HOMEWORK # 1 - Deadline : October 28, 2019

Consider a synchronous machine with the following parameters:

$$S_N = 1200 \text{ MVA} \qquad f_N = 50 \text{ Hz}$$
$$X_\ell = 0.20 \text{ pu} \qquad R_a = 0.004 \text{ pu}$$
$$X_d = 2.10 \text{ pu} \qquad X_q = 2.10 \text{ pu}$$
$$X'_d = 0.30 \text{ pu} \qquad X'_q = 0.73 \text{ pu}$$
$$X''_d = 0.25 \text{ pu} \qquad X''_q = 0.256 \text{ pu}$$

(as usual the values in pu refer to the machine nominal power and voltage)

	Variant 1	Variant 2	Variant 3	Variant 4
T''_{do} (s)	0.025	0.028	0.030	0.027
T'_{do} (s)	8.500	7.500	9.100	8.000
T''_{qo} (s)	0.220	0.300	0.200	0.250
T'_{qo} (s)	2.200	2.500	2.300	2.100

Determine the rotor winding resistances and the inductance matrices $\boldsymbol{L}_d, \boldsymbol{L}_q$ of the Park model, using the EMFL per unit system.

Check your answers by computing $X_d^{''}$ and $X_q^{''}$ from the Park inductance matrices and comparing with the given values.

Compute $X_d^{'}$ and $X_q^{'}$ from the Park inductance matrices and compare with the given values. Comment.

Suggestion. First identify the time constants in :

$$\ell_d(s) = L_{dd}\frac{(1+sT_d^{'})(1+sT_d^{''})}{(1+sT_{d0}^{'})(1+sT_{d0}^{''})} \qquad \ell_q(s) = L_{qq}\frac{(1+sT_q^{'})(1+sT_q^{''})}{(1+sT_{q0}^{'})(1+sT_{q0}^{''})}$$

then, identify the resistances and inductances of the dynamic equivalent circuits (slide # 26 of "Dynamics of the synchronous machine") by matching $s\ell_d(s)$ and $s\ell_q(s)$ with the corresponding impedances.

Caveat. Consider the time constant of a simple R-L circuit : $\tau = L/R$.
Assume L and R are both in pu. Then τ is also in pu.
Hence, to identify L or R from τ, the latter must be converted into per unit.