Date: February 15, 2006 Name ________________________

CE 3201 Introduction to Transportation Engineering
Spring 2006 – QUIZ 1 – Transportation Planning

Qualitative Questions (20%)

1. (5) What are the steps in building a model? Illustrate by showing how those apply to trip generation.

2. (5) Upon what does trip distribution (destination choice) depend? List 5 important variables and explain how they affect choice of destination.

3. (5) Is the gravity model an aggregate or disaggregate model? Which better reflects how decisions are made by individuals? How might you model choice of destination differently than the gravity model, explain your proposals strengths and weaknesses..

4. (5) Identify 5 reasons for using a transportation forecasting model.

Problems (80%)

You are given the following situation: The towns of Saint Cloud and Minneapolis, separated by 110 km as the crow flies, are to be connected by a railroad, a freeway, and a rural highway. Answer the following questions related to this problem

1 (10) Trip Generation

Your planners have estimated the following models for the PM Peak Hour

$T_i = 0.5 * W_i + 0.2 * N_i$
$T_j = 1.0 * H_j$

Where:
T_i = Person Trips Originating in Zone *i*
T_j = Person Trips Destined for Zone *j*
H_i = Number of Households in Zone *i*
W_j = Office Employees in Zone *j*
N_j = Non-office Employees in Zone *j*

Your are also given the following data

	Saint Cloud	Minneapolis
H_i	22,652	162,352
W_j	34,000	244,000
N_j	12,000	141,000

A. (5) According to the model, what are the number of PM peak hour person trips <u>originating in</u> **and** <u>destined for</u> Saint Cloud **and** Minneapolis?

B. (5) Assuming the origins are more accurate, and these are the only two zones, <u>normalize</u> the number of destination trips for Saint Cloud **and** Minneapolis.

2. Trip Distribution

(30) Assume a gravity model where the impedance $f(C_{ij}) = C_{ij}^{-1}$; C_{ij} given in minutes

A. (5) Compute the impedance matrix

The travel time between zones (in minutes) is given by the following matrix:

Origin \ Destination	**Minneapolis**	**Saint Cloud**
Minneapolis	15	95
Saint Cloud	85	10

B. (10) Set up and briefly explain the process for balancing the matrix, assume the trips generated in question 1 above.

C. (10) Complete the calculations for 2 iterations of balancing: one each of origins and destinations.

D. (5) Approximately how many trips are going from Minneapolis to Saint Cloud in the PM peak hour? How certain are you of this answer?

3. (15) Mode Split

You are given the following utility expression for a logit mode choice model for a proposed Rail Line between Minneapolis and Saint Cloud. Assume all other travelers use their vehicles and drive alone.

$U_A = -\ 0.1*T_A - 1.0*D_A$
$U_R = -\ 0.1*T_R - 0.3*T_{Access}$

Where T_m = Travel Time from origin to destination by mode m
D_A = Dummy variable (1 if car, 0 otherwise)
D_R = Dummy variable (1 if rail, 0 otherwise)
T_A = In-Vehicle Travel Time by Car (95 minutes)
T_R = In-Vehicle Travel Time by Rail (60 minutes)
T_{Access} =Access Time (15 minutes)

According to this logit model:

A. (10) What percentage of PM peak hour **riders** will there be **on the train** from Minneapolis to Saint Cloud,
B. (5) What percentage will **take the car**?

4. (25) Route Assignment

Assume the auto flow from Minneapolis to Saint Cloud, is 1000 vehicles per hour and that there are 4000 other cars that will always be on the freeway and 1000 other cars that will always be on the rural road. Flow between Minneapolis and Saint Cloud on the freeway is denoted Q_f, and flow on the parallel rural road is denoted Q_r. Total flow on the freeway segment is Q_{ft} and total flow on the rural road is Q_{rt}. The travel time on the freeway (C_f) is given by:

$C_f = 90 + 0.04*Q_{ft}$

The Travel time on the rural road (C_r) is given by:

$C_r = 120 + 0.10*Q_{rt}$

A. (10) Apply Wardrop's User Equilibrium Principle and determine the flow and travel time on **each route**.

B. (10) Apply Wardrop’s System Optimal Principle and determine the ideal flow and travel time on **each route**, minimizing the total cost for all travelers (including those already on each route).

C. (5) Comment on the difference.

Equations:

$$T'_j = T_j \frac{\sum_{i=1}^{I} T_i}{\sum_{j=1}^{J} T_j}$$

$$\boldsymbol{T_{ij} = K_i K_j T_i T_j f(C_{ij})}$$

$$T_i = \sum_j T_{ij}$$

$$T_j = \sum_i T_{ij}$$

$$K_i = \frac{1}{\sum K_j T_j f(C_{ij})}$$

$$K_j = \frac{1}{\sum K_i T_i f\left(C_{ij}\right)}$$

$$P_m = \frac{e^{U_{mij}}}{\sum_{n=1}^{m} e^{U_{nij}}} \Rightarrow \sum_{n=1}^{m} P_n = 1$$

$$U_m = f(C_{ijm,...})$$

Average Cost = $\frac{TC}{Q}$

Marginal Cost = $\frac{\partial TC}{\partial Q}$