A three-phase, 60 Hz, 4-pole, Y-connected induction motor is rated at 460V, and 1,760 rpm (at full load). In addition, the following information is known about the motor:
Friction and windage loss: \( P_{F&W} = 750 \) W
Core loss: negligible
Stray loss: negligible
\( R_1 = 0.5 \) \( \Omega \)
\( R_2 = 0.25 \) \( \Omega \)
\( X_1 = 1 \) \( \Omega \)
\( X_2 = 0.5 \) \( \Omega \)
\( X_m = 25 \) \( \Omega \)
Assume that the motor is running at full load. Calculate the following:

1) Source current is nearly,
   a) 20 A  
b) 24 A  
c) 31 A  
d) 45 A

2) Motor power factor,
   a) 81.1%  
b) 83.2%  
c) 86.7%  
d) 89.2%

3) Motor efficiency
   a) 84.2%  
b) 85.3%  
c) 86.9%  
d) 88.3%

4) Motor starting torque.
   a) 67 Nm  
b) 94 Nm  
c) 106 Nm  
d) 123 Nm

5) Approximate motor starting current.
   a) 24 A  
b) 65 A  
c) 274 A  
d) 158 A

A 60 Hz, 208V, 4-pole synchronous motor has a synchronous reactance of 2.5 \( \Omega \). The motor delivers 15 hp to a mechanical load. The field current is adjusted so that the motor power factor is 80% leading. Ignore all losses. Find the following:
6) motor current,
   a) 38.8 A
   b) 42.1 A
   c) 55.0 A
   d) 64.2 A

7) Excitation voltage $E$ (per-phase)
   a) 120 V
   b) 133 V
   c) 178 V
   d) 194.5 V

8) power angle $\delta$.
   a) $-10^\circ$
   b) $-17^\circ$
   c) $-23^\circ$
   d) $-27^\circ$

If the mechanical load is increased to 25 hp, and the field current is kept as is, find the new

9) power angle $\delta$.
   a) $-14.1^\circ$
   b) $-41.8^\circ$
   c) $-34.5^\circ$
   d) $-27.2^\circ$

10) motor current
    a) 42.1 A
    b) 52.6 A
    c) 60.2 A
    d) 73.3 A

11) motor power factor
    a) 80% lead
    b) 90% lead
    c) 98.2% lead
    d) 96% lag

A 13.2 kV, 60 Hz, 2-pole synchronous generator is rated at 100 MVA and 85% power factor (lag). It has a synchronous reactance of 1.2 $\Omega$ and negligible armature winding resistance. The machine is connected to the utility grid at a node where the voltage is equal to 13.2 kV (line-to-line).

12) If the machine is set to deliver 25 MW to the grid and 15 MVAR to the grid, calculate the generator current
    a) 4,374 A
    b) 1,275 A
    c) 631 A
    d) none of the above
13) If the machine is scheduled to deliver 50 MW at unity power factor, calculate the power angle $\delta$.
   a) 10 deg.
   b) 13 deg.
   c) 19 deg.
   d) 28 deg.

14) Starting with the operating condition in 13) above, the field current is reduced such that the excitation voltage $E$ drops by 10%. Calculate the new reactive power supplied by the generator
   a) 0 MVAR
   b) -16.33 MVAR
   c) +16.33 MVAR
   d) None of the above

15) Starting with the operating condition in 13) above. If the field current is increased such that the excitation voltage $E$ increases by 10%. Calculate the new reactive power supplied by the generator
   a) +16.17 MVAR
   b) -16.17 MVAR
   c) 25.2 MVAR
   d) None of the above.