AVTC Model Based Design Curriculum Development Project

MODEL-BASED DESIGN CURRICULUM PROJECT

An Introduction to Modeling an Energy Storage System (ESS)

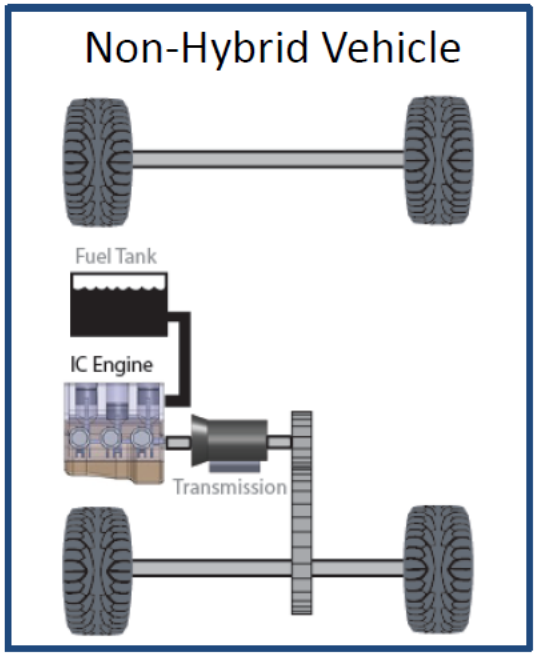
Lesson 6.1
Hybrid Vehicle Power Management

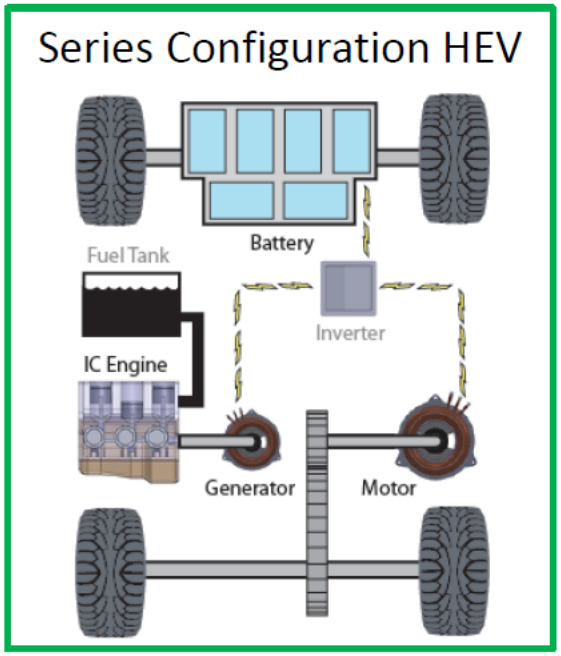
Donald Docimo
Mohammad Ghanaatpishe
Hosam Fathy

MODEL-BASED DESIGN CURRICULUM PROJECT

Hybrid Electric Vehicles (HEVs)

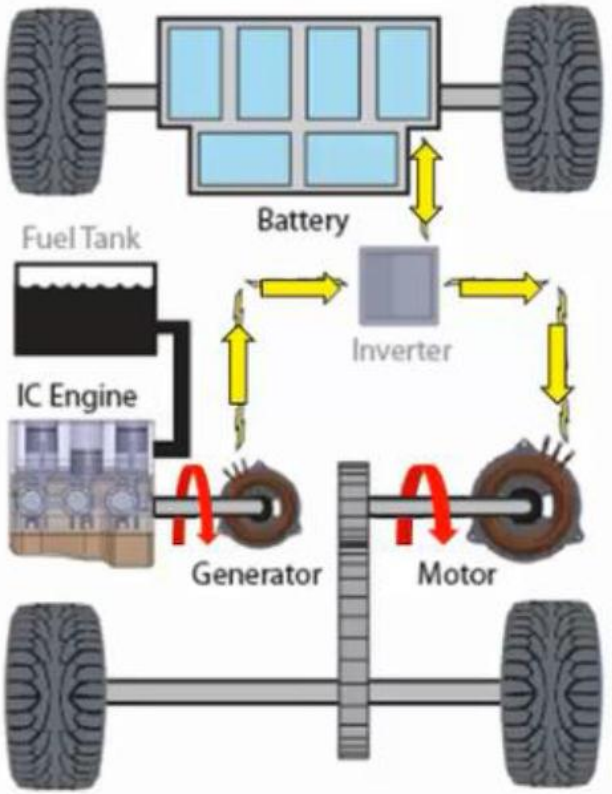
- A hybrid electric vehicle differs from a conventional vehicle because it has two different power sources.[1]
- The second power source is an electric motor/generator that is powered by a battery pack.[1]





