湖北工業大學
HUBEI UNIVERSITY OF TECHNOLOGY

Course Title	Graph Theory
Course Code	MATH 4231
Semester	Summer 2026
Course Length	4 Weeks, 60 Contact Hours
Credits	4
Instructor	TBA
Office	TBA
Email	TBA
Prerequisite	MATH 2151 Linear Algebra I MATH 2331 Discrete Mathematics

Course Description:

Graph Theory studies discrete structures formed by vertices and edges and provides mathematical tools for modeling relationships, networks, and optimization problems. It is widely used in mathematics, computer science, operations research, engineering, and economics. Students will explore the structural properties of graphs, including connectivity, traversability, and planarity. Emphasis is placed on rigorous proof, problem-solving methods, and the interpretation of graph models in practical applications such as transportation systems, communication networks, scheduling, and resource allocation.

Course Goals:

Students who successfully complete this course will demonstrate competency in the following general education core goals:

- **Critical Thinking Skills** – Students will engage in analytical thinking, demonstrating the ability to critically evaluate, synthesize, and apply knowledge to complex problems, and construct well-reasoned solutions and arguments.
- **Independent Research and Inquiry** – Students will conduct independent research, utilizing academic resources to explore relevant topics, formulating research questions, analyzing data, and presenting findings in a coherent, scholarly manner.
- **Problem-Solving and Application** – Students will apply theoretical concepts and methodologies learned in the course to real-world problems, demonstrating the ability to develop practical solutions informed by academic inquiry.
- **Global and Cultural Awareness** – Students will gain awareness of the global and cultural contexts relevant to the course, appreciating diverse perspectives and considering the implications of their studies in a broader, international context.

Student Learning Outcomes:

Upon completion of this course, students will be able to:

- Understand the basic language and fundamental structures of graph theory;
- Construct rigorous mathematical proofs involving graphs and networks;
- Analyze trees, connectivity, traversability, and spanning structures;
- Apply matching and coloring methods to combinatorial optimization problems;
- Use planar graph theory and Euler-type arguments in structural analysis;
- Understand directed graphs and network flow methods;
- Apply classical graph algorithms to shortest path, spanning tree, and flow problems;
- Model practical real-world systems using graph-theoretic frameworks.

Textbooks/Supplies/Materials/Equipment/ Technology or Technical Requirements:

Textbook: *Introduction to Graph Theory, 2nd Edition,* by Douglas West. Pearson.

Course Requirements:

Problem Sets (20%)

Students complete four written problem sets distributed across the semester to strengthen proof-writing, theorem application, and analytical problem solving. The assignments cover major course topics including trees, connectivity, traversability, matchings, coloring, and planar graphs.

In-Class Quizzes (15%)

Two short quizzes are conducted during regular class sessions to assess students' ongoing understanding of definitions, fundamental theorems, and standard proof techniques.

Midterm Examination (25%)

The midterm examination is a closed-book, in-person written assessment. It evaluates students' understanding of the first half of the course, including fundamental graph concepts, trees, distance, connectivity, paths, Eulerian and Hamiltonian properties, and introductory matching theory. Questions include proof-based problems, theorem applications, and structured analytical exercises completed under supervised written examination conditions.

Graph Modeling Project (10%)

Students complete one individual applied project involving the use of graph theory to model and analyze a practical system such as transportation networks, communication systems, scheduling problems, or social networks. The project emphasizes mathematical modeling, interpretation of graph structures, and concise written explanation.

Final Examination (30%)

The final examination is cumulative and places greater emphasis on later topics such as graph coloring, planar graphs, cycles, directed graphs, network flows, and advanced applications. The exam shall be completed on campus in a supervised in-person format.

Assessments: Activity	Percent Contribution
Problem Sets (4)	20%
In-Class Quizzes (2)	15%
Midterm Examination	25%
Graph Modeling Project	10%
Final Examination	30%

Grading:

Final grades will be based on the sum of all possible course points as noted above.

Grade	Percentage of available points
A	94-100
A-	90-93
B+	87-89
B	84-86
B-	80-83
C+	77-79
C	74-76
C-	70-73
D	64-69
D-	60-63
F	0-59

Course Schedule:
The schedule of activities is subject to change at the reasonable discretion of the instructor. Minor changes will be announced in class, major ones provided in writing.

