LG Chem Update

University of California, Berkeley

Energy, Controls, and Applications Lab (eCAL)

07/26/2018

Overview

- Project Schedule

- Optimal Charging Results

- Summary of Results

Project Schedule

Project Title: Rapid-Safe Battery Charging: Controls & Learning with Electrochemical Models	Year 1				Year 2			
Start of Project: INSERT OFFICIAL DATE	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Task 1 — **Optimize Charge w/ Reduced EChem Model**	████	████	██					
1.1 Optimal Charging Literature Review	█							
1.2 Optimal Charging Preliminary Results – UCB Parameters								
1.3 Reduced Order Model Validation – LG Chem Parameters	█	██						
1.4 Optimal Charging Results – LG Chem Parameters		██	█					
Task 2 — **Refinement w/ Simulation Based Reinforcement Learning**		████	████	████	████	█		
2.1 Reinforcement Learning Literature Review			█					
2.2 Full Order Model Validation – LG Chem Parameters		██	█					
2.3 Reinforcement Learning Problem Formulation			██					
2.4 Optimal Charging Results – LG Chem Parameters			█	████	███			
Task 3 — **Battery-in-the-Loop Experiments**					████	████	████	████
3.1 Battery Cell Acceptance Experiments and Model Calibration					█			
3.2 Battery Cell Charge Cycling Experiments - Traditional					█	████	███	
3.3 Battery Cell Charge Cycling Experiments - Custom Algorithm					█	████	████	████
Task R — **Progress Reports**			████	████	████	████	████	████
R.1 Mid-Year Report		█						
R.2 End-of-Year Report				█				
R.3 Mid-Year Report						█		
R.4 End-of-Year Report								█
Task P — **Publication**				████	████	████	████	████
P.1 Publication on Task 2 Results			█					
P.2 Publication on Task 3 Results								█
Task PA — **Patent Application**					█			
PA.1 Patent on Task 2 Results					█			

Task	Complete	In Progress	Future

Optimal Charging Preliminary Results

- Minimum time to reach desired SOC from initial SOC subject to operating constraints
  - Parameter Set: LGC*
  - Models: SPMeT
  - Initial Conditions: ~25°C, ~5% SOC
  - Terminal Condition: 80% SOC
  - Constraints:
    - Current: 0 to 5C**
    - Temperature: 25°C to 60°C
    - Solid Concentration: 0% to 100% Cell SOC Stoichiometric Window
    - Electrolyte Concentration: 0mol/m^3 to 5000mol/m^3

* The parameter set is based on given, calculated, and within range parameters for the LG Chem cell under study