Plug-in HEV Series Configuration

- A plug-in hybrid allows the user to charge the battery pack to use a larger range of power than a standard hybrid.[1]
  - A series PHEV main power source is the electric motor, which drives the vehicle.[1]
  - The IC engine and electric generator is called the additional power unit (APU), which assists the power demand of the vehicle.[1]
  - The APU can send electrical power to charge the battery pack or supplement the power sent to the electric motor.[1]



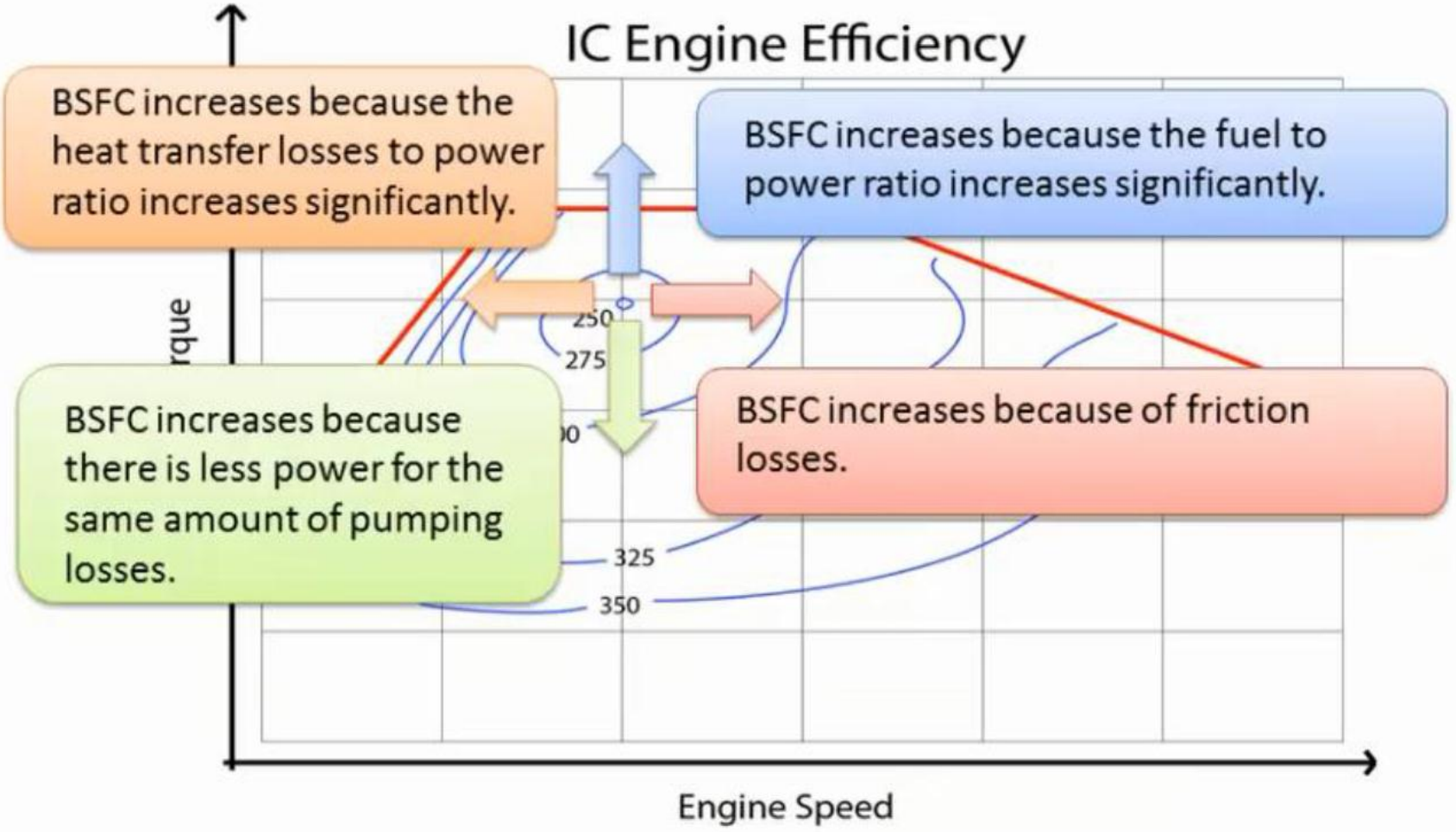
PHEV Supervisory Power Management

- The pedal position still commands the vehicles acceleration profile, but no longer dictates the power demand from the IC engine. [1]

- Instead, a supervisory controller determines how much to power to draw from the APU and the battery pack to propel the vehicle. [1]

