testing, Vulnerability Analysis, Threat matrices, Firewall and IDS/IPS, Wireless networks, Wireless Fidelity (Wi-Fi), Wireless network security protocols, Nmap, Network fingerprinting, BackTrack, Metasploit.

Readings:

1. R. Rajkumar, D. de. Niz and M. Klein, **Cyber Physical Systems,** Addision-Wesely, 2017

2. Rajiv Alur, **Principles of Cyber-Physical Systems**, MIT Press, 2015.

3. E.A.Lee and S A Shesia, **Embedded system Design: A Cyber-Physical Approach,** Second Edition, MIT Press, 2018

4. A. Platzer, **Logical Foundations of Cyber Physical Systems,** Springer, 2017.

5. Peter W. Singer and Allan Friedman, Cybersecurity and Cyberwar, Oxford University Press, 2014

6. Jonathan Clough, Principles of Cybercrime, Cambridge University Press, 24-Sep-2015

MCSE302: GRAPH THEORY

Course Objectives: This course will thoroughly introduce the basic concepts of graphs theory, graph properties and formulations of typical graph problems. The student will learn to model real-life problems such as graph coloring and connectivity as graph problems

Course Learning Outcomes :
On successful completion of the course, students will be able to:
CO1: model problems in different types of basic graphs like trees, bipartite graphs and planar graphs.
CO2: identify special graphs like Euler graphs and Hamiltonian graphs.
CO3: identify various forms of connectedness in a graph
CO4: examine different graph-coloring problems and their solutions.
CO5: model simple problems from real life as graph-coloring problems.

Syllabus:

Fundamental Concepts: Definitions, examples of problems in graph theory, adjacency and incidence matrices, isomorphisms, paths, walks, cycles, components, cut-edges, cut-vertices, bipartite graphs, eulerian graphs, vertex degrees, reconstruction conjecture, extremal problems, degree sequences, directed graphs, de Bruijn cycles, Orientations and tournaments.

Trees: Trees and forests, characterizations of trees, spanning trees, radius and diameter, enumeration of trees, Cayley's formula, Prüfer code, counting spanning trees, deletion-contraction, the matrix tree theorem, graceful labelling, minimum spanning trees (Kruskal's algorithm), shortest paths (Dijkstra's algorithm).

Matching and Covers: Matchings, maximal and maximum matchings, M-augmenting paths, Hall's theorem and consequences, Min-max theorems, maximum matchings and vertex covers, independent sets and edge covers,Connectivity, vertex cuts, Edge-connectivity.

Connectivity and Paths: Blocks, k-connected graphs, Menger's theorem, line graphs, network flow problems, flows and source/sink cuts, Ford-Fulkerson algorithm, Max-flow min-cut theorem.

Graph Coloring: Vertex colorings, bounds on chromatic numbers, Chromatic numbers of graphs constructed from smaller graphs, chromatic polynomials, properties of the chromatic polynomial, the deletion-contraction recurrence.

Planar Graphs: Planar graphs, Euler's formula, Kuratowski's theorem, five and four color theorems.

Readings:

1. Douglas B West, "Introduction to Graph Theory", II Edition, 2017, Pearson.
2. Gary Chartrand and Ping Zhang "Introduction to Graph Theory", 2017, Tata McGraw Hill.
3. Jonathan L. Gross and Jay Yellen, "Graph Theory and Its Applications", 2nd Edition, 2005, Chapman Hall (CRC).
4. The course will also be taught through various research Courses.

MCSE303: NETWORK SCIENCE

Course Objectives: The course aims to acquaint the students with the graph theory concepts relevant for network science. The students learn dynamics of and on networks in the context of applications from disciplines like biology, sociology, and economics

Course Learning Outcomes :

At the end of the course, the student will be

CO1: able to appreciate ubiquity of graph data model
CO2: able to understand the importance of graph theoretic concepts in social network analysis
CO3: able to understand the structural features of a network
CO4: familiar with the theoretical graph generation models
CO5: identify community structures in networks
CO6: able to write programs to solve complex network problems

Syllabus:

Introduction: Introduction to complex systems and networks, modelling of complex systems, review of graph theory.