**600.469 / 600.669 Approximation Algorithms** **Lecturer:** Michael Dinitz
**Topic:** Topic **Date:** 1/27/15
**Scribe:** Your Name Here

## 1.1 The Topic

Citing a reference [CW87].

A description list.

**Part a**: The first part.

**Part b**: The second part.

**Part c**: The last part.

An itemized list.

- Item #1.
- Item #2.

A numbered list.

1. First
2. Second

### 1.1.1 Statements of Results

**Definition 1.1.1** *Define your problem here.*

**Theorem 1.1.2** *A theorem.*

**Lemma 1.1.3** *A helpful lemma.*

**Proof:** Proof of the lemma goes here. ■

Now we can prove Theorem 1.1.2.

**Proof of Theorem 1.1.2:** Follows from Lemma 1.1.3 ■

## 1.2 Some Formulas and Algorithms

### 1.2.1 A Linear Program

Consider linear program (**TSP-LP**) below.

$$
\begin{aligned}
\text{minimize:} \quad & \sum_e c(e) \cdot x_e & & & \textbf{(TSP-LP)} \\
\text{subject to:} \quad & x(\delta(S)) \geq & 2 & \quad \text{for each cut } \emptyset \subsetneq S \subsetneq V & (1.2.1) \\
& x(\delta(v)) = & 2 & \quad \text{for each vertex } v \in V & (1.2.2) \\
& x \geq & 0 & &
\end{aligned}
$$

Constraints (1.2.1) are the *cut constraints* and Constraints (1.2.2) are the *degree constraints*.

### 1.2.2 Tips

Use $\log n$, not *log n*.

$V = \{v_1, v_2, \ldots, v_n\}$.

Check out $\sum_{i=1}^{n} i$ vs. $\displaystyle\sum_{i=1}^{n} i$.

A displayed equation:

$$H_n = \sum_{k=1}^{n} \frac{1}{k} = \int_1^n \frac{dx}{x} + O(1) = \ln n + O(1)$$

A matrix:

$$\begin{pmatrix} x_1 & y_1 & z_1 \\ x_2 & y_2 & z_2 \\ 0 & 0 & 1 \end{pmatrix}$$

Problem names should look like this: Set Cover.

### 1.2.3 An Algorithm

**Algorithm 1** Kruskal's Minimum Spanning Tree Algorithm

**Input**: Undirected graph $G = (V, E)$ with edge costs $c(e) \geq 0, e \in E$.
**Output**: A minimum spanning tree of $G$.

$T \leftarrow \emptyset$
**for** each edge $e \in E$ in increasing order of cost $c(e)$ **do**
  **if** $T \cup \{e\}$ does not contain a cycle **then**
    $T \leftarrow T \cup \{e\}$
  **end if**
**end for**
**return** $T$

## References


CW87 D. Coppersmith and S. Winograd, Matrix multiplication via arithmetic progressions, *Proceedings of the 19th ACM Symposium on Theory of Computing*, 1987, pp. 1–6.

S69 V. Strassen, Gaussian Elimination Is Not Optimal, *Numerische Mathematatik* **13**, 1969, pp. 354–356.

P84 V. Pan, *How To Multiply Matrices Faster*, Springer-Verlag, Lecture Notes in Computer Science Vol. 179, 1984.