NIRMA UNIVERSITY

Institute:	Institute of Technology
Name of Programme:	B.Tech. Computer Science and Engineering
Course Code:	2CSDE81
Course Title:	Complex Networks
Course Type:	Departmental Elective
Year of Introduction:	2021-22

Credit Scheme

L	T	Practical Component				C
		LPW	PW	W	S	
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Course Learning Outcomes (CLO):

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

1. illustrate various types of complex networks
2. analyze real world networks empirically
3. apply the fundamentals of graph theory and statistical methods to large scale networks
4. design networks for real world applications

Syllabus: **Total Teaching hours: 45**

Unit	Syllabus	Teaching hours
Unit-I	**Fundamentals of Network Theory**: Mathematics of Networks, Types of Graphs, Hypergraphs, weighted and directed graphs, trees, degree, paths components **Empirical Studies of networks:** Biological Networks, Social Networks, Technological Networks	07
Unit-II	**Analysis of Complex Networks:** Vertex degrees, communities, Node and link centrality, degree centrality, hubs, closeness and betweenness centrality, paths and network diameter	08
Unit-III	**Structural Properties of Networks**: Community structures, components, statistical properties, degree distributions, network motifs, network resilience to attacks and failure, clustering, graph-based clustering, subgraph discovery	11
Unit-IV	**Types of networks:** Scale free networks, small-world networks, random networks, ER-Networks, Models for network generation and growth	08

Unit-V	**Applications:** Protein Interaction Network, Topological properties, detection of protein complexes, network alignment, Social networks, relationships, equivalence, community detection, Network visualization algorithms, The Internet, services, web graph, link analysis, mobile social networks	11

Self-Study: The self-study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self-study contents.

Suggested Readings/ References:

1. Kayhan Erciyes, Complex Networks - An Algorithmic Perspective, CRC Press
2. Marc Newman, Networks: An Introduction, Oxford University Press
3. Ernesto Estrada, The Structure of Complex Networks - Theory and Applications, Oxford University Press
4. Maarten van Steen, An Introduction to Graph Theory and Complex Networks, EBook
5. Hocine Cherifi, Complex Networks and Their Applications, Cambridge Scholar Publishing

Suggested List of Experiments:

Sr.	Practical Title	Hours
1	To explore NetworkX, PyVis, Visdcc in Dash - Network analysis package in Python.	04
2	To implement graphs with following operations: · Create empty graph · Add nodes to the graph · Add edges to the graph · Generate path graph · Renaming nodes · Accessing edge and neighbour	02
3	To examine elements in a network graph, addition and removal of elements	02
4	To implement graph generators and graph operations	02
5	To draw and analyze the graph	02
6	To compute pagerank on the graph using page rank function in NetworkX package (python) using suitable blog dataset.	04
7	To implement graph optimization in Python by solving the Chinese Postman Problem.	04
8	To count motifs in a network, statistical significance of motifs and enumerating motifs in network	04
9	To test the graph isomorphism	02
10	To show the community structure on suitable social network dataset.	04

Suggested Case List: -NA-