CE 560 Public Mass Transportation

Name: ___jdf solutions_____

Test 2 (6 questions on 2 pages)

Wed. 8 April 2009

OPEN BOOK AND NOTES

8:30-9:20 AM, Room 1113 CIVL

μ=63.1, σ=13.7

1. (15 points) **Estimating ridership changes** due to service changes. The present schedule calls for a bus to leave the start of Route 19 at hh:04, hh:14, hh:24, hh:34, hh:44, hh:54, etc. A proposed schedule change would have bus departures at hh:04, hh:19, hh:34, hh:49, etc. If current ridership is 4723 and the service elasticity value of -0.42 is suggested, estimate the ridership on Route 19 if the service change is implemented.

   Headway h(0) = 10 min, h(1) = 15 min

   Frequency freq(0) = 6/hr, freq(1) = 4/hr

   ε(svc) is negative, so service variable is headway, not frequency.

$$\varepsilon_{svc} = \frac{\left(\frac{Q1-Q0}{Q0}\right)}{\left(\frac{h1-h0}{h0}\right)}; \; Q1-Q0 = Q0*\frac{h1-h0}{h0}*\varepsilon_{svc} = \left[4723*\frac{15-10}{10}*-0.42\right] = Q1-4723$$

   Q1 = 4723-991.83 = 3731.17 = 3731

   (5:15)

2. **Using APC data.** The handout used in class on 27 Feb 2009 was an excerpt of APC data for Bus 1506, taken from one of the files emailed to you on 25 Feb 2009.

   A. (10 points) At what speed did the bus operate between Point 18 (PMU) and Point 22 (Beering Hall)? Show your calculations.

point	distance	Actual depart
18	0.0	7:28:52
22	0.62 mi	7:33:50
	0.62 mi	0:04:58

   4:58 = 298 seconds. Speed = $\frac{0.62\,mi}{298\sec}*\frac{3600\sec}{hr}$ *= 7.49 mph*

   (2:00)

   B. (10 points) Describe a way in which you might be able to use APC data to develop a mathematical relationship between #Boardings and Dwell Time.

   Try to plot time between departures at consecutive "Stops" vs. number of Boardings (B) and Alightings (A) at previous stops. Look for dwell time when B+A = 0 vs. all other cases. Also try to account for acceleration and deceleration when passengers must be picked up or dropped off.

   (4:30)

3. (15 points) **Create a Vehicle Block.** Can you read a train schedule? See the schedule below for the Rail Runner commuter rail service in New Mexico. Engine C leaves Los Lunas

at 4:50AM. Indicate (either directly on the schedule or in a list of trip end locations with times) the trips that could be made by Engine C, so that it makes as many trips as possible.

One solution is:

NB lv Los Lunas 4:50AM, arr Santa Fe Depot 6:42AM

SB lv Santa Fe Depot 7:12AM, arr. Downtown Albuquerque 8:43AM

NB lv Downtown Albuquerque 10:37AM, arr. Santa Fe Depot 12:05PM

SB lv. Santa Fe Depot 4:10PM, arr. Belen 6:16PM

NB lv. Belen 6:42PM, arr. Downtown Albuquerque 7:25PM

(1:45)

NORTHBOUND

Train number	#500	#502	#504	#506	#508	#510	#512	#514	#516	#518	#520	#522	#524
Belen	---	---	---	5:40A	6:50A	7:56A	---	2:00P	---	---	5:35P	6:42P	7:40P
Los Lunas	---	---	4:50A	5:50A	7:01A	8:07A	---	2:12P	---	---	5:47P	6:54P	7:52P
Isleta Pueblo	---	---	5:03A	6:05A	7:15A	8:22A	---	2:26P	---	---	6:03P	7:10P	8:06P
Bernalillo Co./ Int'l Sunport	---	---	5:10A	6:11A	7:21A	8:28A	---	2:33P	---	---	6:09P	7:16P	8:12P
Downtown Albuquerque	4:23A	5:05A	5:21A	6:23A	7:33A	arrives 8:37A	10:37A	arrives 2:41P	4:15P	5:21P	6:35P	arrives 7:25P	arrives 8:21P
Los Ranchos/ Journal Center	4:35A	5:17A	5:33A	6:35A	7:45A	---	10:49A	---	4:26P	5:33P	6:47P	---	---
Downtown Bernalillo	---	5:29A	---	---	---	---	11:03A	---	4:40P	5:47P	7:02P	---	---
Sandoval Co./ US 550	4:49A	arrives 5:50A	5:47A	6:49A	7:59A	---	11:08A	---	4:45P	5:52P	7:06P	---	---
South Capitol	5:40A	---	6:37A	7:39A	8:49A	---	11:59A	---	5:41P	6:46P	7:57P	---	---
Santa Fe Depot	arrives 5:45A	---	arrives 6:42A	arrives 7:44A	arrives 8:54A	---	arrives 12:05P	---	arrives 5:46P	arrives 6:51P	arrives 8:02P	---	---

