| | National Institute of Technology Meghalaya<br>An Institute of National Importance | CURRICULUM |
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|---|---|---|---|
| Programme | **Bachelor of Technologyin Computer Science and Engineering** | Academic Year of Regulation | **2018-19** |
| Department | **Computer Science and Engineering** | Semester | **VII** |

| Course Code | Course Name | Credit Structure | | | | Marks Distribution | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | INT | MID | END | Total |
| **CS 415** | **Complex Networks** | **3** | **0** | **0** | **3** | **50** | **50** | **100** | **200** |

| Course Objectives | Course Outcomes | | |
|---|---|---|---|
| **To provide the students with some knowledge about the definition of complex networks, graph theory, and the significance of graph theory.** | | CO1 | **Able to demonstrate the basic concept of graph theory with an example like the bridge of Konigsberg.** |
| **To develop the student's ability to understand the various centrality measures and their importance.** | | CO2 | **Able to explain the centrality measures of network nodes based on the degree, such as degree centrality, eigenvector centrality, and α-centrality.** |
| **To provide the students with some knowledge about various random graphs and generalised random graphs and their importance to connect multiple complex networks.** | | CO3 | **Able to identify various random graphs and generalized random graph, degree of distributions, how average properties of a random graph changes with the number of links etc.** |
| **To develop the student's ability to understand the correlation between various complex networks.** | | CO4 | **Able to examine how the individuals of a social network discover shortest paths, even if they have local knowledge and the appearance of small-world behavior in the biological systems.** |
| **To develop the student's ability to understand the general approach to define and detect the building blocks of various complex networks.** | | CO5 | **Able to interpret the models of continuous growth of various networks such as Scientific papers Citation Networks, the World Wide Web network, etc.** |
| | | CO6 | **Able to construct graphs with positive or negative degree-degree correlations.** |

| No. | COs | Mapping with Program Outcomes (POs) | | | | | | | | | | | | Mapping with PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| 1 | CO1 | **2** | **0** | **0** | **0** | **0** | **1** | **2** | **0** | **1** | **1** | **0** | **0** | **2** | **1** | **1** |
| 2 | CO2 | **2** | **3** | **1** | **1** | **0** | **2** | **1** | **0** | **3** | **2** | **1** | **2** | **1** | **2** | **2** |
| 3 | CO3 | **3** | **2** | **1** | **0** | **2** | **3** | **0** | **1** | **0** | **1** | **3** | **1** | **3** | **2** | **2** |
| 4 | CO4 | **1** | **0** | **3** | **2** | **0** | **2** | **1** | **0** | **3** | **2** | **1** | **0** | **1** | **2** | **2** |
| 5 | CO5 | **2** | **0** | **1** | **0** | **2** | **3** | **1** | **0** | **1** | **2** | **1** | **0** | **3** | **2** | **3** |
| 6 | CO6 | **1** | **2** | **0** | **3** | **1** | **2** | **0** | **2** | **0** | **1** | **0** | **0** | **2** | **3** | **2** |

SYLLABUS

| No. | Content | Hours | COs |
|---|---|---|---|
| I | **Graphs and Graph theory:**<br>**Basic definitions, Directed graphs, Weighted graphs, Bipartite graphs, Trees, Graph Theory and the Bridge of Konigsberg, How represent a graph;** | **4** | **CO1** |
| II | **Centrality Measures:**<br>**The importance of being central, Connected Graphs and Irreducible Matrices, Degree and Eigenvector Centrality, Measures based on Shortest Paths, Group Centrality;** | **6** | **CO2** |
| III | **Random Graphs:**<br>**Erdos and Renyi (ER) Models, Degree Distribution, Trees, Cycles and Complete Subgraphs, Giant Connected Component, Scientific Collaboration Networks, Characteristic Path Length;**<br>**Generalised Random Graphs:**<br>**The World Wide Web, Power-Law Degree Distributions, The Configuration Model, Random Graphs with Arbitrary Degree Distribution, Scale-Free Random Graphs, Probability Generating Functions;** | **9** | **CO3** |
| IV | **Small-World networks:**<br>**Six Degree of Separation, The Brain of a Worm, Clustering Coefficient, The Watts-Strogatz (WS) Model, Variations to the Theme, Navigating Small-World Networks;** | **6** | **CO4** |
| V | **Model of Growing Graphs:**<br>**Citation Networks and the Linear Preferential Attachment, The Barabasi-Albert (BA) Model, The importance of being Preferential and Linear, Variations of the Theme, Can latecomers Make it? The Fitness Model, Optimisation Models;** | **6** | **CO5** |
| VI | **Degree Correlations:**<br>**The Internet and Other Correlation Networks, Dealing with Correlated Networks, Assortative and Disassortative Networks, Newman's Correlation Coefficient, Models of Networks with Degree-Degree Correlations;** | **5** | **CO6** |
| Total Hours | | **36** | |

**Essential Readings**


1. Latora V, Nicosia V, Russo G. Complex networks: principles, methods and applications. Cambridge University Press; 2017.
2. Cohen R, Havlin S. Complex networks: structure, robustness and function. Cambridge university press; 2010.
3. Estrada E. The structure of complex networks: theory and applications. Oxford University Press; 2012.


**Supplementary Readings**


1. Boccaletti S, Latora V, Moreno Y, Chavez M, Hwang DU. Complex networks: Structure and dynamics. Physics reports. 2006 Feb 1;424(4-5):175-308.
2. Meyn S, Meyn SP. Control techniques for complex networks. Cambridge University Press; 2008.
3. Ganguly N, Deutsch A, Mukherjee A. Dynamics on and of complex networks: Applications to biology. Computer Science, and the Social Sciences. Birkhäuser. 2009.