CEE 123 Transport Systems 3: Planning & Forecasting

Spring 2025: McNally [15450]

Homework #1. Review of Pre-requisite Material [40 points]

Complete problems 1-3 plus either problem 4 or 5. These problems represent material that you need to know before taking this course. You must work independently to provide an accurate picture of your level of understanding.

Problem 1. [CEE121] Travel Forecasting (10 points)
Review Mannering, Kilareski, and Washburn (2004) Chapter 8. Read 8.1-8.3; skim 8.4-8.5; read 8.6; skim 8.7 and Appendix 8A (note: this book was used in CEE121). The same material is available in most transportation texts and on-line (for example, The Four Step Model (MGMcNally) or Travel Forecasting Primer (Bierborn)).

Answer the following questions ***in your own words***:

a. What is the Transportation Planning Process?
b. What are the **steps** in the sequential approach to forecasting future travel?
c. What are the inputs and outputs of each forecasting step?
d. What is a **link performance function**? What role does it play in travel forecasting?
e. What is the difference between **User Equilibrium** and **System Optimal** route choice formulations?

Problem 2. [CEE110, 121] Statistical Methods (20 points)
The following speed and density data was collected on a local freeway segment.

Table 2. Speed and Density Measurements (2025)

Observation	Units	1	2	3	4	5	6	7	8	9	10
Speed SMS	mph	50	45	40	30	25	50	35	35	25	20
Density D	veh/mi	10	20	35	40	70	15	40	50	80	100

{Speed,Density} = {60,15},{15,120},{20,115},{55,10}

a. **Estimate** a linear speed-density regression model with X = density (D) and Y = Speed (u_s). You may perform the calculations by hand or use available software (e.g., Excel). Identify software and include model input and output.

b. **Define** and **find** mean free speed (u_f) and jam density (D_j) and express the results in Greenshield's format:

$u_s = u_f (1 - D / D_j)$

c. Is the model **significant**? What **specific tests** support your contention?

d. Find the model including the four additional data points (in Table 2). **How** will these points affect the estimated model? Does a **plot** suggest that the linear Greenshield's model might not be appropriate?

Problem 3. [CEE121] Performance-Demand Equilibration (10 points)
Two single-link paths connect an origin and destination with performance functions:

$t_1 = 1 + 0.5\ x_1$
$t_2 = 2 + 1.0\ x_2$

with time t in minutes (min.) and volume x in thousands of vehicles per hour (kvph).

a. Determine UE flows if the total origin-to-destination demand is 800 veh/hr
b. Determine UE flows if the total origin-to-destination demand is 3,000 veh/hr
c. Calculate the total vehicle-hours of travel for both case (a) and (b)
d. Referring to Problem 1, how does this problem fit the sequential forecasting process? What elements are demand and what elements are supply?

Problem 4. [CEE110] Project Evaluation (10 points)
In the final task of the CEE123 term project, teams will compare future alternative transportation systems in terms of system performance and system cost relative to a "No Build" alternative. There are several project evaluation techniques that can be utilized.

In 2000, Miasma Beach considered three different intersection improvement alternatives for the intersection of 1st Street and Mountain Boulevard. The City defined the following goals for this project: (1) improve travel speeds; (2) increase safety; and (3) reduce operating expenses for motorists. Project benefits and costs have been quantified and summarized. Each alternative has a design life of 50 years and the discount rate is 3 percent.

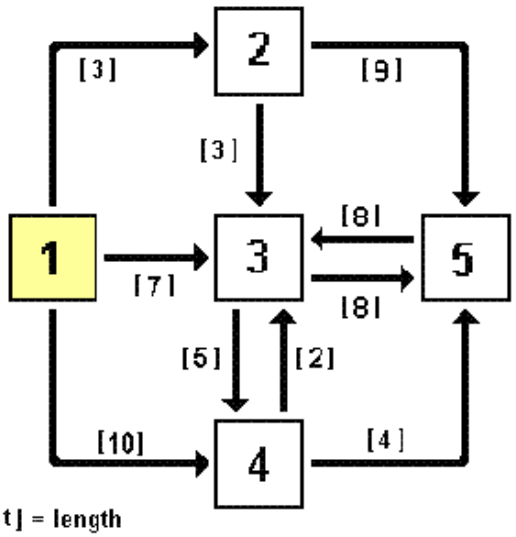
Table 1. 1st & Mountain Intersection Improvement Project

Alt	Project Costs		Annual Project Benefits		
	Initial Construction	Annual M&O	Savings in Travel Time	Accident Savings	Savings in Operations
1	$185,000	$1,500	$3,000	$5,000	$500
2	220,000	2,500	6,500	5,000	500
3	310,000	3,000	6,000	7,000	2,800

Note: except for initial construction, all benefits, as well as Maintenance & Operations costs are annual.

Which alternative should be selected? Apply **two** project evaluation methods, choosing from: (a) Net Present Worth; (b) Benefit Cost Analysis; or (c) Rate of Return.

Problem 5. [CEE111] Network Models and Optimization (10 points)
Formulate the linear program to find the minimum path from node 1 to node 5 (no need to solve).



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