ELEC 5970/6970 **ELECTRIC VEHICLES**
HOMEWORK #2

Problem 1 A length of the road is straight, and it has a profile in the x-y plane described by

$$f(x) = 200\ln\left[7.06*10^{-4}\left(x+1416\right)\right].$$

Where $0 \le x \le 3 miles = 15{,}840\, ft.$; *f(x)* and *x* are in feet.

a) Plot the road profile in the x-y plane for $0 \le x \le 15{,}840\, ft.$

b) Derive an expression for $\beta(x)$. Calculate $\beta(500ft.)$.(answer: $\beta(500ft) = 5.96^o$)

c) Derive an expression for *percent grade(x).* Calculate *percent grade(500ft.).* *(answer: %Grade(500ft) = 10.4%)*

d) Derive an expression for tangential road length *s(x),* such that *s(0)=0*. Calculate *s(500ft.)* *(answer: s(500 ft) = 504 ft)*

Problem 2 An electric vehicle has the following parameter values:

m=692kg, $C_D = 0.2$, $A_F = 2m^2$, $C_0 = 0.009$, $C_1 = 1.75*10^{-6}\ s^2/m^2$,

Also, take $\rho = 1.16\ kg/m^3$, $g = 9.81\ m/s^2$,

The EV is stopped at a stop sign at a point in the road where the grade is +15%. The tractive force of the vehicle is supplied by the vehicle brakes.

i) Calculate the tractive force necessary for zero rolling resistance (The vehicle is at rest). (answer: $F_{TR} = 1007$ N)

ii) Calculate the minimum tractive force required from the brakes to keep the EV from rolling down the grade. ((answer: $F_{TR} = 946$ N)

Problem 3

The EV in problem # 2 is moving at a constant velocity along a road that has a constant grade of -12%.

i) Plot, on the same graph, the magnitudes of the tangential gravitational force (F_{gT}), the aerodynamic drag force (F_{AD}), and the rolling resistance force (F_{ROLL}) versus velocity for $0 < V \leq 180 mph$. Over that range of velocity, does F_{gT} dominate? When does F_{AD} dominate? When does F_{ROLL} dominate? Label these regions on the graph.

ii) Derive an expression for the tractive force as a function of velocity. Plot this expression on its own graph. Is the tractive force always in the same direction?