MATH 4231 Schedule

Lecture	Topic	Readings
L1	Introduction to graphs, terminology, degree, subgraphs	Ch. 1
L2	Isomorphism, bipartite graphs, complete graphs, graph representations	Ch. 1
L3	Walks, trails, paths, cycles, connected graphs	Ch. 1
L4	Trees and fundamental properties of trees	Ch. 2
L5	Spanning trees and applications	Ch. 2
L6	Distance, eccentricity, centers, shortest paths	Ch. 2
L7	Minimum spanning trees; Kruskal and Prim algorithms	Ch. 2 + Appendix B
L8	Connectivity: vertex connectivity and edge connectivity	Ch. 4
L9	Cut vertices, bridges, blocks Quiz 1	Ch. 4
L10	Menger's Theorem and connectivity applications	Ch. 4
L11	Euler trails and Euler circuits	Ch. 7
L12	Hamiltonian paths and cycles; sufficient conditions	Ch. 7
L13	Matchings in bipartite graphs; Hall's Theorem	Ch. 3
L14	Perfect matchings and factor concepts	Ch. 3
L15	**Midterm Examination**	
L16	Vertex coloring and chromatic number	Ch. 5

L17	Edge coloring and applications to scheduling	Ch. 5
L18	Planar graphs and planar embeddings Graph Project assigned	Ch. 6
L19	Euler's Formula and consequences for planar graphs	Ch. 6
L20	Dual graphs and coloring consequences of planarity Quiz 2	Ch. 6
L21	Directed graphs and tournaments	Ch. 8
L22	Network flows and max-flow min-cut theorem	Ch. 8 + Appendix B
L23	Applications of network flows and exercises	Ch. 8
L24	Counting arguments and extremal graph ideas	Ch. 8
L25	Comprehensive Review/Graph Project due	All chapters
/	**Final Examination**	/

Accommodation Statement:

Academic accommodations may be made for any student who notifies the instructor of the need for an accommodation. It is imperative that you take the initiative to bring such needs to the instructor's attention, as he/she is not legally permitted to inquire. Students who may require assistance in emergency evacuations should contact the instructor as to the most appropriate procedures to follow.

Academic Integrity Statement

Each student is expected to maintain the highest standards of honesty and integrity in academic and professional matters. The University reserves the right to take disciplinary action, up to and including dismissal, against any student who is found guilty of academic dishonesty or otherwise fails to meet the standards. Any student judged to have engaged in academic dishonesty in coursework may receive a reduced or failing grade for the work in question and/or for the course.

Academic dishonesty includes, but is not limited to, dishonesty in quizzes, tests, or assignments; claiming credit for work not done or done by others; hindering the academic work of other students; misrepresenting academic or professional qualifications within or outside the University; and nondisclosure or misrepresentation in filling out applications or other University records.

Other Items:

Attendance and Expectations

All students are required to attend every class, except in cases of illness, serious family concerns, or other major problems. We expect that students will arrive on time, be prepared to listen and participate as appropriate, and stay for the duration of a meeting rather than drift in or out casually. In short, we anticipate that students will show professors and fellow students maximum consideration by minimizing the disturbances that cause interruptions in the learning process. This means that punctuality is a must, that cellular phones be turned off, and that courtesy is the guiding principle in all exchanges among students and faculty. You will be responsible for the materials and ideas presented in the lecture.

Assignment Due Dates
All written assignments must be turned in at the time specified. Late assignments will not be accepted unless prior information has been obtained from the instructor. If you believe you have extenuating circumstances, please contact the instructor as soon as possible.

Make-Up Work
The instructor will not provide students with class information or make-up assignments/quizzes/exams missed due to an unexcused absence. Absences will be excused and assignments/quizzes/exams may be made up only with written documentation of an authorized absence. Every effort should be made to avoid scheduling appointments during class. An excused student is responsible for requesting any missed information from the instructor and setting up any necessary appointments outside of class.

Access, Special Needs, and Disabilities
Please notify the instructor at the start of the semester if you have any documented disabilities, a medical issue, or any special circumstances that require attention, and the school will be happy to assist.