** 1C current as defined in current data

SPMeT Optimal Charging Profiles via Modified Reference Governor

SPMeT Model Simulation – 1C Max Charge
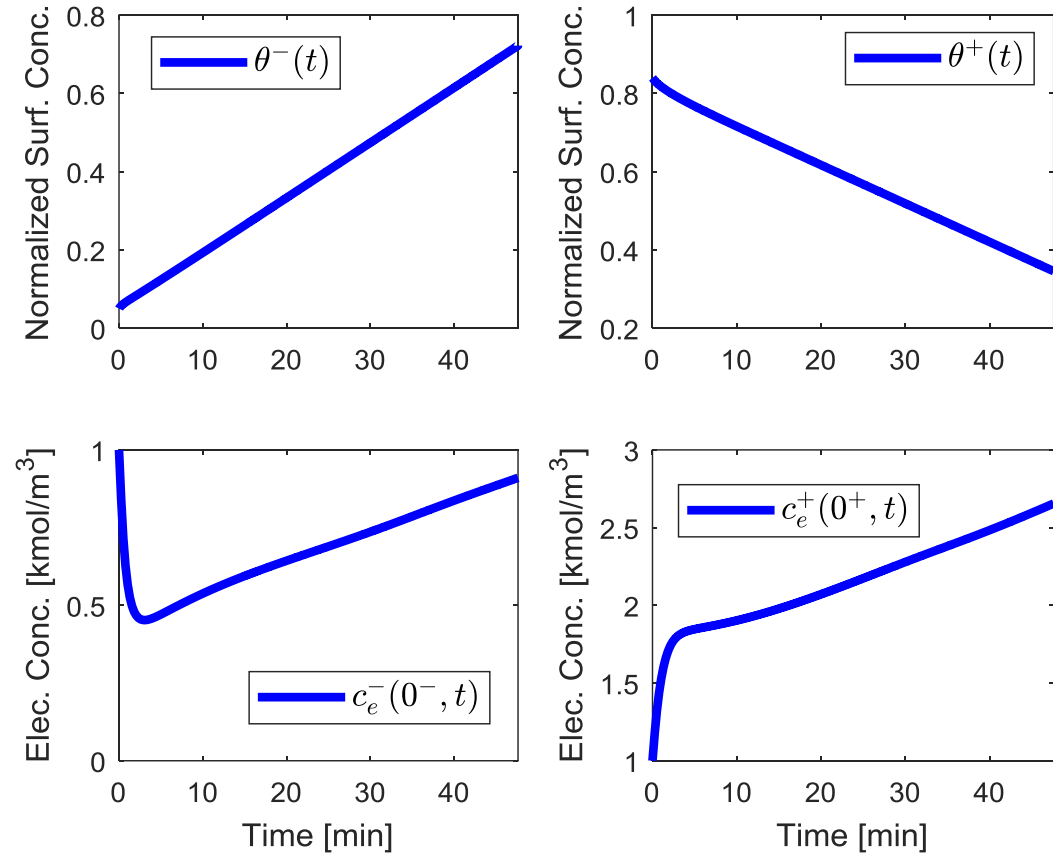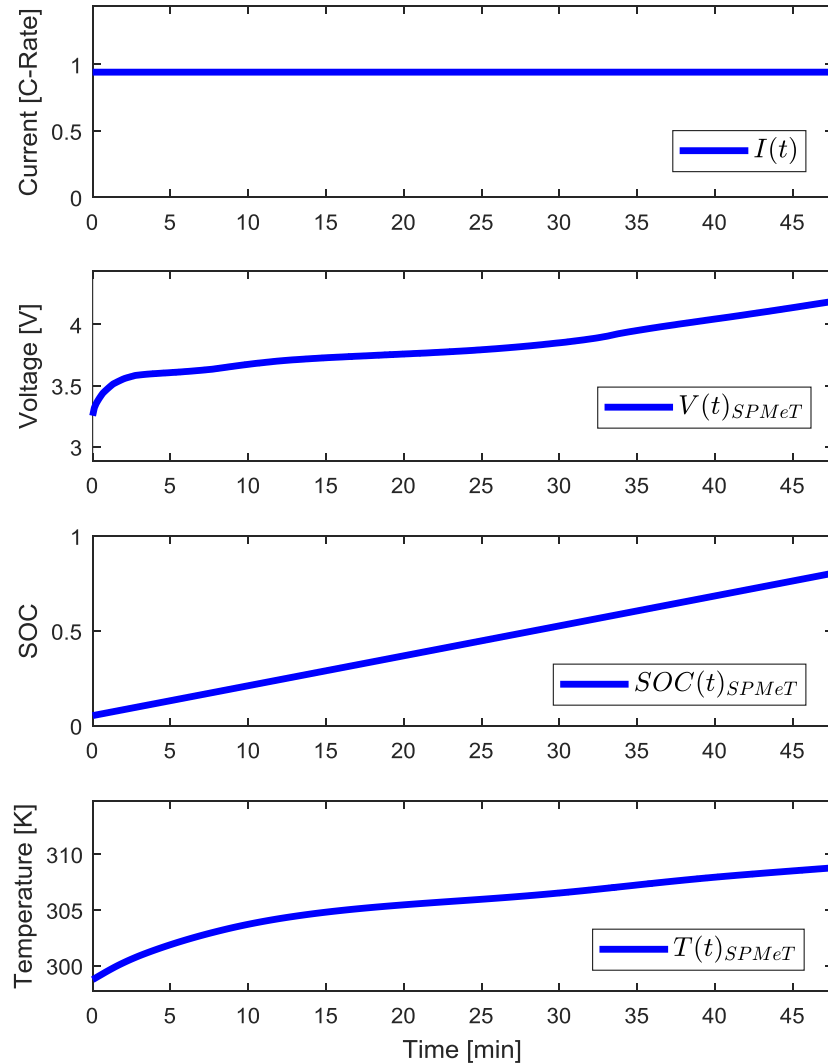
Charge Time = 47.35min

