The function, which is supposed to provide the torque set-points for the combustion engine and the electric motor, is applied to a P2-HEV which is a Ford Focus consisting of a 12 V and a 48 V battery.

The algorithm has to be able to use the gear position as input as well as treat it as a state. The engine on/off decision should be controlled or set by a simple rule: if engine torque set point is zero, engine is off and clutch is disengaged.

The optimal fuel consumption for the New European Driving Cycle (NEDC) and for the WLTC cycle has to be computed.

The following constraints hold:

* calculation of optimal torque split (i.e. determine torque set-points for engine and motor) with three cases
  + Calculation of optimal control for gear and engine on/off
  + calculation of optimal engine on/off trajectory with given gear and
  + using the simple rule-based strategy: engine will be decoupled and turned off, if its torque set-point equals zero (gear is given)
* additional power consumption of 12 V auxiliary loads (including losses of power electronics) is given as time-based vector and considered to be covered by the 48 V battery
* computation of all solutions for SOC range from 30% to 90% all starting with 60%

Vehicle Model Parameters:

|  |  |  |
| --- | --- | --- |
| Drag Coefficient (0.5cwAρ) | kg/m | Scalar |
| Vehicle Mass (including rotational masses) | kg | Scalar |
| Rolling Resistance Coefficient |  | Scalar |
| Dynamic Rolling Radius of Wheels | m | Scalar |
| Battery Resistance (Charge & Discharge) | Ohm | Scalar |
| Open Circuit Voltage of Battery depending on Battery Energy | V | Lookup Table (ℝ1) |
| Power Limits of Battery | W | Scalar |
| Maximal Battery Energy | J | Scalar |
| Gear Ratio for every Gear |  | Lookup Table (ℝ1) |
| Gear Efficiency |  | Scalar |
| Fuel Density | kg/l |  |
| Fuel’s Lower Heating Value | J/kg |  |
| Fuel Power depending on ICE speed and ICE torque | W | Lookup Table (ℝ²) |
| ICE speed meshgrid (equidistant) | rad/s | Lookup Table (ℝ²) |
| ICE torque meshgrid (equidistant) | Nm | Lookup Table (ℝ²) |
| Boundaries of ICE torque depending on ICE speed (in rad/s) | Nm | Lookup Table (ℝ1) |
| Electric Power of EM depending on EM speed and EM torque | W | Lookup Table (ℝ²) |
| EM speed meshgrid (equidistant) | rad/s | Lookup Table (ℝ²) |
| EM torque meshgrid (equidistant) | Nm | Lookup Table (ℝ²) |
| Boundaries of EM torque depending on EM speed (in rad/s) | Nm | Lookup Table (ℝ1) |
| Torque of EM depending on EM speed and EM power | Nm | Lookup Table (ℝ²) |
| EM power meshgrid (equidistant) | W | Lookup Table (ℝ²) |
| Boundaries of EM power | W | Lookup Table (ℝ1) |