

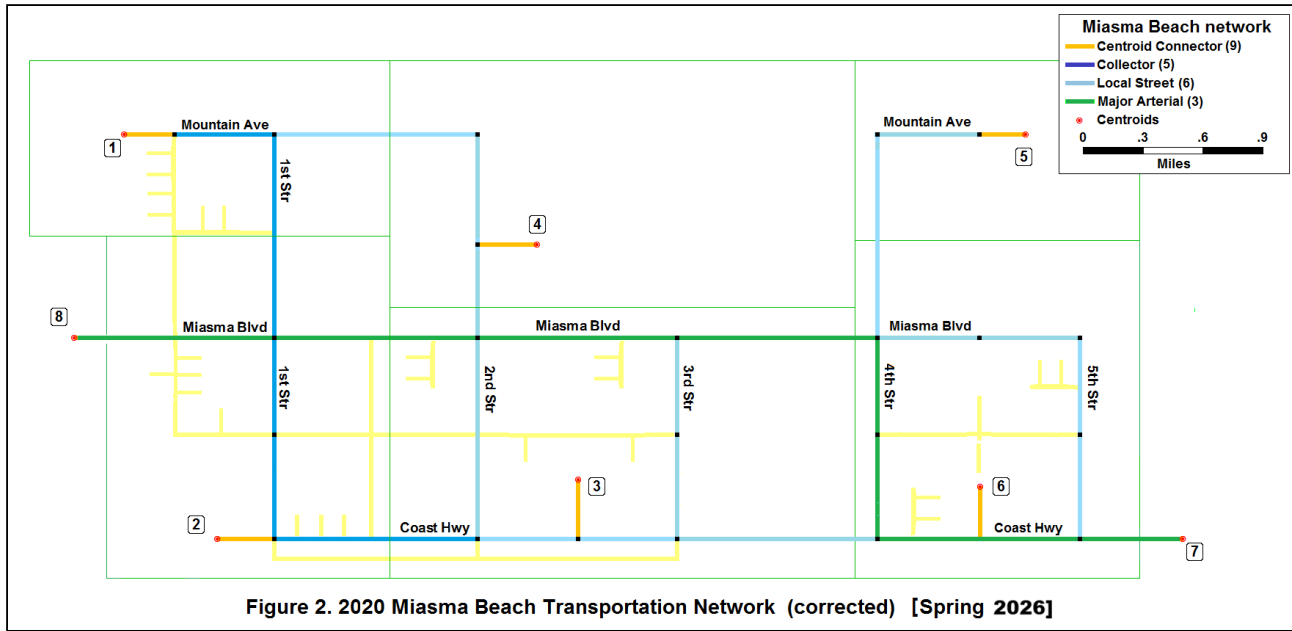
CEE 123 Transport Systems 3: Planning & Forecasting

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Homework #3 -- Shortest Path Algorithms / Skim Trees [Due: Wednesday, 15 April 2026]

Problem 1. Network Characteristics [10 points]

Depicted below is the corrected 2020 Miasma Beach network. Using the network map and the information in Task 1 Table 1, convert speeds and distances to travel times. **Produce** a network map depicting link *distance*, *speed*, and *travel time* annotated on each link. You may use TransCAD to complete the calculations and produce the final labeled network, but you must do this work **individually**.



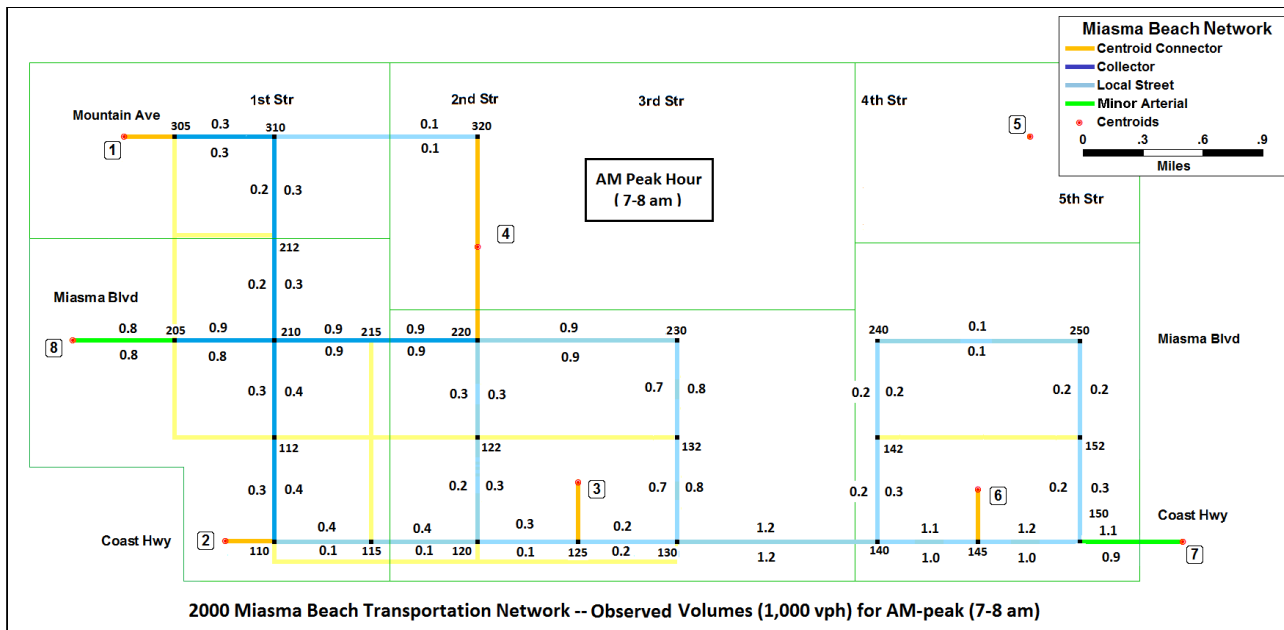
Problem 2. Performance Analysis (20 points)

