CVG4150 Fall – 2017
Highway & Transportation
ASSIGNMENT #3
Due on Nov. 27 (by 17:00)

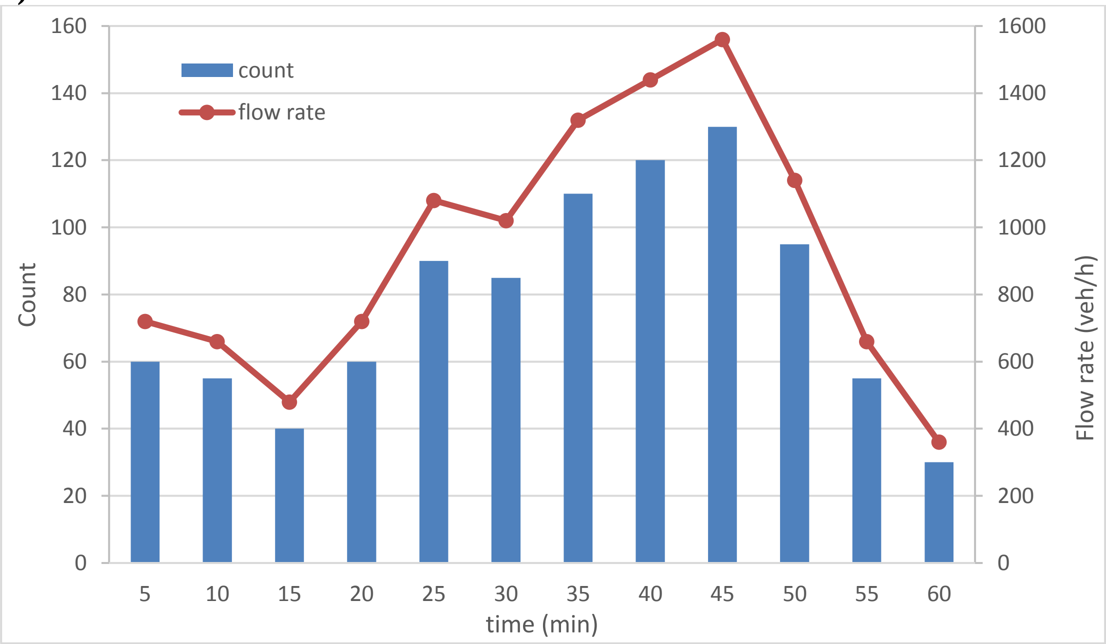
Capacity and Level of Service

Q1. The following 12 consecutive 5-min vehicle counts were taken on a highway:

60	55	40	60	90	85	110	120	130	95	55	30

a) Plot the histogram of these counts and the histogram of the flow rates computed on the basis of the preceding counts
b) Calculate the hourly volume and the PHF.
c) Show that for t = 15 min the PHF can theoretically range from 0.25 to 1.00 using the data given.

Q1 Solution:
a)



b)
V=∑Ni=930 veh/hr
PHF=930/(12*130)=0.596   Based on Max. 5 min. flow
OR: PHF=930/(4*360)=0.646   Based on Max. 15 min. flow
c)
For a perfectly uniform flow, one fourth of the hourly count occurs during any 15 minute period. Hence:

PHF = V/ (4*(V/4)) = 1.00

For an extremely peaked demand, the entire hourly counts occurs in the peak 15 minute interval. Hence: PHF = V/(4V) = 0.25

Q2. Determine the LOS on a regular weekday on a 0.65-km section of a six-lane freeway (three-lane each) with a grade of 2 percent, using the following data:

Hourly volume: V = 3000 veh/hr
PHF = 0.85
Traffic Composition:
  Trucks = 10 percent
  RVs = 2 percent
Lane width = 3.5 m
Terrain = Level
Base free-flow speed = 110 km/hr
Shoulder width = 2 m
Interchange spacing = 1 km
Driver population adjustment factor f_p = 0.95

