The purpose of the 2015-2016 Baja MQP was to modify the pre-existing vehicle for competition in 2017. Major design modifications were made to the chassis, suspension, drivetrain and steering subsystems. Mechatronic, material, kinematic, and manufacturability studies were conducted on the vehicle. A fully operational automobile that meets the Mini Baja Society of Automotive Engineers (SAE) competition specifications was created.

Methodology

Drive Train: A theoretical speed calculation was performed in order to obtain the maximum output speed, torque, and drive ratio. The torque and final drive ratio needed to succeed in the hill climb event were also calculated.

Theoretical Maximum Speed (v_theoretical) = v_{emax} \times c_t / r_{actual}

The required torque to complete the hill climb challenge and the maximum torque of the vehicle were found using the following equations.

Maximum Torque (τ_{max}) = τ_{emax} \times r_{actual} \times η_{CVT} \times η_ρ

Torque Required for Hill Climb (τ_{required}) = F_{required} \times \frac{d_z}{2}

The drive ratio for the vehicle was calculated with the following equation.

Actual Drive Ratio (r_{actual}) = r_{dz} \times r_{CVT}

Suspension: Vector and graphical analysis were conducted with the fixed condition being camber. Bond graphs were then derived and a system of equations was determined to understand how the vehicle will react to off road environments.

Abstract

This equation was used to confirm the angle, and derive the final length of the A-arms for both the front and rear suspension:

θ = \tan^{-1} \left( \frac{B_y - A_y}{B_x - A_x} \right)

A_x = a \cos θ
A_y = a \sin θ

“A” represents the length of the upper A-arms and “B” represents the length of the hubs. See Figure 3.

Figure 2: Final Baja Design

Figure 3: Suspension Analysis

Figure 4 describes our free body diagrams used when deriving response equations for mechatronic analysis. A simplified model was used to calculate dynamic response.

Future Work

Areas of improvement for future teams:
- Add additional safety features to comply with Baja SAE competition specifications
- Continue to test vehicle on off road courses and hills
- Complete cost report for entire vehicle
- Complete chassis remanufacturing
- Improve caster on front suspension
- Redesign lower rear A-arm
- Participate in annual Baja SAE competition

Acknowledgements

We would like to thank the following people and organizations for their contributions to this project:
- Worcester Polytechnic Institute
- Professor David Planchard
- Adrian Pickering
- Hubb Equipment
- Assabet Valley Regional Technical High School
- WPI Society of Automotive Engineers
- The Lathe Man