SOUTHBOUND

Train number	#501	#503	#505	#507	#509	#511	#513	#515	#517	#519	#521
Santa Fe Depot	---	6:10A	---	7:12A	11:30A	4:10P	---	5:17P	6:18P	8:15P	9:30P
South Capitol	---	6:15A	---	7:17A	11:35A	4:15P	---	5:22P	6:23P	8:20P	9:35P
Sandoval Co./ US 550	6:00A	7:10A	---	8:12A	12:28P	5:05P	---	6:12P	7:21P	9:11P	10:25P
Downtown Bernalillo	6:03A	7:14A	---	8:17A	12:34P	---	---	---	---	9:16P	10:30P
Los Ranchos/ Journal Center	6:18A	7:29A	---	8:32A	12:48P	5:20P	---	6:27P	7:36P	9:30P	10:45P
Downtown Albuquerque	arrives 6:30A	arrives 7:41A	6:47A	arrives 8:43A	1:03P	5:35P	4:25P	6:42P	arrives 7:48P	arrives 9:42P	arrives 10:57P
Bernalillo Co./ Int'l Sunport	---	---	6:56A	---	1:12P	5:44P	4:34P	6:51P	---	---	---
Isleta Pueblo	---	---	7:02A	---	1:18P	5:50P	4:40P	6:57P	---	---	---
Los Lunas	---	---	7:18A	---	1:32P	6:04P	4:54P	7:11P	---	---	---
Belen	---	---	arrives 7:30A	---	arrives 1:44P	arrives 6:16P	arrives 5:06P	arrives 7:23P	---	---	---

Shown are departure times, unless otherwise noted. *--- means train does not stop.*

4. (15 points) **Runcutting and pay hours**. The platform time for the bus on Vehicle Block 30 is 18 hours. Given the rules below, calculate the pay hours (and minutes) associated with (a) 2 drivers versus (b) 3 drivers to operate the bus.
   - Report time = 9 minutes before pull-out or relief time
   - Travel time = 6 minutes to reach route start or relief point
   - Travel time = 8 minutes from relief point or from route end
   - Minimum pay, regardless of computed pay hours = 8 hours
   - Overtime premium = 0.50 minute for every minute more than 8 hours

Each of two drivers: (9+6+8 minutes) + (18/2) hrs = 9:23 worked.
*OT premium = (9:23-8:00)*0.5 = 0:42 per driver.*
Pay hrs per driver = 9:23 + 0:42 = 10:05; <u>20:10</u> for two drivers.
Each of three drivers: (9+6+8 minutes) + (18/3) hrs = 6:23 → 8:00 minimum per driver; <u>24:00</u> for three drivers.

(4:00)

5. (15 points) **Commuter rail capacity.** The Rail Runner service runs in the median of Interstate Highway 25. Each weekday, 8 northbound and 8 southbound trains run between Albuquerque and Santa Fe. Each train has 3 cars. Each car can carry 140 seated passengers and 60 standing passengers. The ADT on I-25 is about 40,000. Assuming average occupancy is 1.5 persons per automobile on I-25, how many 3-car trains would be needed to provide space for 60,000 rail passengers.

   *Each train: 3 cars/train * (140+60) pax/car = 600 pax/train*

   $\frac{60{,}000\ pax/day}{600\ pax/train}$ *= 100 trains per day.*

   (2:00)

6. **Cost equations.**
   A. (10 points) When regression is used to determine the values of the coefficients A, B, and C in Equation (14-1), should a constant term be permitted, so that the equation becomes A(VM) + B(VH) + C(PV) + D? Why (not)?

   Letting the statistical fit determine the D value in HW6 resulted in very large (about -10 million) negative values. This experience indicates that keeping D=0 is advisable.

   (2:00)

   B. (10 points) Which method is best for estimating the cost of new or extended service for a transit agency? Explain.
      - Total cost method, as in GLPTC's Performance Indicators
      - A regression equation based on data from peer systems
      - Cost allocation method

      - *The Total Cost Methods risk multiple counts of each "unit cost", e.g., Total Cost/Veh Hrs*
      - *Regression equations depend on the choice of "peer systems". The resulting coefficients may not be applicable to extended service.*
      - *The <u>Cost Allocation Method</u> can be implemented from the transit system being analyzed, and connects cost components to the variables that best explain the associated operating cost variables.*

      (4:15)

      (25:45)