Problem #1

$W_r = 1150$ lbs
$W_f = 1520$ lbs
$h = 24.5$ in
$h_n = 14$ in
$L = 120$ in

Consider the above van on level ground having the following properties:
$W_r = 1520$ lbs
$W_f = 1150$ lbs
$h = 24.5$ inches
$h_n = 14$ inches
$L = 120$ inches

a) Find $b$

\[ W_r = W \frac{b}{L} \implies b = \frac{L W_r}{W} \]

\[ W = W_r + W_f = 1150 \text{ lbs} + 1520 \text{ lbs} = 2670 \text{ lbs} \]

\[ b = \frac{(120 \text{ in})(1150 \text{ lbs})}{(2670 \text{ lbs})} = 51.7 \text{ in} \]

\[ b = 51.7 \text{ in} \quad \text{ans (a)} \checkmark \]

b) Find $c$

\[ W_f = W \cdot \frac{c}{L} \implies c = \frac{L W_f}{W} \]

\[ c = \frac{(120 \text{ in})(1520 \text{ lbs})}{(2670 \text{ lbs})} = 68.3 \text{ in} \]

\[ c = 68.3 \text{ in} \quad \text{ans (b)} \checkmark \]
Problem #2

A two-axle 2000lb trailer is attached to the van of Problem 1 and the van is driven on an incline. The tow bar on the trailer is perfectly horizontal so that no vertical load is applied to the trailer hitch. The vehicle is moving at low speed and not accelerating.

a) Find the tow bar tension as a function of $\theta$

$$R_{hx} = W_z \sin \theta$$
$$= 2000 \sin \theta$$

$$R_{hx} = 2000 \sin \theta$$

$\text{ans (a)}$ √

b) Find $W_f$ as a function of $\theta$ including the effect of the trailer.

$$W_f(\theta) = \frac{W_z \cos \theta - R_{hx} h_k - W_h \sin \theta}{L}$$

$$R_{hx} = W_z \sin \theta$$

$$W_f(\theta) = \frac{W_z \cos \theta - W_z h_k \sin \theta - W_h \sin \theta}{L}$$

$\text{ans (b)}$ √
(c) Verify that \( W_f = 1520 \) lbs when \( \theta = 0 \)

\[
W_f(\theta = 0) = \frac{W_c \cos \theta - W_t h_w \sin \theta - W_h \sin \theta}{L}
\]

\[
= \frac{W_c}{L} = \frac{(2670 \text{ lbs})(68.3 \text{ in})}{(120 \text{ in})}
\]

\[
W_f(\theta = 0) = 1520 \text{ lbs}
\]  

**ans (c) √**

(d) The tire coefficient of friction \( \mu = 0.25 \). With front wheel drive, what is the maximum angle of torque without slip?

Front Wheel Drive: \( F_x = \mu \cdot W_f(\theta) \)

\[
= (W_t + W) \sin \theta
\]

\[
\Rightarrow \frac{\mu}{L} \cdot (W_c \cos \theta - W_t h_w \sin \theta - W_h \sin \theta) = (W_t + W) \sin \theta
\]

\[
\mu W_c \cos \theta = (LW_t + LW + \mu W_t h_w + \mu W_h) \sin \theta
\]

\[
\mu W_c = (LW_t + LW + \mu W_t h_w + \mu W_h) \tan \theta
\]

\[
\tan \theta = \frac{\mu W_c}{LW_t + LW + \mu W_t h_w + \mu W_h}
\]

Solving ...

\[
\theta = 4.47°
\]  

**ans (d) √**
Problem # 3

Solve Problem 28 for Rear-wheel drive.

\[ W_r(\theta) = \frac{W_b \cos \theta + W_h \sin \theta + W_h \sin \theta}{L} \]

\[ F_x = \mu W_r(\theta) = (W_x + W) \sin \theta \]

\[ \frac{M}{L} (W_b \cos \theta + W_h \sin \theta + W_h \sin \theta) = (W_x + W) \sin \theta \]

\[ \mu W_b \cos \theta = (-\mu W_h + \mu W + LW + LW) \sin \theta \]

\[ \tan \theta = \frac{\mu W_b}{-\mu W_h + \mu W + LW + LW} \]

\[ \theta = 3.68^\circ \]

\[ \text{ans (3)} \checkmark \]
Problem #4

a) Using MathLab, plot $F(v)$

b) Using numerical integration, find $0$ to $30$ m/s time.

$V = 30 \text{ m/s}$

$t = 3.3 \text{ s}$
C) What is \( 30 \text{ m/s} \) in \( \text{mph} \)?

\[
\frac{30 \text{ m}}{1 \text{ sec}} \times \frac{1 \text{ mile}}{1609 \text{ m}} \times \frac{3600 \text{ sec}}{1 \text{ hr}} = 67.1 \text{ mph}
\]

\( 30 \text{ m/s} = 67.1 \text{ mph} \)

\( \text{ans (c)} \checkmark \)