# Mathematical Programming with Applications to Economics

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**Schedule:** Every **Tuesday and Thursday 9:30 AM - 11:30 AM**.

**Aim:** The course will cover some fundamental concepts of mathematical programming, graph theory, and discrete optimization in general with applications to economics.

**Prerequisites:** There are no prerequisites for the course. However, familiarity with basic linear algebra will help.

**Course Material:** I will put electronic notes online on course website. The website for the course is:

`http://www.isid.ac.in/~dmishra/mp.html`

Standard books on linear programming, combinatorial optimization, and graph theory can be used as references.

**Evaluation:** There will be about five assignments. I encourage you to do the assignments on your own or in groups, and discuss it with me in case of doubts. Breakup of weights: assignment - 10%, mid-term - 40%, end-term - 50%.

**Topics:** Here are the main topics for the course.

1. **Basic Graph Theory**

    - Graphs and directed graphs: path, cycle, degree, cut, tree, connectedness

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- Minimum cost spanning tree problem
- Application: A game on graph
- Hall's marriage theorem
- Application: Matching
- Matching theory
- Max-flow min-cut
- Application: Reduced form auctions
- Shortest paths on directed graphs
- Potentials of graphs
- Applications: fair prices; incentive compatibility

2. **Convex Sets**

    - Separating hyperplane theorem
    - Polyhedra and polytopes
    - Farkas Lemma, Caratheodery theorem
    - Application: core of cooperative games

3. **Linear Programming and Duality**

    - Simplex method
    - Duality theorems
    - Application: zero-sum games
    - Linear relaxation of integer programs
    - Totally unimodular matrices
    - Application: assignment problem and prices

4. **Other Topics**

    - Submodular optimization
    - Polymatroid optimization
    - Matroid theory
    - Discrete convex analysis
    - Application: Walrasian equilibrium with indivisible goods