Optimal Profile = CC

SPMeT Model Simulation – 2C Max Charge
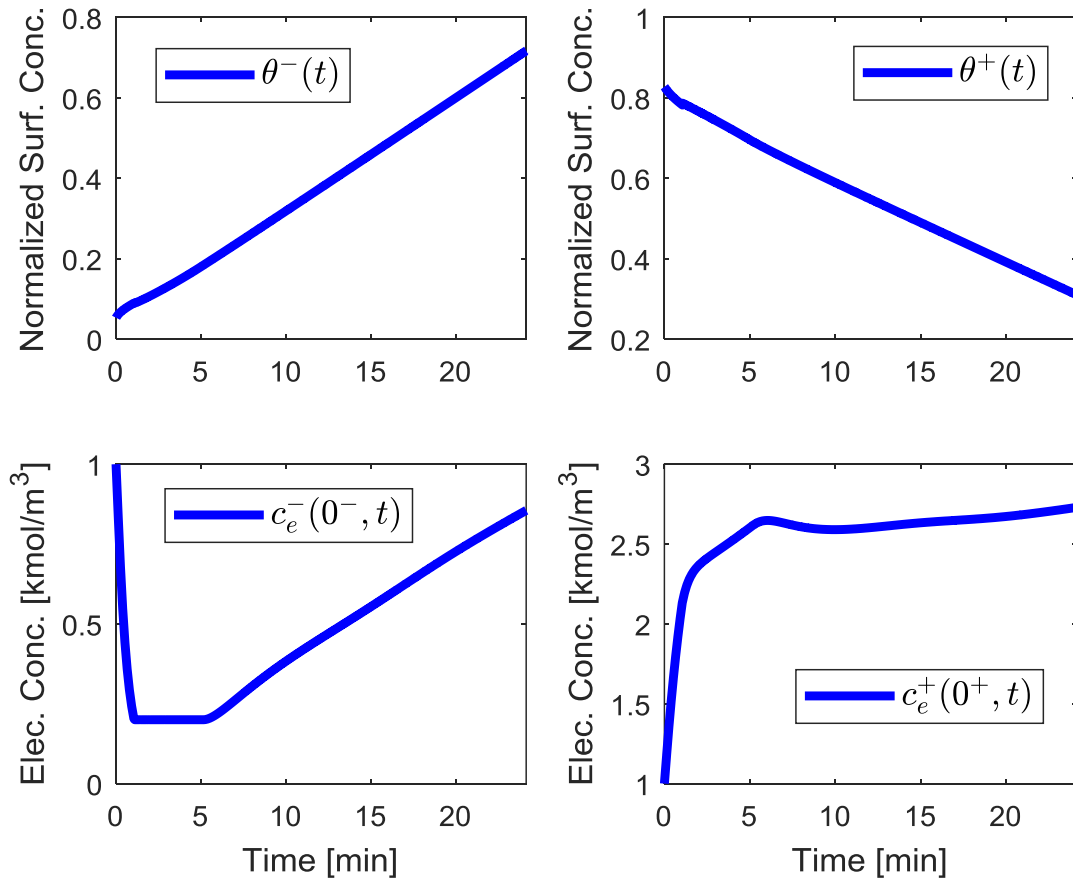