Depicted below is the 2000 Miasma Beach transportation network with observed 2000 traffic volumes (kvph by direction) for the AM peak hour (7-8 AM). **Calculate** performance characteristics for each link (VMT, VHT, speed) and **summarize** results by link facility type as well as by network-wide totals for VMT, VHT, and average speed. Use the BPR link performance function to estimate link travel times based on observed volumes (use default values for α and β): $t = t^0(1 + \alpha(\text{vol}/\text{cap})^\beta)$. Use the tabular format provided ([xls](#)). Do **not** include centroid connectors.

Computation of Level-of-Service (LOS) can be complex and varies by facility type. Typically, freeway sections utilize link traffic density while arterials utilize link average speed and average time spent following. To simplify analysis, use the density-based assessment for all link types.

Table 3.12 Density Ranges for Freeway LOS	
L-o-S (A-F)	Density (vpm/lane)
A	0 - 11
B	> 11 - 18
C	> 18 - 26
D	> 26 - 35
E	> 35 - 45
F	> 45

Describe any 2000 network problems. Consider LOS and observed volume/capacity ratios as a possible congestion measure. Summarize 2000 observed VMT, VHT, and average speed (total and by facility type).



Problem 3. Shortest Paths (20 points)

Apply Dijkstra's Algorithm **by hand**, as illustrated in class, for **either** part 3A or 3B:

- Find** two minimum path trees for a **single** centroid (1-6) from the Miasma Beach network, using *travel times* from Problem 1 for one skim tree and *distance* for the second. Compare the two skim trees (since link speeds vary, so may the resulting skims). Show all work. You should verify your results with TransCAD.
- Find** two minimum path time trees for **centroids 2, 3, or 4** from the in-class network.

Include tables and plots that should approximate presentation standards. Use either the [table format](#) or the graph format (see [skim tree](#) notes). Plot the minimum path tree for each case. **Construct** the interzonal travel time matrix (t_{ij}) corresponding to the Miasma or class networks, including computed O-D travel times (or distances), including those from class.

Problem 4. Cost of Network Improvements (10 points)

Based on the 2000 Transportation Study, the City of Miasma Beach expanded the transportation network. Using the cost estimates [provided](#), compute the cost of the network improvements between 2000 (the network in Problem 2) and 2020 (the network in Problem 1). Use the same spreadsheet as in Problem 2.

Please note that all costs are per lane-mile and that all links improvements and additions must include link costs **and** the associated intersection costs, plus any development penalties.

Problem 5. Dijkstra's Algorithm (5 points)

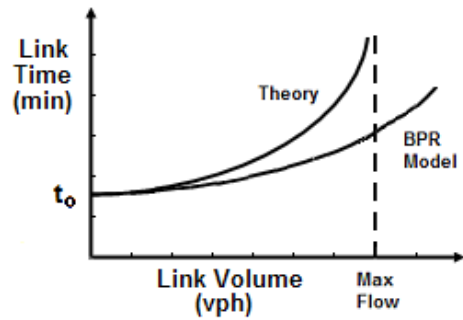
Write the formal algorithm steps for Dijkstra's Algorithm.

Review Topics: Network Supply/Performance

- Network Characteristics: link and node types, link and node attributes
- Minimum Path Algorithms: Dijkstra (Label-setting) to find path sequence and path length
- Link Performance Functions: BPR & other empirical functions, Fundamental Diagram, Queueing

Review Questions: (for review only: do **not** submit with HW#3)

- a. What is a skim tree?
- b. How does label-setting differ from label-correcting in Minimum Path Algorithms?
- c. The diagram below depicts the BPR link performance function and the theoretical relationship that would be expected based on queueing theory or the fundamental diagram. Why are they different?



Last Updated: 8 April 2026