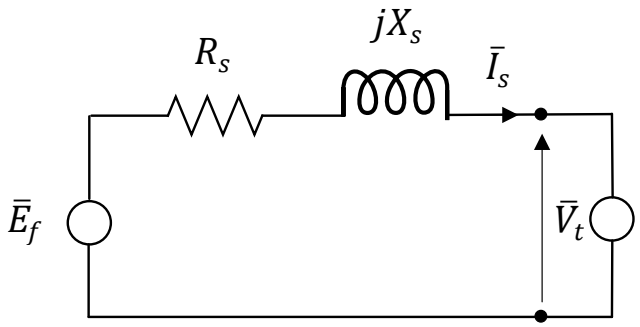
EE 331 Homework Set 8 (Due at 11AM on Monday – Nov 25th, 2019)

Problem 1 (20 points)

A three phase 60 Hz synchronous motor has four poles. The motor rated voltage is 460 V/266 V wye. Equivalent stator impedance $X_s = 1.5\ \Omega$ and $R_s = 0.05\ \Omega$. The motor rated stator current is 180 A. The motor internal voltage is $E_f = 30I_f$, where I_f is the motor field current. The per phase equivalent circuit is shown below.

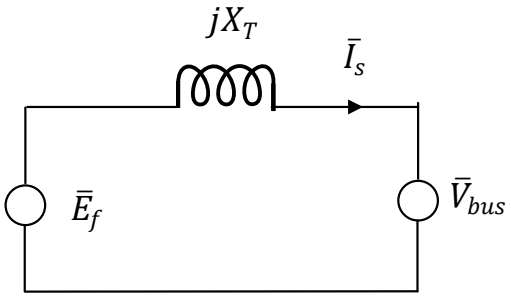


Develop the V curve for this motor under the real power consumption of *120 kW*, plotting stator current as a function of field current using MATLAB. Include **at least five data points** in the V curve.

Problem 2 (20 points)

A three phase, four pole 60 Hz synchronous generator is rated at 1000 MVA and 22.5 kV/13 kV wye. The generator synchronous reactance $X_s = 0.7\ \Omega$. The generator is feeding into a system that has system equivalent reactance $X_{sys} = 0.1\ \Omega$ and infinite bus voltage of 13.0 kV line to neutral.

a. The generator internal voltage E_f = 19.5 kV line to neutral. Determine P_{max} for this operating point.
b. The generator is delivering 700 MW to the infinite bus. Determine the angle δ of the generator internal voltage.
c. Determine the generator terminal voltage V_t.
d. Determine the VAR flow at the generator terminal for this operating point.
e. The generator power decreases to 200 MW. Determine the new value of the power-angle δ.



Problem 3 (20 points)

A three-phase, 8-pole, 75 HP squirrel cage induction motor has the following characteristics:

$R_1 = 0.05\ \Omega$	$X_1 = 0.2\ \Omega$	$X_m = 10\ \Omega$
$R_2' = 0.055\ \Omega$	$X_2' = 0.2\ \Omega$	

The motor is operating at a speed of 875 rpm with a terminal voltage of 460V/266V – 60 Hz.

a. Calculate the motor slip.
b. Calculate the stator current $\bar{I}_1$ and the rotor current $\bar{I}_2'$. Assume that the motor terminal voltage is at 0° for this calculation.
c. Calculate the motor efficiency
d. Calculate the developed torque of the motor T_e.

Problem 4. (20 points)

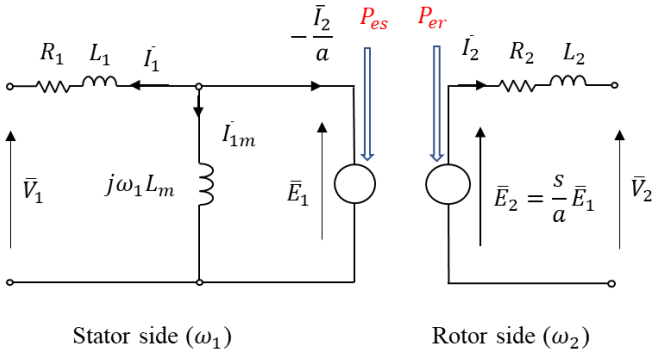
The previous motor in problem 3 is fed from a source with an open circuit voltage of 277 V at the frequency of 50 Hz and a source impedance of Z_{th}= 0.04 + j0.11Ω. Determine the motor terminal voltage, stator current and torque at motor starting s = 1 and at the motor's rated speed.

Problem 5. (20 points)

An 8-pole doubly fed induction generator (with the below equivalent circuit) has the following parameters

$R_1 = 0.05\ \Omega$	$L_1 = 1\ mH$	$L_m = 200$ mH
$R_2 = 0.01\ \Omega$	$L_2 = 0.3\ mH$	$a = 2$

a. With the input frequency of 60 Hz, the generator is operating at the speed of 1850 rpm. Determine the slip of the generator
b. The generator is operating with a stator line to neutral voltage of V_1 = 2400V. The stator winding is delivering 1.5 MW at 20 degree lagging power factor to the grid. Determine the value of the current I_1.
c. Solve the per phase equivalent circuit to find the rotor voltage and current.
d. Find the real and reactive power flowing out of the rotor.



Equivalent circuit of double-fed induction machine