Index Page

Semester VII

Semester VIII (DSC)

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):

REDIT 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 Graphics (DSE)	**4**	**3**	**1**	**0**	**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 Understanding of Virtual Augmentation applications in security, medicine and manufacturing
- Have basic understanding of video databases and understanding indexing and retrieval of video.

SYLLABUS

Unit I: Overview of Computer Graphics - Usage of Graphics and their applications, Over view of Graphics systems - Refreshing display devices, Random and raster scan display devices, Colour Models: RGB, HSV etc., Tablets, Joysticks, Track balls, Mouse and light pens, plotters, printers, digitizers. **(12 hours)**

Unit II: Output primitives - DDA Line drawing algorithm, Bresenham's Line Drawing Algorithm, Midpoint circle algorithm, Mid-point Ellipse algorithms. Transformations - Basic 2D Transformations, Matrix representations & Homogeneous Coordinates, Matrix Representations

for basic 2D and 3D transformations, Composite Transformations, reflection and shear transformations **(12 hours)**

Unit III: Two dimensional viewing - Barky line clipping algorithm, Algorithm for polygon clipping, Sutherland-Hodgeman polygon clipping, Curves - Bezier Curves, 4 point and 5 point Bezier curves using Bernstein Polynomials **(9 hours)**

Unit IV: Shading and Hidden Surface Removal - Shading, Guard Shading, Phong Model, Back Face Detection, Depth Buffer (Z-Buffer, A-Buffer) Method **(9 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		
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.

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		
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)
		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		
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		
Internet and Web Technology (DSE)	4	3	1	0	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

Unit I: Web Technologies - HTTP, HTTPs, WWW, URL, Email, Domain Name Service, Web Browsers, Search Engines-Architecture, Crawlers, Type of crawlers, search tools.

(12 hours)

Unit II: Chat & bulletin board Services, SNMP, Security - Concept of Internet security, Firewall-Functioning, types of Firewall. Sniffing, spoofing, viruses, worms, Trojan horses, and their security.

(12 hours)

Unit III: Cyber Laws - Introduction, The rights the various parties have with respect to creating, modifying, distributing, storing and copying digital data- concurrent responsibilities and potential liabilities.

(9 hours)

Unit IV: Web Design - Key issues in web site design, Use of Different HTML tags in web pages, Building HTML documents, Cascading Style Sheets-Internal, Inline and external style sheets, Javascript, Dynamic HTML with Javascript, database connectivity.

(10 hours)

Essential/recommended readings

1. Data Communication and Networking, Forouzan, B.A., Tata McGraw-Hill. 2013
2. Professional JAVA Server Programming, Allamaraju and Buest, SPD Publication. 2007
3. Internet and World Wide Web: How to Program, 5th Edition, Deitel and Deitel, Pearson Education. 2008
4. 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		
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 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		
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

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 **(10 hours)**

Unit II: Method of characteristics, Classical methods for simple PDE models **(9 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,NarosaPubl.Co.,NewDelhi,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		
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		
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 primarilty 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 hours)**

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 hours)**

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

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)**

- Practical exposure to STRING and Cytoscape for building and analysis of protein and gene networks
- Microarray Analysis
- Building Ecological Models
- Neural Networks
- Energy calculations in complex ecological food webs
- Analysis of models related to gene regulation, epigenetic and other networks
- Networks as filters and integrators of biological information
- network diffusion methodology
- Network prediction of gene function
- Network distance between two samples
- 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		
Systems Biology (DSE)	**4**	**2**	**0**	**2**	**12th Pass**	**Linear algebra Artificial ntellignence**

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 **(10 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 **(10 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

Unit III: Interaction studies **(10 hours)**

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

(30 hours)

Practical components

1. Gene Regulation/Interaction networks models.
2. Intercellular signalling network analysis.

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.

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 Neurosciences (DSE)	**4**	**3**	**1**	**0**	**12th Pass**	**Linear algebra Artificial intellignence**

Learning Objectives

This module is designed to:

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

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

SYLLABUS

Unit I: Introduction to Neuroscience **(9 hours)**

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

Unit II: Networks (Neural, Artificial Networks) **(12 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 **(12 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 **(10 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.

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			
Environment Management (GE)	4	2		2	Class XII pass.	NA	Faculties of CIC

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;

- to evaluate the Environmental Impact Assessment (EIA) &
- to understand the legal frameworks associated with Environment in India.
- to use Geospatial and environmental information through opensource.
- to prepare basic maps e.g., elevation, vegetation etc.
- to classify Land use and Land cover information and maps.
- to assess urbanization through spectral band index.
- 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/ Practice			
Principles of Financial Decision Making	**4**	**3**	**1**	**0**	**Class XII pass**	**Basic knowledge of mathematics and understanding of IT project 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	12th 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

(30 hours)

Practical components

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 electronics and circuit analysis	Physics/Electronics faculty of CIC

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 functionalitySpintronic 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		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 integrals **(12 hours)**

Unit III: Sets, relations, functions - Groups, subgroups - Permutations – Cyclic notation of permutation – Even and odd permutations - Permutation groups – Alternating groups – Subgroups **(9 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), Cengagae Learning, 2013.
3. An Introduction to Theory of Groups, J. J. Rotman,(4thEdition), Springer,1995.

ANNEXURE I

Industry-Integrated Learning Outcomes for B.Tech. (IT and Mathematical Innovation)

The course structure of the B.Tech. (IT and Mathematical Innovation) is designed to foster an innovation mindset among students, preparing them to meet industry demands. The curriculum is crafted to equip students with the skills and knowledge necessary to become industry-ready professionals. As a result, many B.Tech. graduates secure positions in leading industries upon completing the program.

A key factor contributing to this successful transition is the emphasis on industry internships and academic projects. The B.Tech. (IT and Mathematical Innovation) program, which prior to NEP followed a four-year structure, integrates practical industry exposure to prepare students comprehensively. Accordingly, the following outcomes are expected from students opting for industrial internships in lieu of a dissertation, academic project, or entrepreneurial venture in Semester VII.

Outcomes Expected of Students Pursuing the Industrial Internship Track:
By the end of Semester VII, students are expected to achieve the following outcomes:

1. **Skill Development:**
    - Gain proficiency in industry-relevant skill sets such as web development, app development, graphic design, data analysis, machine learning, API development, or other relevant technological domains.
2. **Industry Networking and Exposure:**
    - Identify and establish connections with a suitable industry or startup for internship opportunities.
3. **Professional Advancement:**
    - Accomplish at least one of the following:
      a. Secure an offer letter for placement in the same or a related field.
      b. Obtain an extension of the internship with financial support for the next semester.
      c. Receive formal recognition or acknowledgment from the industry for exceptional contributions during the internship.
    - Demonstrate the ability to apply theoretical knowledge to practical industry problems, leading to tangible outcomes such as a functional prototype, process improvement, or innovative solution.
4. **Communication and Reporting:**
    - Develop professional reporting and presentation skills through regular progress reports and a final presentation to both industry mentors and academic supervisors.

Note:

- The internship will be monitored by a mentor from the center, ensuring alignment with academic standards.
- Part of the internship must be conducted during the preceding summer break to maximize hands-on experience and industry engagement.