 hours)

Clubbing of income; set off and carry forward of losses, permissible deductions under section 80C to 80U; Computation of taxable income and tax liability of an individual. **(On-line filing of Returns of Income and PAN Card).**

Practical Exercises:

(30 hours)

The learners are required to:

1. Identify and educate the individuals not having PAN Card and help them understand the crucial relevance of holding a PAN Card. Help them in filling out the online application for the PAN Card and prepare the summarised report for the same.
2. Identify the relevance of various allowances and deductions in the present context and give a presentation for the same.
3. Identify and evaluate the tax liability of some individuals having income under different heads of income and present a case of the deductions and exemptions availed by each assessee.
4. Explore and attempt on-line filing of Returns of Income under ITR-1 and ITR-2. (Excel Utility)

Essential/recommended readings

- Ahuja, G., & Gupta, R. (2022). Simplified Approach to Income Tax. Flair Publications Pvt. Ltd., Delhi.
- Mittal, N. (2019). Concept Building Approach to Income Tax Law & Practice. Cengage Learning India Pvt. Ltd., Delhi.
- Singhania, V. K., & Singhania, M. (2022). Student's Guide to Income Tax. Taxmann Publications Pvt. Ltd., Delhi.

Suggested Resources:

- Income tax Act 1961
- www.incometaxindia.gov.in

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Generic Electives (GE):

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Integrative Biology	4	3	0	1	PASS IN XII	NIL

Learning Objectives

This course would make students understand the nature and evolution of genetic material and transfer of information in living systems. It will introduce the design of living systems.

Learning outcomes

After completion of the course the student will be able to;

- Comprehend current research in different streams of Biological Sciences
- Get in depth knowledge of how living system functions (regulation, communication)
- Know about different model system and their utilization in biology
- Apprehend study design in biology
- Get an idea of career prospects in bioscience

To design small innovative research projects in biosciences.

Syllabus

Unit I: Demystifying living state, Choice of the genetic material, RNA world, Evolution of DNA and Proteins

(15

hours)

Unit II: Designing living systems, Nature of biological processes, Approaches to study Biology: Observational and Experimental, Synthetic cell and beyond

(15

hours) Unit III: The regulated activities: Communication (external & internal) as the basis of regulation, Circuits and regulations in living systems, Interaction of biological components

Model organisms in study of Biology

(15

hours)

Practical Exercises:

(30 hours)

- Isolation of DNA from bacteria and eukaryotic tissue and separation on agarose gel
- Isolation and separation of RNA from eukaryotic cells
- Isolation and separation of proteins from tissues and bacteria
- Evolution networks and cellular networks

References:

- An Introduction to Systems Biology: Design Principles of Biological Circuits, Uri Alon, Chapman & Hall, 2nd edition, 2013.
- Physical Biology of the Cell, Phillips et al., Garland Science, 2nd edition, 2012.
- Molecular Cell Biology, Lodish et al., W. H. Freeman & Company, 7th edition, 2012.
- Biochemistry, Berg, Tymoczko and Stryer, W H Freeman & Company, 7th edition, 2011.

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