- This power management must control the IC engine to extract the correct amount of power and run it at peak efficiency. [1]

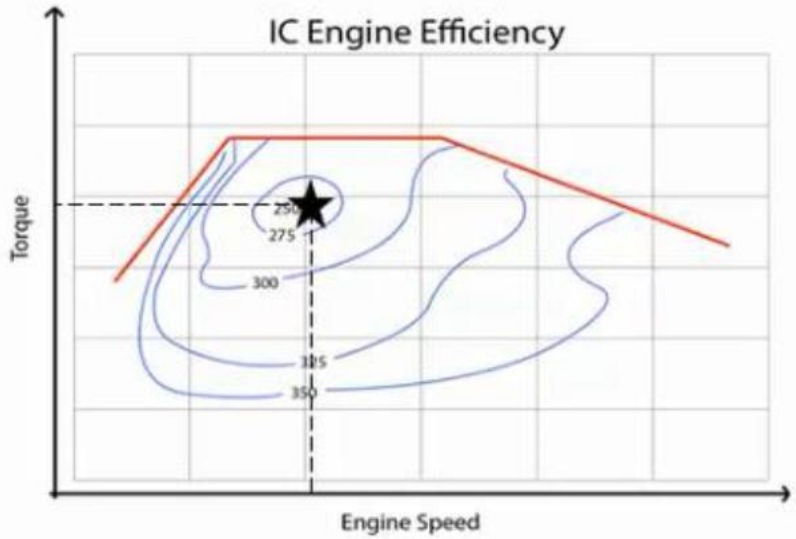
Brake Specific Fuel Consumption Map



Charge Depleting / Charge Sustaining

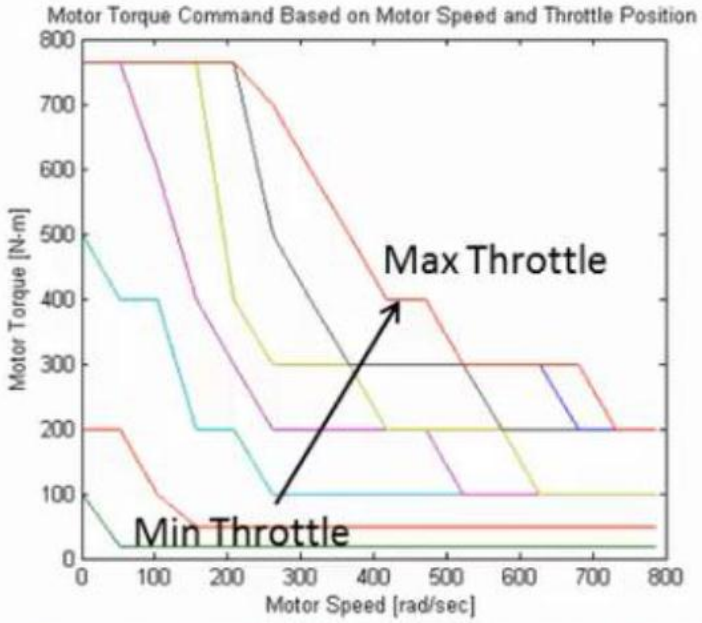
- The simplest power management strategy is to only use the battery to power the motor until the battery reaches a minimum charge level.

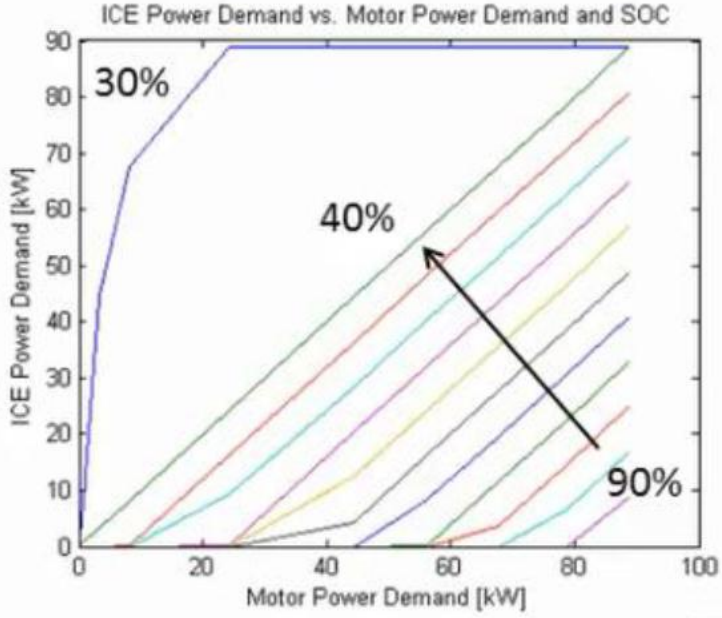
- At this point, the APU is activated and controlled to operate at its maximum power and efficiency level to sustain the battery charge level.