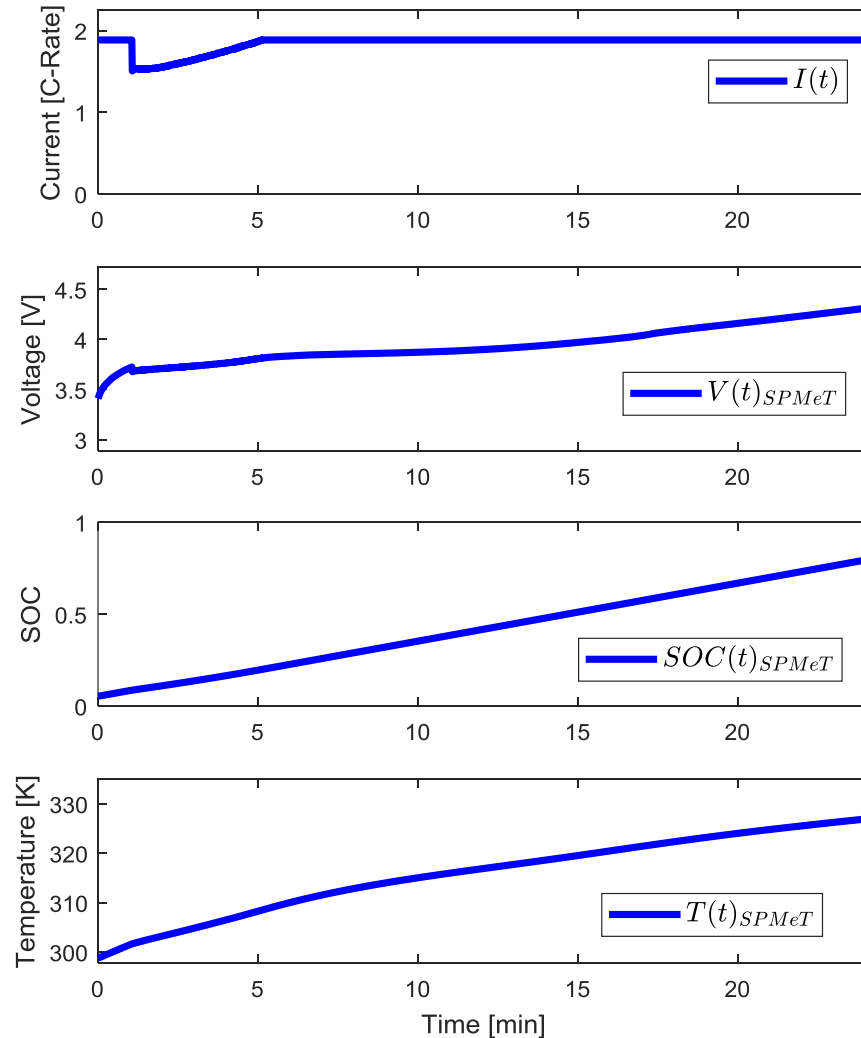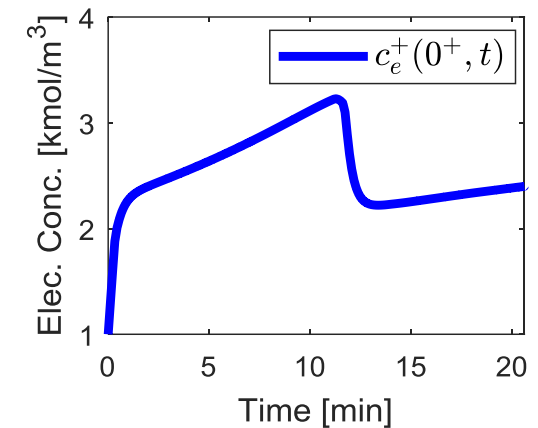

