

Advanced Vehicle Dynamics

Torque Vectoring Assignment

Introduction

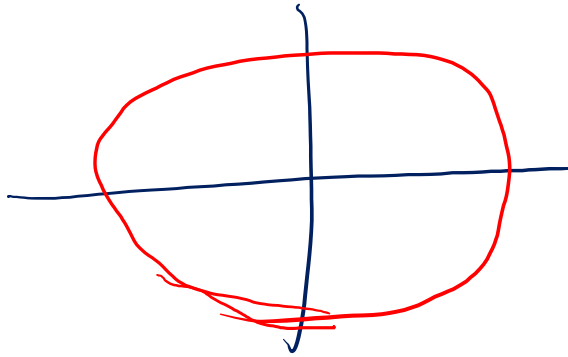
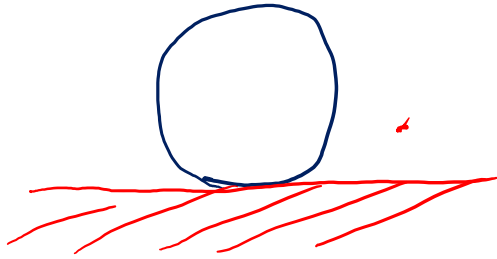
- In March 2011 Ferrari unveiled its first AWD vehicle the FF. As if working for a rival vehicle manufacturer you have been asked by the engineering director to analyse the Ferrari FF vehicle All Wheel Drive systems in order to understand the effects on vehicle dynamics and potential control strategies from the torque vectoring front wheel drive system. Produce an engineering report to explain the system.
- Your report should include:

- 1) An abstract of the report

2) Base vehicle data.

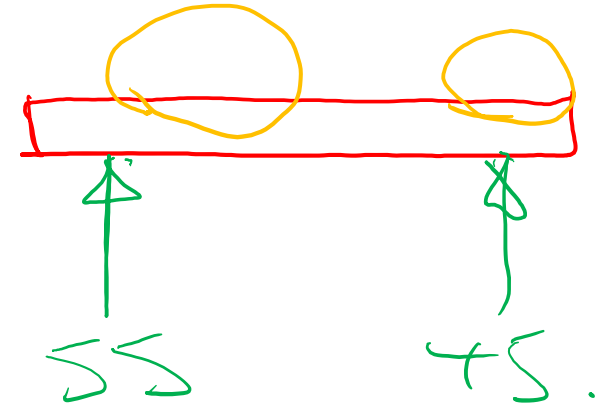
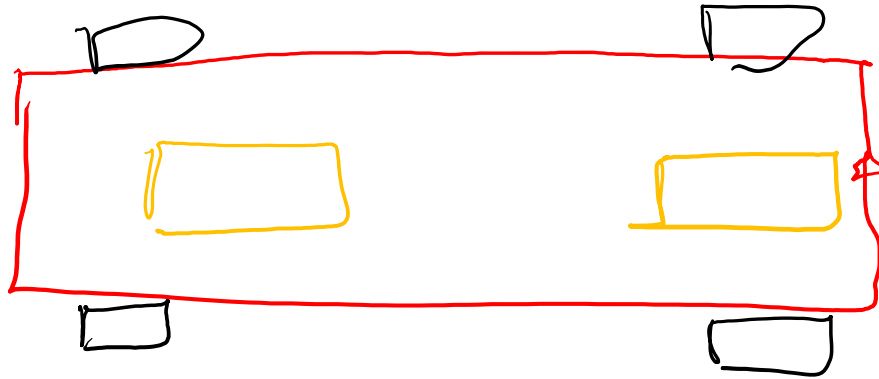
- Put the researched data in the appendices
- Just list any significant measures that you will use in the test/table
- You may refer to any variant eg Manual or Automatic Transmission

