CSCE 5170: Graph Theory

1. Timing and Access

Class Hours: Tuesday 5:30-8:20
In Person Class: Main Campus; WH 316

2. Course Content. Course will focus on graph properties, graph algorithms, their proofs of correctness and applications of graph algorithms.

3. Prerequisites. It is expected that the students have taken undergraduate courses in algorithms, data structures and know basics of set theory and combinatorics.

4. Evaluation

There will be one midterm and one final. Each will be worth 25%, **together making 50% of the total grade. Midterm will be held in class on March 21st** , the week after Spring break**. Finals will be held in finals week** according to university schedule.
The exams have to be taken individually. You can bring a cheat sheet for the exams.

There will be 4 assignments. The time for each assignment will be approximately 10 days. Each assignment will be worth 10%, so together the **assignments will be 40% of the total grade**. Assignments can be done **in groups of two, but no more than two**. You are responsible for forming groups. There will be weekly quizzes each worth 2%. **Five quizzes together will be worth 10%.**

Extra Credit: Any extra quizzes other than the first 5 will be counted as extra credit. Moreover, we will call on students in class to answer questions. You will get extra credits (5 points per question) if you are there when your name is called and you can answer the question.

There will be interactive problem solving activities during the class. These can be done in groups and will not be graded. However, participating will help you do well in the exams.

5. **Grading scheme.** The highest score will be set to 100, and the scores of the rest of the class will be scaled based on the highest grade.

Two points will be deducted for each day (weekends included) of late submission of assignments. The passing marks in this class is 55 or lower. Anyone getting lower than 55 will get an F

6. **Plagiarism Policy.** Academic Integrity Standards in this course are consistent with UNT policy: STUDENT STANDARDS OF ACADEMIC INTEGRITY (18.1.16), or other related/existing UNT polices. The work that you turn in to be graded, must be your own work. Usage of unauthorized material and sources, or depending on any unauthorized assistance, to answer homework problems, tests questions, writing reports, or carrying any type of assignment, etc., without the permission of the instructor, or without complete and accurate and complete attribution/citation of the source, when applicable, is viewed as an academic misconduct.

Rules specific to this course. You can use any publicly available resource, including code snippets, so long as you cite the source. You cannot use resources from sites that you or others have to pay to access (such as Chegg etc.)

(i) Not citing the source is **CHEATING**
(ii) Using information from a homework helper site, such as Chegg, is **CHEATING**

(iii) Duplicating/nearly duplication answers from another student/ another groups submission is **CHEATING**

(iv) If answers from two exams are the same both exams will be marked for **CHEATING.** It does not matter who copied from whom.

First offence for plagiarism is 0 for the entire submission and report to the graduate school. The second offence is an F in the course. If multiple groups/students have duplicate answers then the penalty will apply to all groups regardless of who did the actual work.

*Policy for working in groups***.** You can distribute the work among group members. However, if your name is in the submission you are responsible for the submission. This means

(i) you should be able to explain the algorithm/code/logic of the solution for all parts of the project even if you were not directly involved in implementing it

(ii) if any group member cheats, the entire group will be penalized

You can switch, merge or create new groups in course of the semester. The only constraint is that there can be no more than 2 people per group.

7. Textbook

There are no official textbooks. The materials in the lectures and associated links should be sufficient. You can also use materials available online.
Suggested books:
Introduction to Graph Theory. Wilson
(https://www.maths.ed.ac.uk/~v1ranick/papers/wilsongraph.pdf)
Graph Theory with Applications. Bondy and Murty
(https://www.zib.de/groetschel/teaching/WS1314/BondyMurtyGTWA.pdf)
Introduction to Graph Theory. West
(https://ia801204.us.archive.org/35/items/igt_west/igt_west_text.pdf)
Network Science. Barabasi
(http://networksciencebook.com/)
Networks: An Introduction
(https://math.bme.hu/~gabor/oktatas/SztoM/Newman_Networks.pdf)
Handbook of Graph Theory. Gross and Yellen.

8. Instructor and TAs

Sanjukta Bhowmick
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TA: Feng Wang. **Email:** wangfeng@my.unt.edu
TA: Krishna Sai Ujwal Kambhumpati. **Email:** krishnasaiujwalkambhumpati@my.unt.edu

9. Office Hours:

Instructor Office Hours: Wednesday 12:30am -2:00 pm at F291.
Zoom link: https://unt.zoom.us/j/6415359859 (virtual meeting by appointment)

Feng's Office Hours: Thursday 3:00pm -5:00pm at F267
Ujwal's Office Hours: Thursday 12:30 to 1:30 at F267

We are also available to help you outside the office hours. If you have any questions or clarifications send email to the instructors as well as the TA. We will respond with 24 hours. If you want to discuss the material outside the regular office hours, send us an email and we can schedule an ad hoc meeting.

All information about the class, any changes in schedule, details about assignments, etc. will be posted on the announcements via CANVAS. Please check the announcements regularly.

10. Syllabus

Topic 1: Introduction

Properties of graphs
Directed and undirected graphs, weighted graphs, attributed graphs (paths, cycles)
Eulerian and Hamiltonian paths
Cliques, regular graphs, complement of a graph, line graph
Software for analyzing graphs.

Topic 2: Traversal and Trees

Representing graphs for implementation
Breadth First Search, Depth First Search, Single source shortest path, All pairs shortest paths
Trees, properties of trees, minimum weighted spanning trees
Centrality of vertices; Closeness, Betweenness, Eigenvector, Page rank

Topic 3: Connectivity and Flows

Strong and weakly connected graphs, bi-connected components
Max flow, min cut
Graph partitioning
Community detection

Topic 4: NP-complete problems on graphs

Recap on complexity
Vertex and Edge Coloring
Graph Fill-in
Travelling Salesman Problem
Vertex Cover

Topic 5: Perfect Graphs

Chordal graphs
Bipartite graphs
Interval graphs
Complementary graphs

Topic 6: Planar graphs and Expander graphs

Planar graphs and embedding
Expander graphs, core numbers, graph resilience
Graceful graphs

Topic 7: Graph Isomorphism

Automorphism
Graph isomorphism algorithms
Measurement of graph similarity

Topic 8: Advanced topics

Hypergraphs
Graph/Feature embedding and neural network