

## CSC 641 Network Science Fall 2019

**Instructor:** Dr. Natarajan Meghanathan, Professor of Computer Science

**Email:** natarajan.meghanathan@jsums.edu

**Phone:** 601-979-3661

**Office:** ENB 275

**Class Time:** TR 7.30 PM to 8.50 PM

**Office Hours:** TR 5.30 PM to 7 PM

### Catalog Description

CSC 641 (3 Hours) Network Science. Topics covered include the measurement and structure of networks, methods for analyzing network data, including methods developed in physics, statistics, and sociology, graph theory, computer algorithms, mathematical models of networks, including random graph models and generative models, and theories of dynamical processes taking place on networks.

**Pre-requisite:** Graduate student status in Computer Science, Computer Engineering or CDSE

### Course Outcomes

Each student who successfully completes this course should be able to:

**CO-1:** Analyze the characteristics of complex networks using graph theoretic metrics and paradigms

**CO-2:** Generate simulated networks from theoretical models and evaluate their characteristics in comparison with real-world networks

**CO-3:** Apply various centrality metrics and related algorithms to determine the topological significance of the nodes in a network

**CO-4:** Extract clusters of related nodes using efficient community detection algorithms and evaluate the effectiveness of the partitioning

**CO-5:** Use hands-on tools and spectral analysis techniques to analyze datasets corresponding to complex real-world networks

### Required Textbook

A. L. Barabasi, "Network Science," 1<sup>st</sup> Edition, Cambridge University Press, ISBN: 1107076269. August 2016.

Available Online: <http://barabasi.com/networksciencebook/>

### Course Modules (Tentative)

Module 1: Graph Theory

Module 2: Spectral Analysis

Module 3: Centrality Metrics

Module 4: Community Detection Algorithms

Module 5: Theoretical Network Models

**Evaluation:** Exams – 75% (5 Exams); Assignments/Projects (3 to 4) – 25%

*Tentative Exam Dates:* 09/26, 10/10, 10/24, 11/07, 11/21

### Grading

90 - 100: A

80 - 89: B

70 - 79: C

60 - 69: D

Below 60: F

**Course Website:** <http://www.jsums.edu/nmeghanathan/csc641-fall2019/>

### Dropping a course

The last day to drop a course with no grade: August 30, 2019

The last day to drop a course with "W" grade: October 25, 2019

### Course Outline (Tentative)

| Week # | Topics to be Covered  | Course Outcomes |
|--------|---|-----------------|
| Week 1 | Module 1: Degree Distribution Analysis, Maximal Assortative and Dissortative Matching | CO-1            |
| Week 2 | Module 1: Cocitation and Bibliographic Coupling, # Walks in a Graph, Bipartite Graphs | CO-1            |
| Week 3 | Module 1: Breadth First Search, # Components  | CO-1            |

|         |  |      |
|---------|--|------|
|         | Module 2: Eigenvectors and Eigenvalues, Spectral Radius Ratio for Node Degree, Bipartivity Index and its Computation | CO-5 |
| Week 4  | Module 2: Protein Folding and Algebraic Connectivity   | CO-5 |
| Week 5  | Module 2: Modularity, Community Detection using Spectral Analysis  | CO-5 |
| Week 6  | Module 3: Degree Centrality, Eigenvector Centrality, Closeness Centrality  | CO-3 |
| Week 7  | Module 3: Betweenness Centrality; Local Clustering Coefficient-based Degree Centrality                               | CO-3 |
| Week 8  | Module 3: Correlation Coefficient Measures; HITS Algorithm   | CO-3 |
| Week 9  | Module 3: PageRank Algorithm   | CO-3 |
| Week 10 | Module 4: Modularity Maximization, Hierarchical Clustering Algorithm   | CO-4 |
| Week 11 | Module 4: Edge Betweenness and Girvan Newman Algorithm   | CO-4 |
| Week 12 | Module 4: Neighborhood Overlap-based Community Detection and Homophily   | CO-4 |
| Week 13 | Module 5: Random Network Model and Simulations   | CO-2 |
| Week 14 | Module 5: Scale-free Network Model, BA Model and BB Model and Simulations  | CO-2 |
| Week 15 | Thanksgiving Break   |      |

### ***Make-up Exams***

- **No make-up examinations will be given except for emergencies such as death in the family or serious illness. The instructor must be informed, through e-mail or a written request, BEFORE the time of the examination that is to be missed.** The instructor will make a decision on the make-up examination after verifying the appropriate written documentation. Failure to furnish, written, verifiable documentation will result in a grade of zero for the missed examination.
- **Any make-up exam for a missed exam has to be taken before the next class meeting time.**
- **A make-up exam will be different and will be relatively tough compared to the actual missed exam.**

### **ADA Statement**

**Compliance with the Americans with Disabilities Act:** If you have a disability for which you are or may be requesting an accommodation, you are encouraged to contact both your instructor and ADA Coordinator (as early as possible in the term) located in the Jacob L. Reddix Building (old student union), rooms 101 and 102. The office hours are: 8:00 a. m. to 5:00 p.m., Monday through Friday. The telephone number is (601) 979-3704 or (601) 979-6919 (TTY) and the facsimile number is (601) 979-6918. The mailing address is: Office of Support Services for Students and Employees with Disabilities, P.O. Box 17156, Jackson State University, Jackson, MS 39217.

### **Diversity Statement**

Jackson State University is committed to creating a community that affirms and welcomes persons from diverse backgrounds and experiences and support the realization of their potential. We recognize that there are differences among groups of people and individuals based on ethnicity, race, socioeconomic status, gender, exceptionalities, language, religion, sexual orientation, and geographical area. All persons are encouraged to respect the individual difference of others.

### **Collegiate Code of Conduct**

Jackson State University students are expected to dress in a manner representative of higher education institution. More information on Dress Code; Verbal and/or Physical Harassment; Indecent, Obscene, Immoral Behavior and/or Profanity is available in the JSU Student Handbook. The most recent version of JSU Student Handbook is available at <http://www.jsums.edu/studentlife/pdf/2010book.pdf>