EE6322D - STATIC VAR CONTROLLERS AND HARMONIC FILTERING – WINTER 2023-24

Assignment – 3

1. An 11kV, 50Hz, 3-Phase FC TCR Unit rated for 1MVAr capacitive and 0.3MVAr Inductive compensation is employed at a 11kV Primary Distribution Station with a short circuit capacity of 20MVA at 0 lag pf.
   a. If the fixed capacitor and TCR units are delta-connected, find the reactance of branch capacitance in FC unit and branch inductance in TCR Unit in ohms.
   b. If the open circuit voltage at the bus is 11.4kV, find the range of reactive power drawn by load such that the FC TCR Unit will be able to maintain the bus voltage at 11kV line to line.
   c. Repeat Part (b) if open circuit voltage at the Bus is 11kV.
   d. Repeat Part (b) if open circuit voltage at the Bus is 10.4kV.
   e. Find the firing angle of TCR (measured from peak of line-to-line voltage) if the open circuit voltage at the Bus is 10.8kV and the load is 1MVA at 0.8 Lag power factor and the FC TCR is maintaining 11kV at the Bus with this load.
2. An 11kV, 50Hz, 3-Phase TSC-TCR Unit rated for 1MVAr capacitive and 0.3MVAr Inductive compensation is employed at an 11kV Primary Distribution Station with a short circuit capacity of 20MVA at 0 lag pf. The TSC Unit comprises four identical units in parallel. All the TSC Units and the TCR Units are delta-connected. The TSC units use a reactor in series with capacitor for surge control purpose and for functioning as a harmonic filter for 5^{th} harmonic. Find reactance values for one branch of individual TSC Unit and one branch of TCR Unit in Ohms.
3. An 11kV, 50Hz, 3-Phase FC TCR Unit rated for 1MVAr capacitive and 0.3MVAr Inductive compensation is employed at an 11kV Primary Distribution Station with a short circuit capacity of 20MVA at 0 lag pf. Use a Three-Phase pu base of 11kV, 1MVA. The load on the Bus is 1MVA at 0.8 Lag PF. The range of variation of bus voltage over a day (with load constant) was seen to be (10.4kV, 11.2kV) without the SVC turned on. Assuming the same daily variation on all days, find the variation range for Bus voltage if SVC is used with V_{tref} = 1pu and (i) droop constant = 0.04 pu and (ii) droop constant = 0.1. You may use graphical procedure if necessary.
4. An 110kV, 50Hz, 3-Phase TSC-TCR Unit rated for 25MVAr capacitive and 7.5MVAr Inductive compensation is employed at an 110kV Station with a short circuit capacity of 250MVA at 0 lag pf. The TSC Unit comprises 5 identical units in parallel. Use a Three-Phase pu base of 110kV, 50MVA.
   a. Design a PI Controller based External Control Loop for this SVC using a droop constant of 0.05 pu for a phase margin of 50^0.
   b. If this SVC with same design of control loop is used at another 110kV station with a short circuit capacity of 150MVA at 0 lag pf, find the phase margin realized at that location. (Use MATLAB to prepare Bode Plots)
5. Two 110kV, 50Hz, 3-Phase FC-TCR Units rated for 25MVAr/-7.5MVAr and 50MVAr/-15MVAr are employed in parallel at an 110kV Station with a short circuit capacity of 300MVA at 0 lag pf. Use a Three Phase pu base of 110kV, 100MVA. Design the composite SVC with an effective droop constant of 0.04pu, phase margin of 50^0 and load sharing in proportion to rating under steady-state as well as dynamic conditions. Show the block diagram of the designed controller.