# MEEN 432 Project 2 — Week 1 Progress Report

Team 4: Dalys Guajardo, Juan Lopez, and Ian Wilhite

February 14, 2026

## 1  Track Generation

The oval track is built in `gentrack.m` as a single continuous loop starting and ending at the origin. Rather than stitching semicircles onto straight segments, the script walks a counter forward by a fixed arc-length step $\Delta s \approx 10\,\mathrm{m}$ and decides at each point whether to advance linearly (straights) or rotate incrementally by $\Delta\theta = \Delta s/R$ about the appropriate curve center (curves). This produces the centerline waypoints `path.xpath`, `path.ypath`, plus inner/outer borders offset by $\pm 7.5\,\mathrm{m}$ (half the 15 m track width). Track parameters: two 900 m straights, two semicircles of radius $R = 200\,\mathrm{m}$, total length $\approx 3057\,\mathrm{m}$.
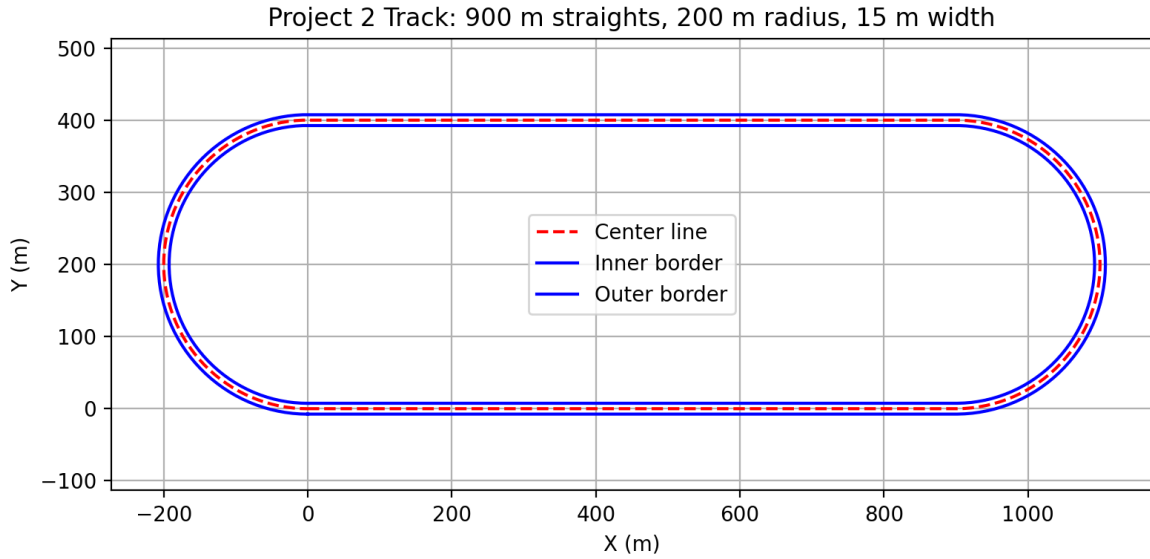


Figure 1: Oval track centerline (dashed) with inner/outer borders. The track starts and ends at $(0, 0)$.

## 2  Vehicle Dynamics (Simulink)

The Simulink model `Project_2_Kinematic_Model.slx` implements a lateral bicycle model in four subsystems:

1. **Tire Slip** — computes front and rear slip angles from lateral velocity $v_y$, yaw rate $\omega$, and steering angle $\delta_f$:
$$\alpha_f = \delta_f - \frac{v_y + \omega\, l_f}{v_x}, \qquad \alpha_r = -\frac{v_y - \omega\, l_r}{v_x}$$

2. **Tire Forces** — linear cornering-stiffness model $F_y = C_\alpha\, \alpha$ clamped to $\pm F_{y,\text{max}}$.