Q2 Solution:
Step 1. Compute heavy vehicle factor
Determine the correction factors for extended general freeway segments (3 percent grade and 0.65 km long):

PCEs:
$E_T = 1.5$
$E_R = 1.2$

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)} = \frac{1}{1+0.10(1.5-1)+0.02(1.2-1)} = 0.95$$

Step 2. Determine the peak 15-minute passenger–car equivalent flow rate.

$$v_P = \frac{V}{\text{PHF}\times \text{N}\times f_{\text{HV}}\times f_p} = \frac{3000}{0.85\times 3\times 0.95\times 0.95} = 1303.57 \ pc/hr/\ln$$

Step 3. Compute the free-flow speed and density.

$FFS = BFFS - f_{LW} - f_{LC} - f_N - f_{ID}$

$=110 - 1.0 - 0 - 4.8 - 9.2$
$=95\ km/hr$

$D = v/S = 1303.57/95 = 13.72\ pc/km/ln$

Step 4. Determine level of service.

LOS = *C* (Since 13.5 lies between 11 and 16 pc/km/ln.)

Q3. A Class I two-lane highway has a base free-flow speed of 110 km/h. Lane width is 3.35 m and shoulder width is 0.6 m. There are 5 access points per km. The roadway is located in rolling terrain with 40% no-passing zones. The two-way traffic volume is 600 veh/hr with PHF = 0.86. The directional split is 60/40. Traffic includes 8% trucks and 2% recreational vehicles. Determine the level of service (LOS).

Q3 Solution:

$FFS = BFFS - f_{LS} - f_A = 110 - 4.9 - 3.3 = 101.8\ km/hr$

Estimated $v_p = V/PHF = 600/0.86 = 697.67\ pc/hr$

Assuming $600 < v_p < 1200$
$f_G = 0.93$, $E_T = 1.9$, $E_R = 1.1$,
$P_T = 0.08$, and $P_R = 0.02$

$$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$$
$$= \frac{1}{1 + 0.08(1.9 - 1) + 0.02(1.1 - 1)}$$
$$= 0.93$$

$$v_P = \frac{V}{\text{PHF} \times f_{\text{HV}} \times f_G}$$
$$= \frac{600}{0.86 \times 0.93 \times 0.93}$$
$$= 806.65\ pc/hr/\ln$$

$600 < 806.65 < 1200$ (O.K.)
$806.65 < 3200$ (O.K.) ➔ LOS is not F
$0.6*806.65 = 483.99 < 1700$ (O.K.)

Average Travel Speed (ATS)
$ATS = FFS - 0.0125v_p - f_{np}$
$f_{np} = 3.08$ *(Interpolation)*

$ATS = 101.8 - 0.0125*806.65 - 3.08 = 88.6$ *km/hr* ➔ *LOS = B*

Determining v_p for percent time spent following, *PTSF*

$600<v_p<1200$
$f_G=0.94,\ E_T = 1.5,\ E_R = 1.0$

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$
$$= \frac{1}{1+0.08(1.5-1)+0.02(1.0-1)}$$
$$= 0.96$$
$$v_P = \frac{V}{\text{PHF}\times f_{\text{HV}}\times f_G}$$
$$= \frac{600}{0.86\times 0.96\times 0.94}$$
$$= 773.13\ pc/hr/\ln$$

$600 < 773.13 < 1200$ *(OK)*

Determining *PTSF*

$PTSF = BPTSF + f_{d/np}$

$f_{d/np} = 10.96$ *(Interpolation)*

Determining *BPTSF*

$$BPTSF = 100\left[1-\exp(-0.000879v_p)\right]$$
$$= 100\left[1-\exp(-0.000879\times 773.13\right]$$
$$= 49.32$$

$PTSF = BPTSF + f_{d/np} = 49.32+10.96=60.3\%$ ➔ *LOS = C*