Charge Time = 24.15min

Optimal Profile = CC-CCe-CC

SPMeT Model Simulation – 3C Max Charge
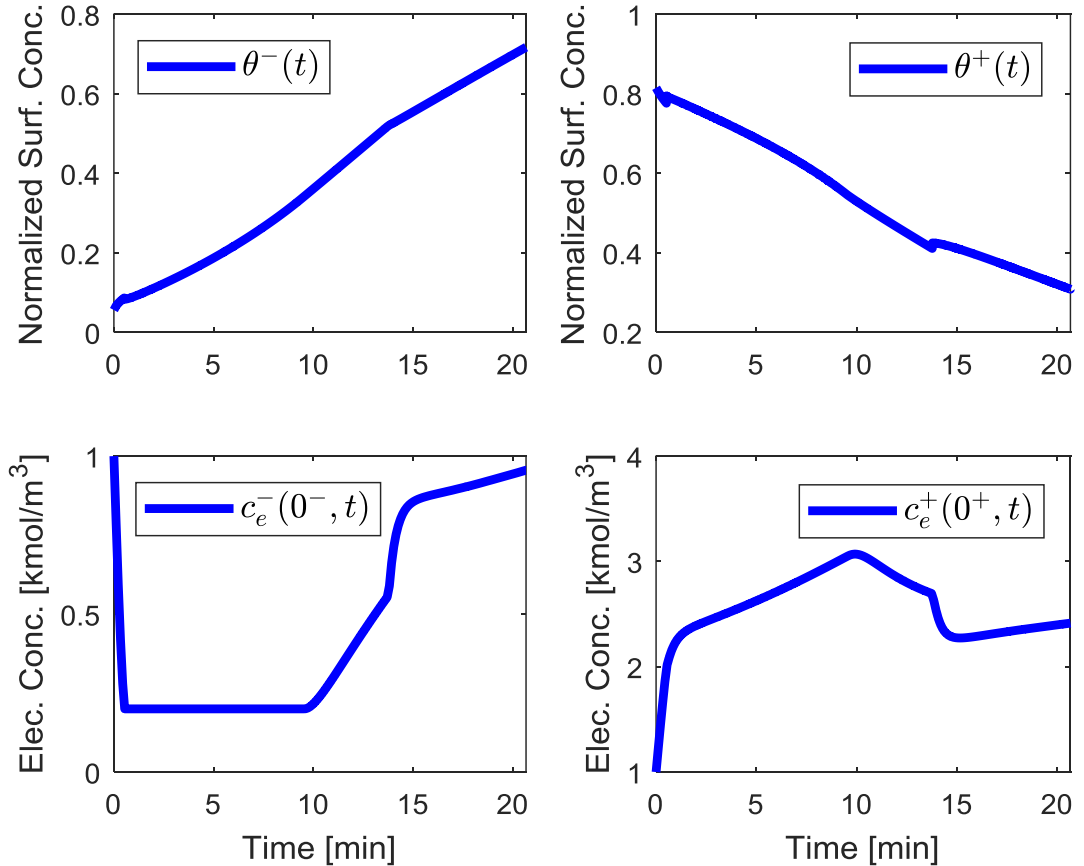