EEET – 241 PROJECT #3

Make sure, for **all** parts of **all** problems, show your work.
For all questions below, be sure to show your work clearly.
Don't just write the answer.
Partial credit cannot be given without you showing your work.

Make sure all of your values have units (ohms, volts, amps, VA, W, VAR, etc.)

The nameplate of an inductive motor indicates:

HP = 15
PH (Phases) = 3
Voltage = 460V (remember that this is the rated voltage, not the applied voltage of 480V)
FLA = 21A
LRA = 116A (Locked Rotor Current)
Rotational speed = 1080 RPM
Efficiency = 85%
P.F. = 85%
Service Factor = 1.05%
Enclosure = TEFC

Hint: This is the same motor as in Project 2.

Some notes from Project 2:

Note the voltage notes above.
The power factor determines the FL active and reactive power.
Note that the power factor determines the impedance angle.
Note that the (normal operating) impedance (shown as Z_{motor}) is determined by the FLA and operating voltage. The X and R are determined by the Z_{motor} and the angle. This impedance looks like a series impedance.
Note that the mechanical output (BHP) is determined by the input (rated) HP and the efficiency.

The FLA is the current when the motor is at full load during normal operation. However, we know that the starting current for an inductive motor approaches

the LRA (Locked Rotor Current) when starting from rest. Note the value above. For the starting current, the motor looks like an impedance (Z_{motor}') – **<u>note the prime</u>**. This is actually a series impedance (like the FL situation) but the R will not change, only the reactive portion.
As a result, the normal operating impedance is $Z_{motor} = R_{motor} + jX_{motor}$ and the locked rotor impedance is $Z_{motor}' = R_{motor} + jX_{motor}'$ with the R_{motor} the same for both as the resistance of the motor does not change with the rotation of the rotor.

The goal of this project is to look at the (worst case) starting conditions (Locked Rotor conditions):

Find the Zmotor (normal operation – part of Project 2)
Find the Zmotor' (locked rotor condition)
Find the R_{motor} & jX_{motor} (normal operation – part of Project 2)
Find the $R_{motor} + jX_{motor}'$ (locked rotor condition)
Find the X/R and the X'/R for each condition.

Finally, **for normal operation**, determine the base power (S) for the motor, like we did for the pu (per unit) calculations for transformers.
(Remember KVA = V * FLA * √3)
Then find the impedance base value (Z_{base} - the same as transformer)
What is the %impedance (Z_{pu}) of the motor (this is the opposite of what we did for transformers)?