3) An explanation of generic torque vectoring systems



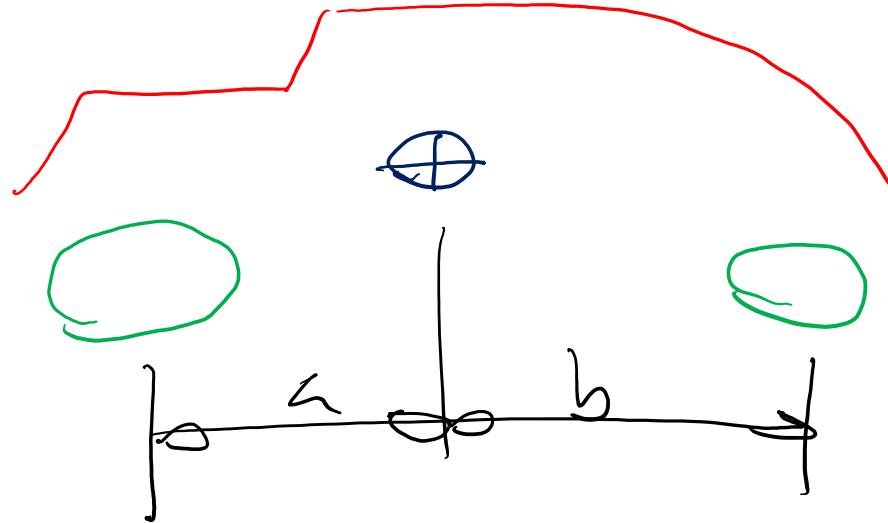
4) A lumped mass model of the vehicle

- This should match up with the published weight distribution figures.



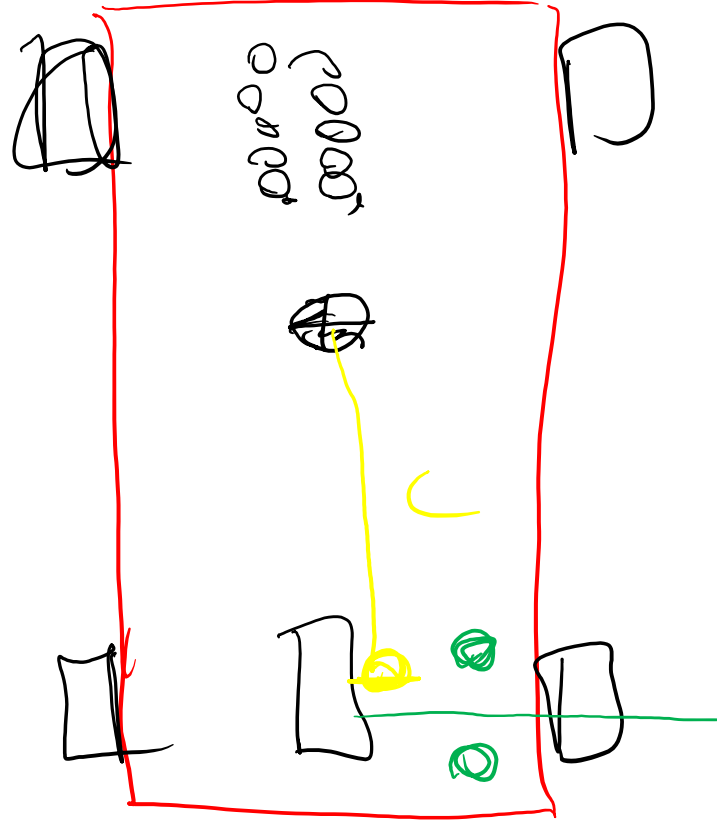
5) Calculation of the longitudinal C of G position

- Take the data from before. You may also add some occupants.



6) Calculation of the vehicle's moment of inertia (about Z-Z axis)