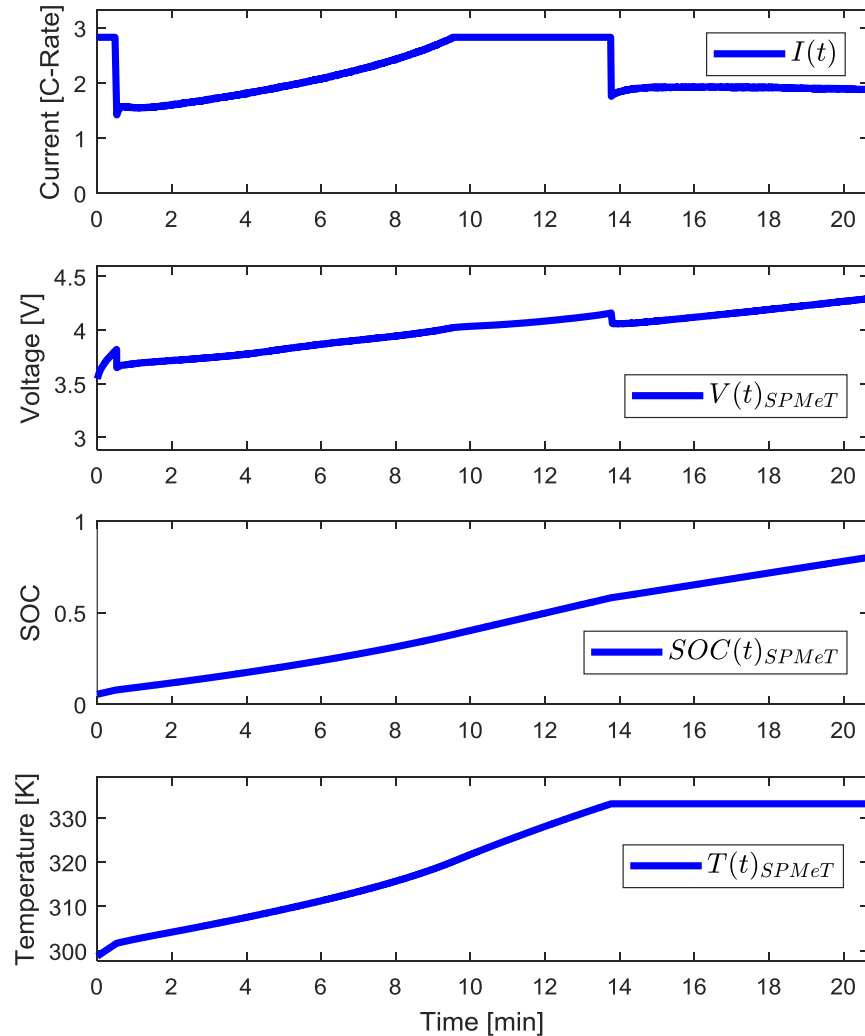
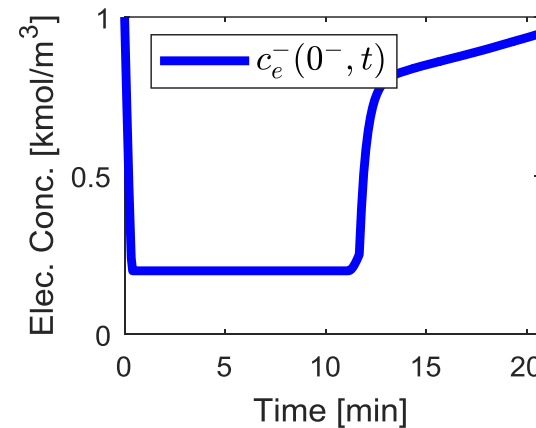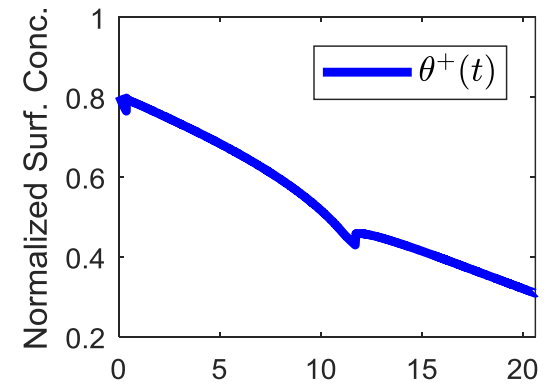