9a April 14, 2012

Problem 9 Power Systems

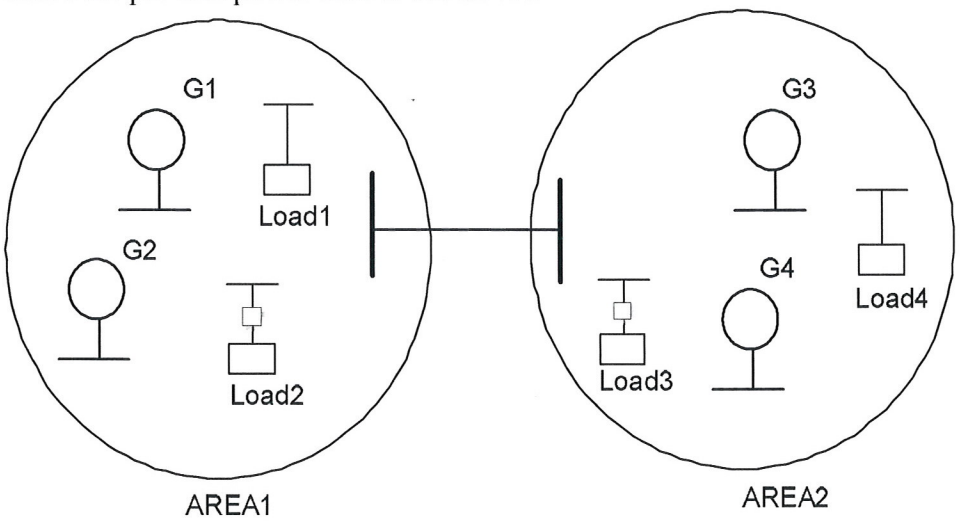
Four generators are connected to a power system. Two in area 1 and two in area 2. The capacity and governor characteristic of each generator is given in the table below:

Generator No.	Generator Capacity (MW)	Governor Constant	Initial MW Output
1	300	0.15	200
2	500	0.25	300
3	400	0.05	300
4	600	0.02	300

Loads:
Load 1 = 550 MW, Load 2 = 50 MW, Load 3 = 50 MW, Load 4 = 450 MW
Load 2 and Load 3 have underfrequency relay devices that disconnect the load if the frequency at the load goes below 60 Hz. If any frequency below 60 Hz is detected the load is disconnected and stays off. If a frequency above 60Hz is detected the load remains connected.

Assume that the governor constants are all expressed as $\frac{\Delta f}{\Delta P} = \frac{\%\_frequency\_change}{perunit\_power\_change}$

where the per unit power base is 100 MVA.



Part a) The system is in steady state at 60 Hz with all loads connected. What is the initial tie flow in MW? What direction is it flowing? 0.5 pts

Part b) The tie line is suddenly opened due to a lightning strike and remains open. Do either of the loads with the underfrequency relays open? If so which loads? Calculate the final generation for each generator and the frequency for each area and fill in the table below. 1.5 pts

Area	G1 (MW)	G2 (MW)	G3 (MW)	G4 (MW)	Frequency
1					
2					

Problem 9(b) Power Electronics

In a photovoltaic system, a Boost converter is used to boost the input voltage $V_{in} = 48V$ to the output voltage of $V_o = 350V$ across a capacitor. The switching frequency $f_s = 200\,kHz$. The maximum output power level of this converter is $P_{o,\max} = 120W$. Assume ideal components and assume the ripple in the output voltage to be negligible.

(a) It is designed such that if the output power is equal to or higher than one-third of $P_{o,\max}$, it remains in the continuous-current-conduction mode; below this output power level, it goes into the discontinuous-current-conduction mode. Calculate the value of the inductor L to satisfy this design condition. 1 pt

(b) This converter is operating at the power level of $(P_{o,\max}/3)$ at the border of continuous/discontinuous modes. Calculate and draw the waveforms of the following variables as a function of time, labeling both axes as appropriate: inductor current i_L, diode current i_{diode} and the capacitor current i_C. 1 pt