7) Establish the position of the inertial conjugate

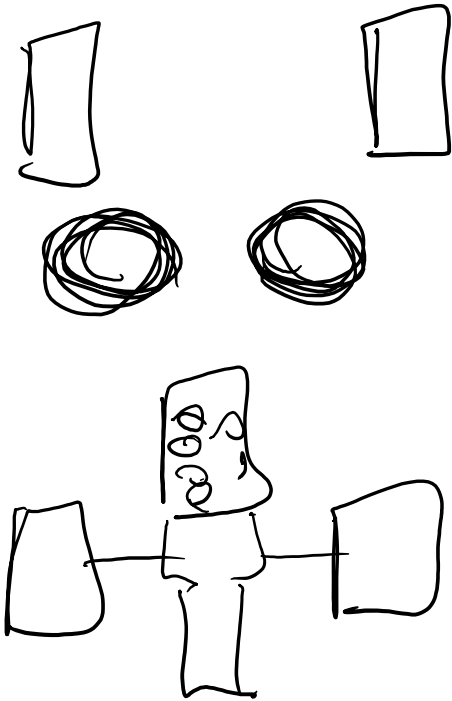


8) Establish the 'dynamic index' of the vehicle

9) Comment on the base vehicle specification.

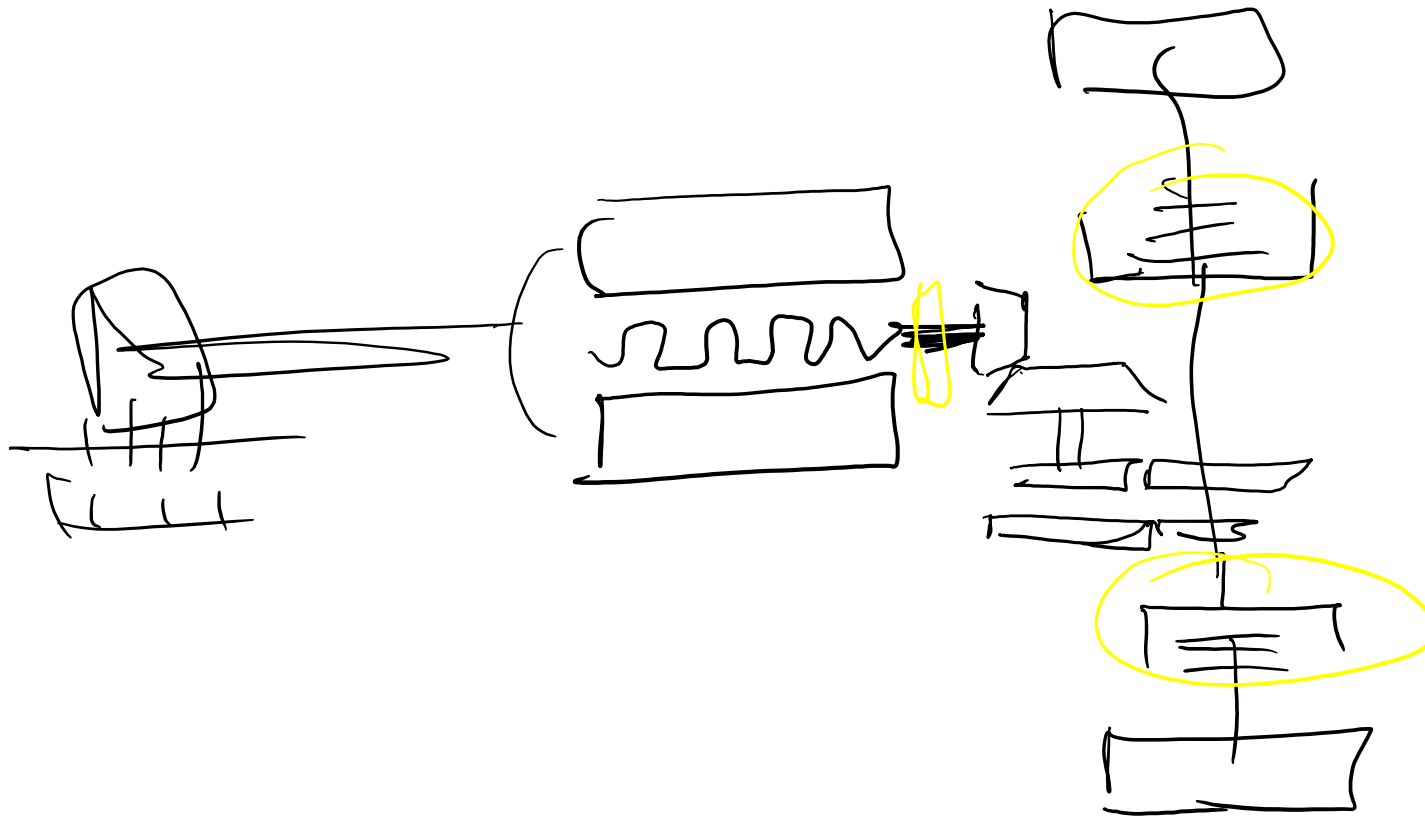
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- Compare to other Ferrari vehicles and their likely DI values.