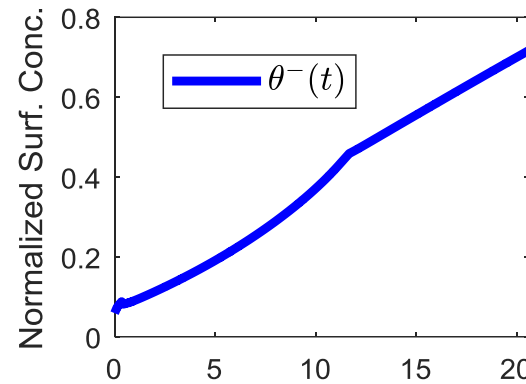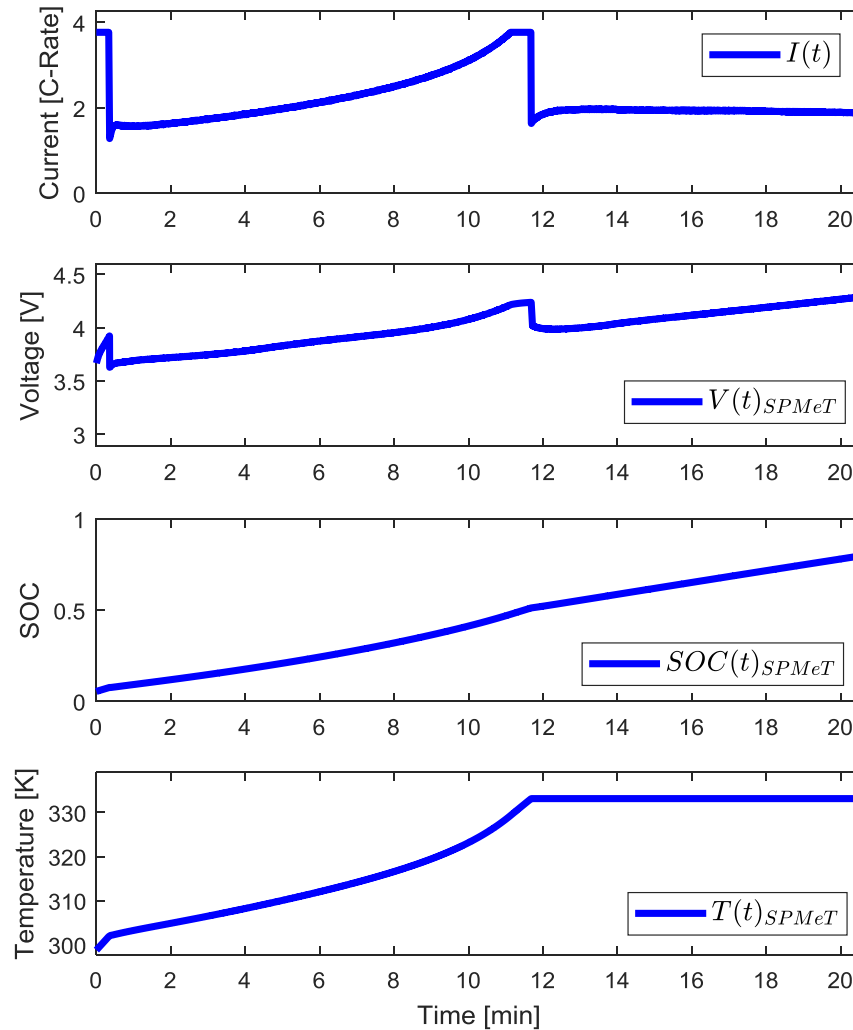**Charge Time = 20.66min**

