Traffic Studies

- Types of traffic facilities
  - Uninterrupted flow
  - Interrupted flow

- Traffic stream and characteristics
  - Individual drivers and vehicles
  - Driver behavior and variability

Traffic Flow Parameters

- Volume and Flow Rate
  - Volume is the total counted vehicles during a time period (veh/day, veh/hr)
  - Flow rate is the equivalent hourly rate, but measured in less than one hour period (e.g., 15 min)

- Daily Volumes
  - AADT
  - ADT
  - AWT

- Hourly Volumes
  - Peak hour volume
  - $DDHV = AADT \times K \times D$
Volume and PHF

- Peak Hour Factor (PHF)
  - Ratio between hourly volume and the maximum flow rate within the hour
  \[ \text{PHF} = \frac{V}{4 \times V_{15\text{min}}} = \frac{V}{V_{\text{peak}}} \]

Example:

<table>
<thead>
<tr>
<th>Interval</th>
<th>Counts (veh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5:00-5:15</td>
<td>150</td>
</tr>
<tr>
<td>5:15-6:00</td>
<td>155</td>
</tr>
<tr>
<td>5:45-6:00</td>
<td>160</td>
</tr>
</tbody>
</table>

(a) Peak hour volume
(b) Peak rate of flow
(c) Peak hour factor
Volume and PHF

Homework

<table>
<thead>
<tr>
<th>Interval</th>
<th>Counts (veh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4:15-4:30</td>
<td>520</td>
</tr>
<tr>
<td>4:30-4:45</td>
<td>580</td>
</tr>
<tr>
<td>4:45-5:00</td>
<td>670</td>
</tr>
<tr>
<td>5:00-5:15</td>
<td>790</td>
</tr>
<tr>
<td>5:15-5:30</td>
<td>700</td>
</tr>
<tr>
<td>5:30-5:45</td>
<td>630</td>
</tr>
<tr>
<td>5:45-6:00</td>
<td>570</td>
</tr>
<tr>
<td>6:00-6:15</td>
<td>510</td>
</tr>
</tbody>
</table>

(a) Peak hour volume
(b) Peak hour factor

Volume, Demand, Capacity

Demand, Volume, and Capacity

- Demand = Volume when demand is less than capacity
- Volume cannot exceed capacity
- Demand can only be measured upstream of facility when demand exceeds capacity

Example:
The number of arriving vehicles during each 15-min interval upstream of an intersection approach (free from vehicle queues) is shown in the Table. Assume the approach has a capacity of 4200 veh/hr.

Calculate:
1. Traffic demand (veh/hr) during each interval
2. Measured flow rate downstream of the approach (stopbar)
3. Hourly demand and volume

<table>
<thead>
<tr>
<th>Time Interval</th>
<th>Arriving Vehicles (veh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5:00-5:15 PM</td>
<td>1000</td>
</tr>
<tr>
<td>5:15-5:30 PM</td>
<td>1100</td>
</tr>
<tr>
<td>5:30-5:45 PM</td>
<td>1150</td>
</tr>
<tr>
<td>5:45-6:00 PM</td>
<td>900</td>
</tr>
</tbody>
</table>
Speed and Travel Time

- Speed and Travel Time
  \[ S = \frac{d}{t} \]

  - Time mean speed (TMS)
  \[ TMS = \frac{\sum d_i}{n} = \frac{\sum v_i}{n} \]

  - Space mean speed (SMS)
  \[ SMS = \frac{d}{(\sum t_i)/n} = \frac{d}{\sum t_i} \]

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Speed

- Example
  Six racing cars traveling in a circular track of 1,000 ft in circumference. The travel times of each car for a complete circle are shown in the table.

  Calculate the TMS and SMS of all the cars

<table>
<thead>
<tr>
<th>Veh. No.</th>
<th>Distance, ft</th>
<th>Travel Time, sec</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1,000</td>
<td>18.0</td>
</tr>
<tr>
<td>2</td>
<td>1,000</td>
<td>20.0</td>
</tr>
<tr>
<td>3</td>
<td>1,000</td>
<td>22.0</td>
</tr>
<tr>
<td>4</td>
<td>1,000</td>
<td>19.0</td>
</tr>
<tr>
<td>5</td>
<td>1,000</td>
<td>20.0</td>
</tr>
<tr>
<td>6</td>
<td>1,000</td>
<td>20.0</td>
</tr>
</tbody>
</table>

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Density and Occupancy

- Density and Occupancy
  - Density, \( D \)
  - Occupancy, \( O \)

  \[ D = \frac{5280 \times O}{L_v + L_d} \]
**Headway and Gap**

- Spacing, Headway and Gap

- Spacing: measured in distance between two successive vehicles
- Headway: measured in time between two successive vehicles
- Gap: also in time, but does not include length of leading vehicle

\[ v = \frac{3600}{h_d} \]

**Fundamental Traffic Flow Theory**

- Relationship among Flow, Speed, and Density

\[ v = S \times D \]

- Example:
  
  Average spacing = 200 ft, average headway = 3.8 sec

  Calculate:
  
  (a) Flow, Speed, and Density
  (b) Verify the relationship

- Many studies on Speed and Density relationship
- Greenshield’s model (1934)

\[ S = a - b \times D \]
Traffic Stream Models

- Relationship between Speed, and Density

\[ S = a - b \times D \]

- Relationship between Flow and Density

\[ v = aD - bD^2 \]

- Relationship between Flow and Speed

\[ v = \frac{a}{b}S - \frac{1}{b}S^2 \]
Example
Assume speed-density relationship is
\[ S = 55 - 0.45D \]
Determine:
(1) Free-flow speed
(2) Jam density
(3) Capacity
(4) Critical speed and critical density