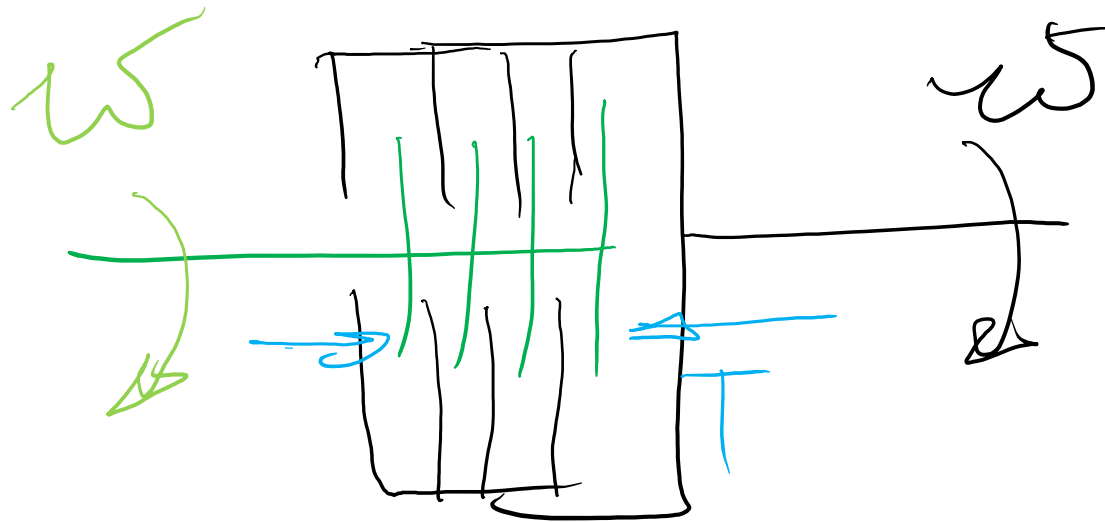


10) Identify the mechanical torque path to the front wheels and comment on your findings

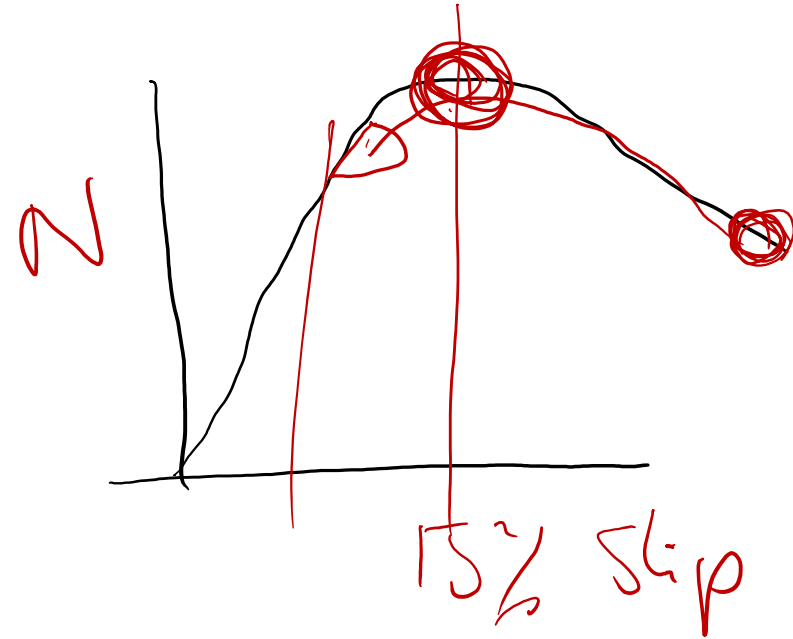
- There is a 'novel' solution.