Optimal Profile = CC-CCe-CC-CT

SPMeT Model Simulation – 4C Max Charge
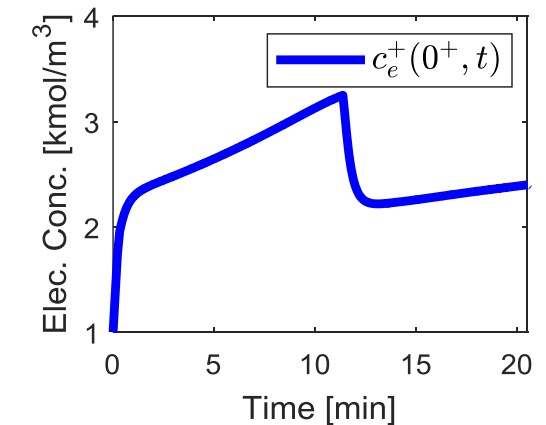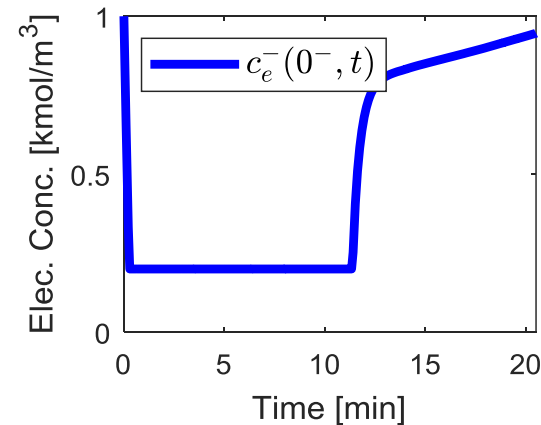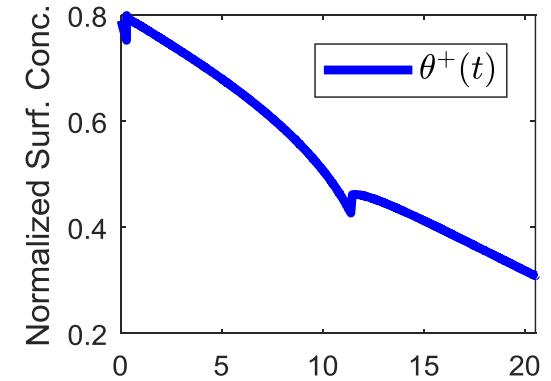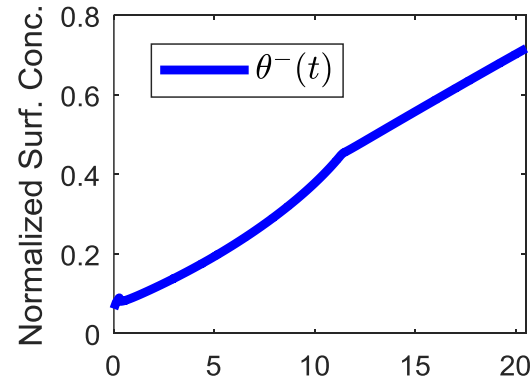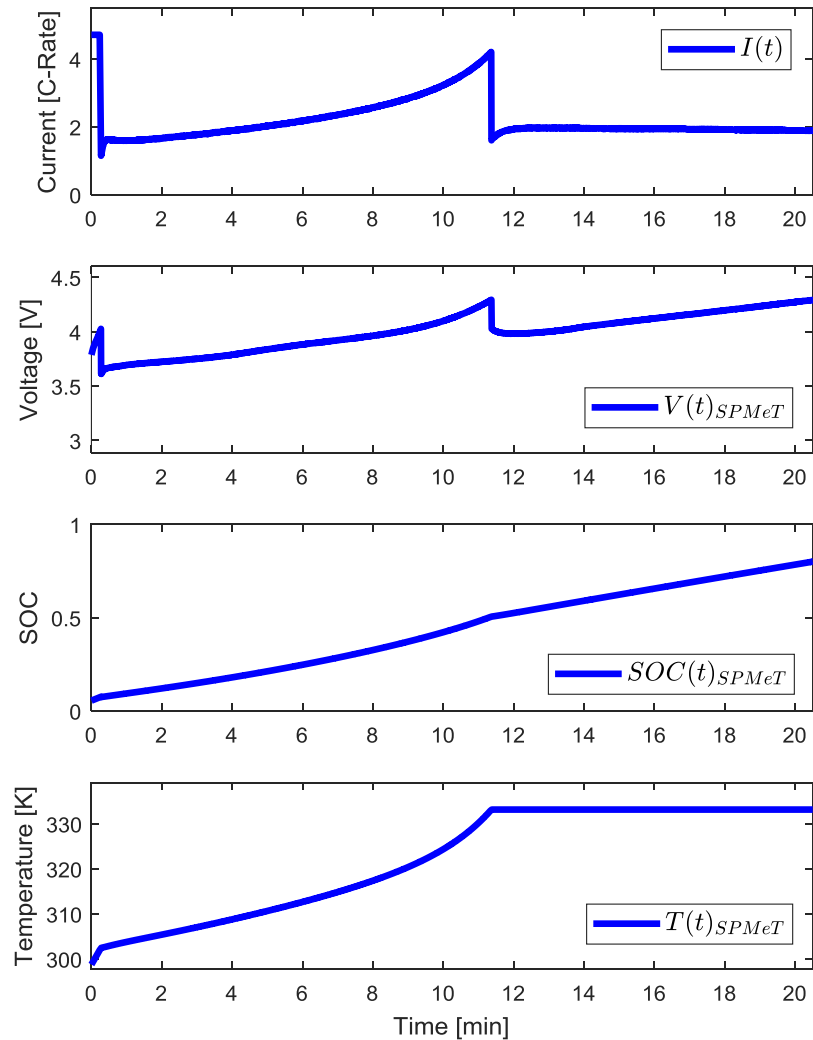

Charge Time = 20.6min

Optimal Profile = CC-CCe-CC-CT

SPMeT Model Simulation – 5C Max Charge

Charge Time = 20.5min

Optimal Profile = CC-CCe-CT

Summary of Results

- SPMeT Optimal Charging Profiles Obtained via MRG
  - Optimal Charging Profile for 1C Max is CC – 47.35min
  - Optimal Charging Profile for 2C Max is CC-CCe-CC – 24.15min
  - Optimal Charging Profile for 3C Max is CC-CCe-CC-CT – 20.66min
  - Optimal Charging Profile for 4C Max is CC-CCe-CC-CT – 20.6min
  - Optimal Charging Profile for 5C Max is CC-CCe-CT – 20.5min