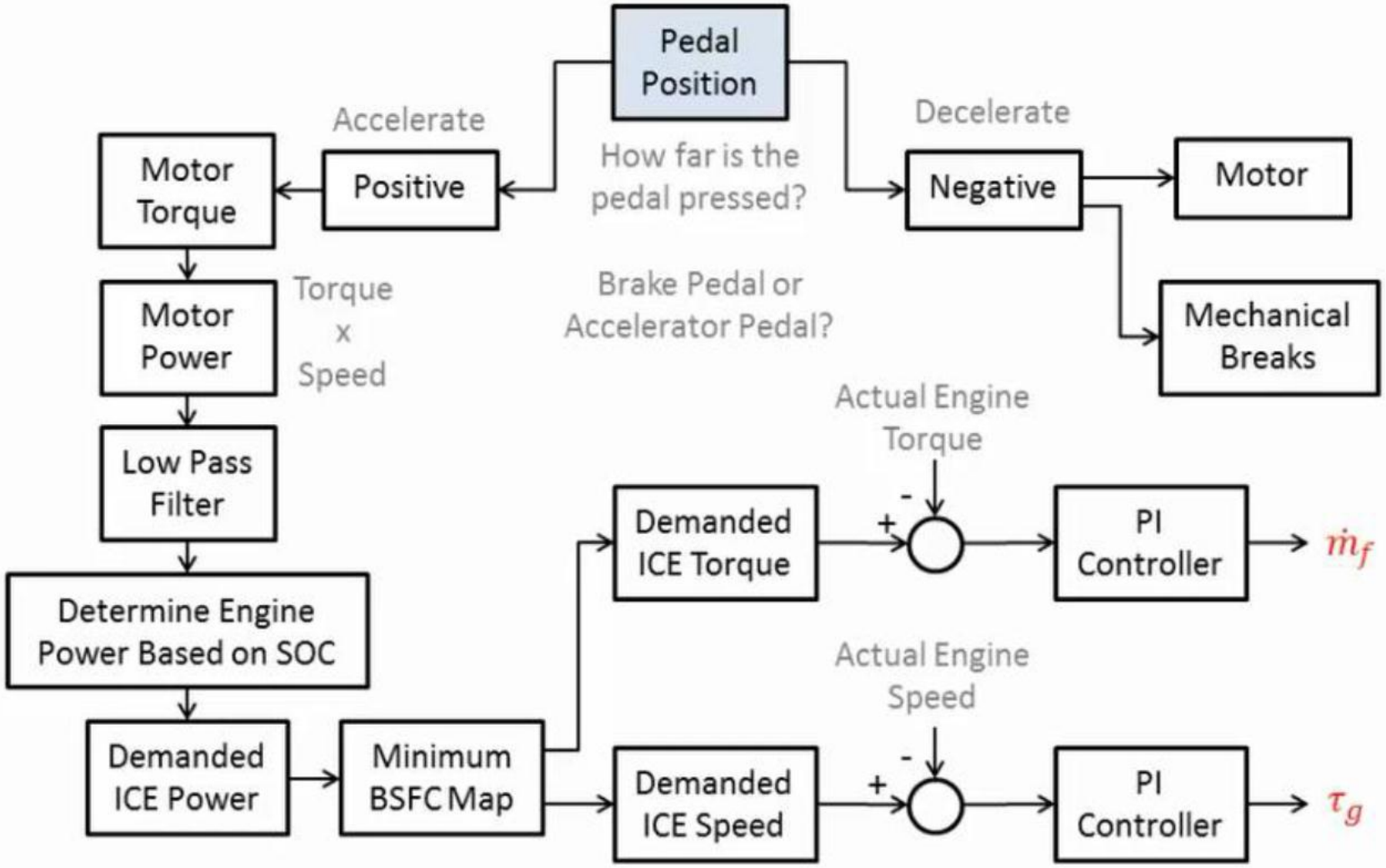
Custom Blended Power Management

- The motor torque command determines the range of output torque values for the current vehicle speed.
- The IC engine controller matches the demanded IC engine power to a fraction of the demanded motor power.
  - This fraction increases as the battery charge level depletes.
  - The IC engine demand is equal to the motor demand at 40% SOC





Overview of the Control Strategy



References

[1] L. Guzzella and A. Sciarretta, Vehicle Propulsion Systems: Introduction to Modeling and Optimization, New York: Springer, 2007.