11) Calculate the clutch pack(s) torque capacity, approximate sizings, axial force application values and power loss characteristics.

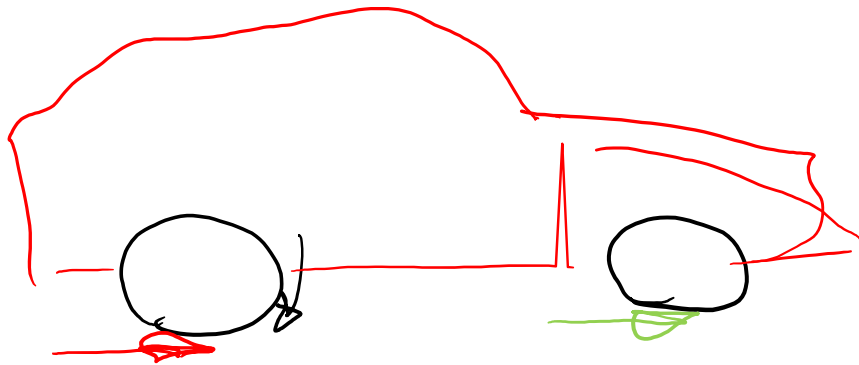


$$\text{Power} = T \cdot \omega$$



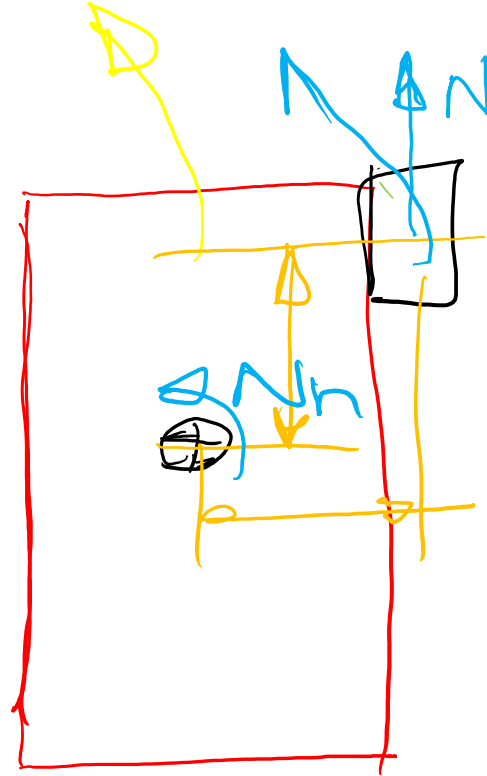
12) Calculate potential longitudinal acceleration improvements on a variety of surfaces.

- This is compared to a base rear wheel drive vehicle.



13) Establish the potential yaw rate increase that the system could generate and relate this to handwheel position

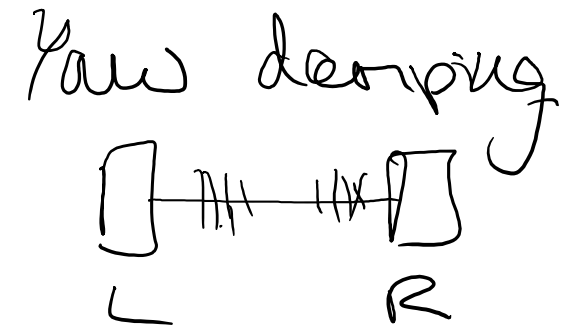
- Find the potential 'moment' caused by the offset drive.



$$T = I\alpha$$

14) Discuss possible control algorithms, sensors required and potential vehicle dynamic improvements, consider:

- on power and off power, *mode* 
- - straight line and cornering



- - on-limit lane change manoeuvres.
- - How the AWD system will inter-react with other vehicle dynamic control systems

ABS. ESP

15) Summarise your findings.

- Why did Ferrari produce this vehicle
- You can also discuss what has happened since, what have other manufacturers done etc?

Hind sight

(SUV

Cayenne
DB X
others?

Any Questions