Semester VII

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		
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.

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CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

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		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.

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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	12^{th} 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.
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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):

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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 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.