Department of
MECHANICAL ENGINEERING
THE UNIVERSITY OF UTAH

Baja SAE Auxiliary

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Introduction

The Baja SAE Auxiliary team's purpose is to contribute to building a single-seat, off-road vehicle meeting all requirements necessary to compete in the Baja SAE 2025 competition this upcoming May in Arizona. The design and manufacturing of the vehicle have been split between four capstone teams: Frame, Suspension, Powertrain, and Auxiliary, each responsible for specific elements of the vehicle.

Subsystem	Objective	Method
Steering	Provide control of vehicle to driver	Space claim model and FEA analysis
Shielding	Protect driver from debris during operation	FEA analysis , CAD Modeling
Brakes	Control vehicle when slowing or stopping	FEA analysis, Python code calculation
Engine Mount	Provide platform to place engine within vehicle frame	FEA analysis, space claim CAD models
Fuel	Deliver enough fuel to engine	Space claim CAD Model
Electrical	Provide desired current to assigned electrical components	MATLAB calculations, real-life testing
Safety	Keep driver safe in case of emergency	Component compatibility checks

1. Safety

The seat and 5-point harness protect the driver, while the kill switches in the electrical system ensure the vehicle can be shut off in an emergency. Fire wall and fire extinguisher will provide safety to the driver in case of a fire. Fire resistant racing suits, DOT approved helmets, and neck braces all protect the driver in case of vehicle failure.

Figure 1: Personal Protective Equipment (PPE) including helmet, roll-off goggles, fire suit, gloves, and neck brace.

2. Engine Mount

Strength and vibration analyses were performed using FEA. Stresses were found that exceeded the material's yield strength at 36,300 psi in the x direction, 40,578 psi in the y direction, and 39,242 psi in the z direction, requiring modifications for improved durability. The frequency response was 153.5 Hz, well above the required minimum of 76.8 Hz, ensuring no resonance issues. These results guided the final design to enhance strength and reliability under off-road conditions.

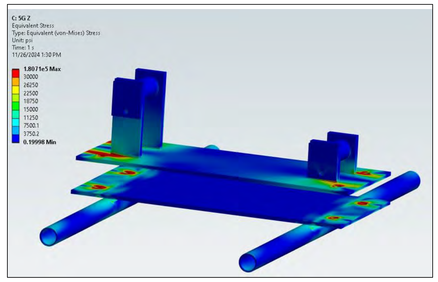

Figure 2: FEA results engine mount undergoing a load of 5G in the Z direction.

3. Brake System

The braking system is a hydraulic disc brake design that slows and stops the vehicle. Competition rules stated that all four wheels must lock while vehicle is in motion. Hydraulic analysis was performed on the braking system to determine necessary driver input to the brake pedal to cause wheel locking. Slip should occur with 1147N (257lbf.) of force on the brake pedal.

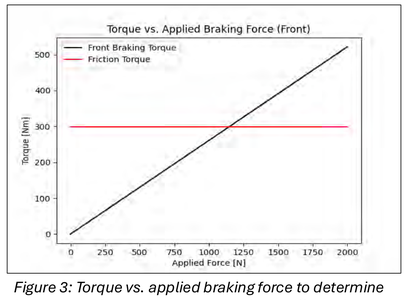

Figure 3: Torque vs. applied braking force to determine brake pedal force required to stop buggy. Critical stop at 1147 N.

4. Steering

The steering of the Baja SAE vehicle turns the car with Castor, Camber, Toe, and Ackermann Steering. Using a rack and pinion system, the geometries can be fine-tuned to give proper road feedback from the road to the driver. The adjustability from this design allows the driver to reach the limit of the vehicle consistently. A force of 500N was tested along 4 different regions, the critical region being 3.

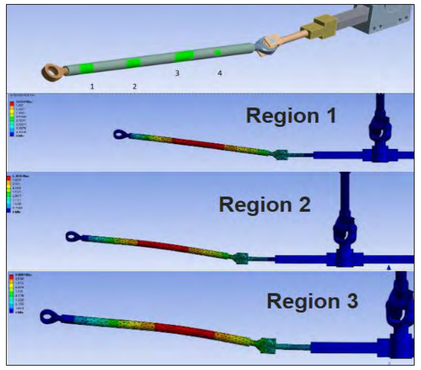

Figure 4: FEA analysis of rack and pinion steering system for debris impact. (Top) Overview of regions in green. (Bottom) Regions 1-3 FEA impact deformation.

5. Fuel & Electrical

The fuel system consists of a securely mounted fuel tank, splash shield, and fuel lines, which gravity feed the fuel to the engine. The electrical system powers multiple components necessary for safety and vehicle function, such as lights and alarms.

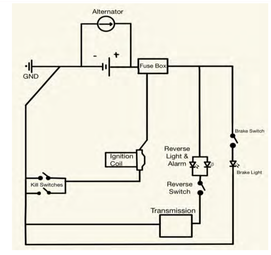

Figure 5: Electrical diagram of Baja buggy, featuring alternator, battery, lights, alarm, ignition coil, and shut off switches.

6. Body Panels

FEA was used to determine the minimum thickness of aluminum plating along the bottom of the buggy if impacted by debris. Carbon fiber was chosen as the body panel for its strength and lightweight properties. Modal analysis was used to determine its minimum thickness of 1/8" to prevent resonance with the vehicle.

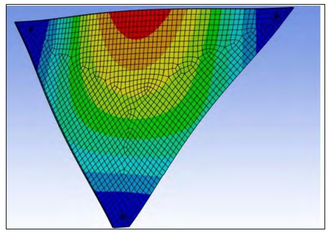

Figure 6: Modal analysis of body panels where Minimum thickness = 1/8" carbon fiber.

Conclusion

In conjunction with the Powertrain team, we have designed and assembled a functional offroad vehicle according to the requirements set by Baja SAE. The vehicle will compete in an offroad competition in May 2025.

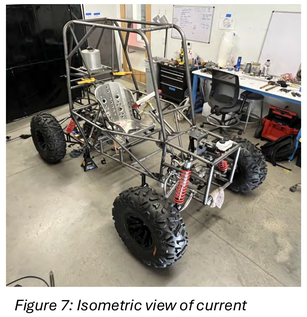

Figure 7: Isometric view of current condition of vehicle.