MA/CSC 416
Synthesis/Review for the Midterm.

On this sheet, I have connected these topics to particular homework problems. Here is the "code": (1.1:5,7) means Problems 5 and 7 in Section 1.1, etc. **But please also note** that these topics were covered in lectures and in your reading, and you are also responsible for what you learned from those sources.

Counting methods.

- Fundamental Counting Principle (1.1:15,16,17,18,21) (1.2:17,18,28) (1.6:27) (1.7:19)
- Second Counting Principle (1.5:15) (1.6:14,19,29)
- Overcount, then divide (1.2:28)
- Count then subtract (1.2:28) (1.3:15,18)

Combinatorial objects.

- Subsets (unordered selections without replacement)
  - All subsets
  - Subsets with r elements (1.6:4)
  - Other families of subsets (1.6:29)
- Tuples/sequences/words
  - Ordered selections with/without replacement (1.6:4)
  - Words with a specified multiplicity for each letter (1.1:5,7) (1.8:6)
  - Compositions (positive integer entries) (1.6:19,27) (1.7:7)
  - Partitions (positive integer entries, weakly decreasing) (1.8:6,18)
    - Ferrers diagrams (1.8:2,13,14,18)
- Unordered selections with replacement (1.6:4)
- Finite functions (2.1:1,2,3,4)
  - All functions (2.1:2)
  - Injective (one-to-one) functions (2.1:3)
  - Surjective (onto) functions (2.1:4)
  - Weakly increasing functions
  - Strictly increasing functions (2.1:2,3,4)
- Set partitions (2.1:5)

Proof methods.

- Algebraic manipulation (1.2:9) (1.5:1,7) (1.7:12)
- Induction (1.1:8) (1.5:6,8) (1.6:19,29) (1.7:12) (1.8:2,13,14)
- Count something two different ways (1.2:9,10) (1.5:15) (1.6:7)
- Bijection (1.2:9,10,26) (1.6:7,19,29)
- Polynomial identities
  - Get coefficients from roots (elementary symmetric functions) (1.9:3)
  - Get new polynomial identity by differentiating both sides (1.7:6)
  - Get numerical identity by finding coefficient of x^r on both sides (1.7:8)
  - Get numerical identity by specializing ($x =$ number) on both sides (1.7:6,11)
- Other (direct argument) (1.1:16,21) (1.2:12) (1.6:17) (1.7:7,11,19) (1.8:9)

Theorems.

- Pascal's Relation (1.2:12) (1.7:12)
- Chu's Theorem (1.5:1,8)
- Binomial Theorem (1.7:6,8)
- Multinomial Theorem (1.7:7,11)