Course Number: 47853-A3
Course Name: Special Topics in Combinatorial Optimization: Packing and Covering
Time: 10:30am-12:20pm (Jan 14—March 4, Tuesdays/Thursdays)
Instructor: Ahmad Abdi
Course webpage on https://www.andrew.cmu.edu/user/aabdi/index.html

Course Description

Menger (1927) showed that the maximum number of disjoint st-paths is equal to the minimum cardinality of an st-cut. Dilworth (1950) proved that the minimum number of chains needed to cover a poset is equal to the maximum cardinality of an antichain. These classic results are what started the field of Packing and Covering. In this course, we will see many theorems of this form, and study the underlying graph theoretic and geometric attributes that lead to such min-max and max-min results.

Key Topics:

Total dual integrality, balanced hypergraphs, perfect graphs, ideal clutters, sums of circuits property

Prerequisite Knowledge:

Basics of the theories of linear programming, convex polyhedra, and graph theory

Course Relevance:

To operations researchers: We will study the underlying structure of set packing and set covering integer programs that are easily solvable.

To combinatorial optimizers and mathematicians: We will study two frameworks that unify a variety of min-max theorems; we will study 0-1 matrices extending totally unimodular and balanced matrices; we will study graphs and matroids that give rise to integral set packing and set covering polyhedra.

To computer scientists: Quite often, min-max theorems are obtained in a quest for finding polynomial time algorithms for optimization problems. We will study min-max theorems sitting at the heart of such algorithms. We will also study the computational complexity of recognizing properties such as total dual integrality, perfection and idealness.

Learning Resources:

Students may find Gerard Cornuejols' book titled "Combinatorial Optimization: Packing and Covering" helpful (available on his personal webpage).

Assessment Structure:

There will be 4 assignments (70%) and a final project (30%). For the final project, each student picks a paper and writes a 4-5 page report on it.

Assignment 1: posted week 1, due week 2
Assignment 2: posted week 2, due week 3
Assignment 3: posted week 3, due week 4
Assignment 4: posted week 4, due week 6

Final project: paper titles posted week 3, titles due week 5, reports due week 7