ECE 529: Homework #2

Due Session 18 (February 22)

1. Implement an averaged model of a three phase VSC with an AC source voltage of 2.3 kV (L-L), \( R = 0.0096 \, \Omega \), \( L = 382 \mu H \) (\( X/R = 15 \)) and a switching frequency of 3060Hz.

   A. Determine \( V_{dc} \) if the maximum amplitude of the modulating function is 0.8 and the maximum reactive power the converter can supply is 5 MVAR while transferring 0 MW (both measured at the source side of the R-L). Round up to nearest 10 V.

   B. Calculate open loop modulating functions \( (m_a(t), m_b(t), \text{ and } m_c(t)) \) such that the current at the point of interconnect is 750 A at unity power factor. Implement the converter in an EMT program using averaged models and verify that it supplies the current current.

   C. Generate open loop modulating functions such that the current at the point of interconnect is 750A at a power factor of 0 lagging. Implement the converter in an EMT program and verify that it supplies the current current.

   D. Generate open loop modulating functions such that the current at the point of interconnect is 750A at a power factor of 0 leading. Implement the converter in an EMT program and verify that it supplies the current current.

   E. Implement using a switching model (note that the switching frequency is different than the examples from class). Compare ac currents to those from the averaged models and the fundamental component of converter terminal voltages to averaged model results for the cases B and D.

2. Now the VSC from problem 1 has a closed loop control scheme implemented in the synchronous rotating d-q reference frame. Assume that the source voltage is constant.

   A. Determine gains \( k_i \) and \( k_p \)

   B. Determine the \( i_{dref} \) and \( i_{qref} \) such that \( P=5 \, MW \) and \( Q=0 \).

   C. Determine the \( i_{dref} \) and \( i_{qref} \) such that \( P=4.0 \, MW \) and \( Q=1.9 \, MVAR \).

   D. Determine the \( i_{dref} \) and \( i_{qref} \) such that \( P=4.0 \, MW \) and \( Q=-1.9 \, MVAR \)

   E. Determine the \( i_{dref} \) and \( i_{qref} \) such that \( P=-4.0 \, MW \) and \( Q=-1.9 \, MVAR \)

   F. Implement cases B-E using closed loop control in your EMT program using averaged models. Make sure you update constants needed for the closed loop controller.