Class Avg: 82.5
Max: 98
Mode: 92
St Dev: 16

Problem 1
$G_0 = ?$

\[
d_b = \frac{450}{1.51}
\]

\[
d_s = 450 \quad d_v = V_i \times t_v = 201.71
\]

\[
d_b = d_s - d_v
\]

\[
= (450 + 201.71) = 248.29
\]

Problem 2
\[
d_b = \frac{V_i^2}{2g \left( \frac{a_0}{g} + G_0 \right)}
\]

\[
\Rightarrow G_i = 5.93%
\]

\[
\gamma_h = \frac{A}{200L} x_h^2
\]
Chapter 5

Objectives:

1. To Understand Basic Concepts Of Traffic Flow: Speed, Flow, Density

2. To Understand The Fundamental Relationship Of Traffic Flow Theory

3. To Understand Basic Models Of Traffic Stream
Model the behavior of different entities/actors in the transportation facility:

\[ \text{Facility} \downarrow \text{Performance} \]

Quantitative techniques that allow to model the different interactions → traffic flow

\[ \text{Traffic Flow} \rightarrow \text{Operational Performance Measures} \]

- Travel Time
- Speed
- No. of Accidents
- Avg. Delay
- Avg. No. of Stops

Two types:

i) Uninterrupted Flow: Freeway, multi-lane highways, two-lane highways

ii) Interrupted Flow:
   1) Signalized Intersection
   2) Stop Sign
Traffic Flow: Speed:

(i) TMS - Time Mean Speed
(ii) SMS - Space Mean Speed

\[ TMS = \frac{1}{n} \sum_{i=1}^{n} u_i \]

Always use this speed.

\[ SMS = \frac{1}{n} \sum_{i=1}^{n} \left( \frac{1}{t_i} \right) \]
Exercise 5.6

**Four Race Cars**

\[
\begin{align*}
U_1 &= 195 \times \frac{5280}{3600} = 286 \text{ ft/s} \\
U_2 &= 190 \times \frac{5280}{3600} = 278.66 \text{ ft/s} \\
U_3 &= 185 \times \frac{5280}{3600} = 271.3 \text{ ft/s} \\
U_4 &= 180 \times \frac{5280}{3600} = 264 \text{ ft/s}.
\end{align*}
\]

*Time Taken to finish ONE Lap: \( \frac{25 \times 5280}{286} \) *

\[
\begin{align*}
1 & = 46.85 \text{ s} \\
2 & = 47.37 \text{ s} \\
3 & = 48.65 \text{ s} \\
4 & = 50 \text{ s}
\end{align*}
\]

*Total Time of Observation = 30 \times 60 = 1800 \text{ sec}*

*No. of laps: \( l = \frac{1800}{46.85} \approx 39 \)*
\[ l_2 = \frac{1800}{97.37} = 37 \, 38 \]

\[ l_3 = \frac{1800}{48.65} = 37 \, 38 \]

\[ l_4 = \frac{1500}{50} = 36 \]

Total No. of laps = 39 + 38 + 37 + 36 = 150 laps

\[ TMS = \frac{l_1 \times u_1 + l_2 \times u_2 + l_3 \times u_3 + l_4 \times u_4}{\text{Total laps}} \]

\[ = 275.24 \text{ ft/s} \]

\[ SMS = \frac{1}{\frac{1}{\text{Total laps}} \left[ \frac{l_1}{u_1} + \frac{l_2}{u_2} + \ldots \right]} = \frac{1}{\frac{1}{150} \left( \frac{39}{287} + \frac{37}{287.67} + \ldots \right)} = 275 \text{ ft/s} \]

Headway: Time elapsed between the arrival of the ith vehicle and the (i+1)th vehicle

True Headway
Traffic Flow: Number of Vehicles Passing A Designated Point During A Time t.

\[ q = \frac{n}{t} \rightarrow (HV) \rightarrow \text{Volume} \]

<table>
<thead>
<tr>
<th>Time</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:00-9:15</td>
<td>800</td>
</tr>
<tr>
<td>9:15-9:30</td>
<td>250</td>
</tr>
<tr>
<td>9:30-9:45</td>
<td>700</td>
</tr>
<tr>
<td>9:45-10:00</td>
<td>600</td>
</tr>
</tbody>
</table>

Volume \[\rightarrow ? \quad 2350/\text{vch/hr} \]

Density: Number of Vehicles Occupying A Certain Segment Of Roadway \[\rightarrow \text{vch/mi} \text{ or } \text{vch/ft} \]

Microscopic Traffic Flow: Individual Vehicles

Macroscopic Traffic Flow: Aggregate Flow

Flow: Speed \times Density

\[ q = \text{Flow} \rightarrow \text{SMS} \]

Fundamental Equation Of Traffic Flow: \[ q = u x k \]
Traffic Flow Models: Speed, Flow, & Density

**Speed vs Density**

\[ u = u_f \left(1 - \frac{k}{k_f}\right) \]

- \( u_f \): Free Flow Speed (mi/hv)
- \( k_f \): Jam Density in (veh/mi)

\[ u = u_f \left(1 - \frac{k}{k_f}\right) \]

\[ \frac{q}{k} = u_f \left(1 - \frac{k}{k_f}\right) \]

\[ q = u_f \left(k - \frac{k^2}{k_f}\right) \]

Flow vs Density

\[ q = \frac{u x k}{2} \]

\[ q \propto k \]
\[ \frac{d q}{d k} = \left( 1 - \frac{2 k}{k_f} \right) \]

\[ u_f (k_f) \]

\[ \frac{k}{n} \left( \frac{1}{2} \right) \]

\[ q = u_f \left( \frac{k_f}{2} - \frac{k_f^2}{4 n k_f} \right) \]

\[ = \frac{u_f k_f}{4} \]