

**Math/CSE 1028:**  
**Discrete Mathematics for Engineers**  
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Course page: <http://www.cse.yorku.ca/course/1028>

# Ch 10: Graphs

- Tool for modeling many real applications
- Abstract model that throws away many non-essential
- Nodes, connected by edges
- No geographical locations attached to node positions, no significance of edge lengths

# Examples

- Road networks
- Subway/Train networks
- Airline networks
- Social Networks
- Power Grid
- Electronic Communication Networks
- Electrical Circuits
- Biological Networks
- Ecological Networks

## Examples - 2

- The web graph
- Software module dependencies
- Computation structure
- Scheduling constraints
- Collaboration graphs
- State graphs of machines and protocols
- Many, many others

# Definitions

- $G = (V, E)$
- degree of a node
- neighborhood of a node
- Thm 1 (pg 653): Sum of degrees equals twice the number of edges in an undirected graph
- Thm 3 (pg 654) Sum of indegrees equals sum of outdegrees in a digraph

# Types of graphs

- Finite vs Infinite
- Simple vs Multigraphs
- Directed vs Undirected
- Pseudographs

# Bipartite Graphs and Matching

- Definition
- Hall's Theorem (pg 659)  
proof done on the board.

# New graphs from old

- Induced subgraphs
- Removing edges or nodes
- Adding edges or nodes
- Unions
- Edge contractions



# Representing and Storing Graphs

- Adjacency list
- Adjacency matrix
- Incidence matrix

# Graph problems

- Graph Isomorphism
- Connectivity
- Graph Coloring

# Trees