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