EBS 221 Agricultural Robotics
Spring Quarter 2025

Assignment 1
Please submit a single assignment file (either PDF or Word) along with all necessary Matlab files to reproduce the results. This is a group assignment, so each team will submit one report (including the source code). The grade will also be the same for all team members.

A. (60 pts) Implement the bicycle model with 1st-order closed-loop steering and speed dynamics in a MATLAB function called `robot_bike_dyn()`. Use global variables for dt, DT (case-sensitive).

```
function q_next = robot_bike_dyn(q, u, umin, umax, Qmin, Qmax, L,
tau_gamma, tau_v)
global dt; global DT;
% model of a vehicle with closed-loop steering and velocity control
% the combined effect of steering/vehicle inertia and control is
% a first order system for steering (tau_gamma) and velocity (tau_v)
% state is vector q
% q(1) -> x
% q(2) -> y
% q(3) -> theta (orientation in world frame)
% q(4) -> gamma (steering angle)
% q(5) -> v (linear velocity)
% inputs are:
% u(1) -> desired steering angle (gamma_d)
% u(2) -> desired linear velocity (v_d)
```

B. (20 pts) In a script file, set the wheelbase L = 2.5 m; $|\gamma_{max}| = \pi/4^o$, and $|v_{max}| = 5$ m/s. Set dt=0.01 s, DT=0.1 s, v_d=1 m/s. Start at the state [10 10 π/2].
Apply appropriate steering input $\gamma_d(t_k)$ for an appropriate amount of time T, to travel on a semicircle of radius 3 m. (This simulates turning in a field with row crops from the exit of one row to the entrance of the next row, and a row-center distance of 6 m.)
Plot the semicircle and the actual motion trace (i.e., $x(t_k)$, $y(t_k)$).
Repeat for a radius of 2 m. Does it work? Why?

C. (20 pts) Plot the trace of the origin of the vehicle's frame when $\gamma_d(t_k)$ starts at 0 and remains 0 for 1s, then switches instantaneously to γ_{max} (step function) and remains at γ_{max} for 10 seconds, then switches instantaneously from γ_{max} to $-\gamma_{max}$ and stays at $-\gamma_{max}$ for 10 seconds. Use the following settings.
1. Speed lag: set to $\tau_v = 0$ s, increase τ_γ from 0 to 2 s with a step of 0.4 s, and plot the six traces in the same figure.
2. Speed lag: set to $\tau_v = 1$ s, and increase τ_γ from 0 to 2 s with a step of 0.4 s, and plot the six traces in the same figure.
(Think how you will implement τ_v or $\tau_\gamma = 0$.)
Comment on these plots.