**Steering Calculations:**

[2019 Steering Calculations – Kelvin edit](https://studentutsedu.sharepoint.com/:x:/r/sites/Course_43019_design_in_mechanical_and_mechatronic_-4fVJuN6RM5oxU-P29-AutonomousSteeri/Shared%20Documents/T21%20-%20P29%20-%20Autonomous%20Steering%20Mechanism/2019%20Steering%20Calculations%20-%20Kelvin%20edit.xlsx?d=web3f3315e7f84277976d2c08667e42b8&csf=1&web=1&e=MNS4cN)

Goal: To find out the required motor torque to overcome the steering torque.

Using a provided resource in the UTSMA drive titled ‘2019 Steering Calculations, additional cells were inserted the highlighted in yellow shown in the picture below:  
  
**Steering column Force:** Is the pinion Torque divided by the Steering Wheel Radius.

**Torque acting on column:** Is the Steering Column Force divided by the Steering Wheel Radius, which is the same as the Pinion Torque.

A chart with text and numbers

Description automatically generated with medium confidence

* Due to the slowness in speed that the Autonomous car travels at on the track, aero downforce was set at 0.
* Lateral Acceleration: The max lateral acceleration is denoted by the tyre coefficient of friction. (cannot exceed it). Through research, it can be assumed that a value of 0.2G is a reasonable estimate for very low speed conditions of which the rate the UTSMA car travels at.
* Tyre coefficient: Various sources valued it between 1.3 – 1.6G.

"Autonomous race vehicles exhibit lateral accelerations ranging from 0.2 G in low-speed conditions up to over 1 G during high-speed maneuvers."  
*— Ziesche, J., Betz, J., & Alrifaee, B. (2020). Autonomous Racing: A Literature Review. SAE International Journal of Connected and Automated Vehicles, 3(3), 167–180.*

A screenshot of a calculator

Description automatically generated

Settings (Static):

Lateral acceleration: 0.2G  
Tyre coefficient: 1.6



Lateral acceleration: 0.2G  
Tyre coefficient: 1.3



Settings (Dynamic):  
  
Through research, the dynamics force during the motion of the car can be estimated at 0.7 of the static forces. This is due to the rolling motion of the tires reduces friction when the vehicle is moving. Static steering force is higher since it requires overcoming static friction when the vehicle is stationary, whereas dynamic friction is lower when the vehicle is in motion.

Using the static value of **16.6nm**, the dynamic value (without external factors) becomes roughly **13.5nm**.

**Factor of Safety - Static:**

For an autonomous FSAE vehicle operating at low speeds, a **factor of safety (FOS) of 1.**5 should be adequate to handle the static torque requirements. This ensures that the design torque of **24.9 Nm** (based on the static torque of 16.6 Nm) is sufficient for safe and reliable operation under these conditions.

**Factor of Safety – Dynamic:**

External road factors are hard to quantify. Due to the UTSMA car will be driven on a mostly smooth surface on the track, we can guesstimate that a FOS value of around 1.5- 2 will be for light to moderate dynamic load factors, while a FOS of between 2.5 - 3 can be assigned for more severe road conditions and dynamic changes.

Using a FOS of 2, the Dynamic value with low – moderate external factors can: 13.5 x 2 = **27nm**