3. **Lateral Dynamics** — Newton/Euler equations for the body frame:
$$a_y = -v_x\, \omega + \frac{F_{yf} + F_{yr}}{m}, \qquad \dot{\omega} = \frac{F_{yf}\, l_f - F_{yr}\, l_r}{I_{zz}}$$

4. **Body→Inertial Transform** — rotates $(v_x, v_y)$ by heading $\psi$ and integrates to get world-frame $X, Y$.

A PID-based **Driver** MATLAB Function computes $\delta_f$ from heading error and feedforward curvature, and feeds the desired longitudinal speed $v_{xd}$. At this stage the car launches at $v_{x0} = 0.1\,\text{m/s}$ toward $v_{xd} = 100\,\text{m/s}$ and leaves the track on the first curve; tuning the gains and speed target is Week 2 work.
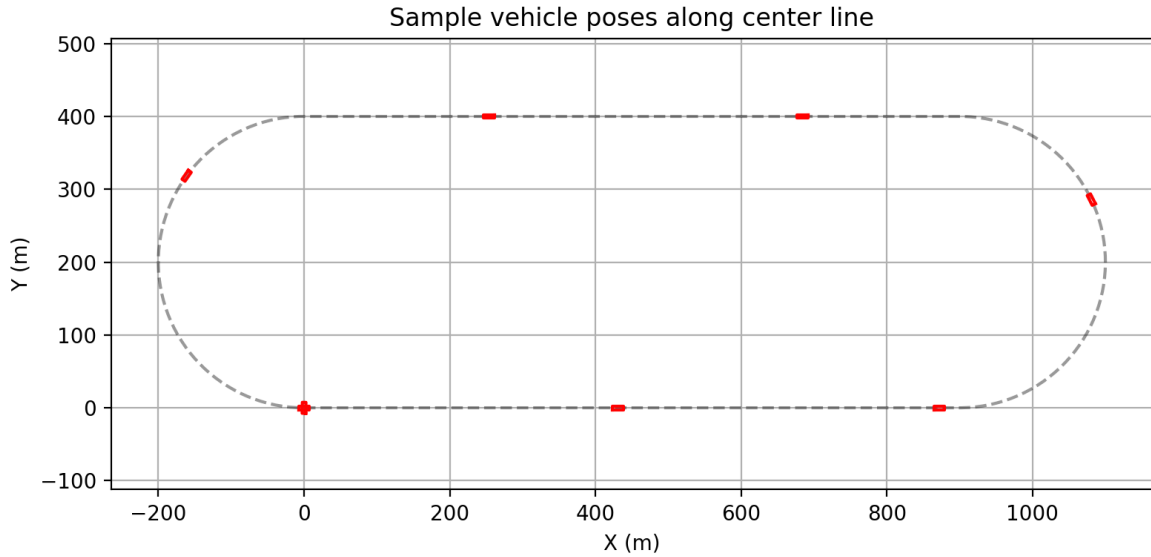


Figure 2: Sample rectangular vehicle poses $(15\,\text{m} \times 5\,\text{m})$ along the centerline, rotated by local heading $\psi$.

# 3   Changes from Starter Code

- `gentrack.m`: added `assignin('base','path',path)` so the `path` struct is available to Simulink and post-processing scripts.
- `animate.m`: added `try/catch` around `sim()`, a `getSimSignal` helper for flexible signal access, validation that X/Y/psi exist, and a green motion trail via `animatedline`.
- `raceStat.m`: extracted from `animate.m` into its own file; fixed the broken `fprintf` format specifier (`%` → `%d`), added per-lap timing output, and returned a full stats struct.
- `run.m`: added a check that the `.slx` file exists and wrapped `animate` in `try/catch` with a descriptive error message.

- Simulink model: wired the Driver, Tire Slip, Tire Forces, Lateral Dynamics, and Body→Inertial subsystems; added `To Workspace` blocks for `X`, `Y`, `psi`; connected the feedback loop from $X$, $Y$, $\psi$, $\omega$ back to the Driver.