1. a) (12 pts) You have a 400/100-V, 1.2-kVA transformer. Can you use this transformer to transform 400 V to 300 V? If yes, show the connections (include source and load) and compute the new VA rating.

b) Show the 400-V source and the load.

c) Could this transformer also be used to transform 240 V to 180 V? If yes, what is the maximum real power that could be transformed at these voltages?

2. (31 pts) The parameters of a transformer are shown below.

Ratings: 360/120-V, 840-VA
Model values: \( R_m := 500 \, \Omega \), \( R_s := 6 \, \Omega \), \( X_m := 400 \, \Omega \), \( X_s := 8 \, \Omega \)

The secondary voltage is measured as \( V_2 := 93.6 \, V \)

The secondary current is measured as \( I_2 := 7.2 \, A \)

The transformer is loaded with a resistor, \( R_L \), in series with a capacitive reactance, \( X_C := -5 \, \Omega \)

a) Find the value of the load resistor. \( R_L = ? \)

b) Find the primary, source voltage. Magnitude only. \( |V_S| = ? \) As part of your answer, make a useful drawing or schematic and label it with known numbers.
c) Find the efficiency of the transformer.

NOTE: This efficiency is unrealistically low.

d) Is this transformer operating within its ratings? Show all evidence and calculations needed to determine this.

3. (26 pts) A 60 Hz, 2-pole, 3-phase, Y-connected synchronous generator supplies 90 kW of power to a 4 kV bus. The synchronous reactance ($X_s$) is 50 $\Omega$/phase. The power angle ($\delta$) is 12.5$^\circ$. Find the following.

a) The magnitude of the generator emf ($E_A$)

b) The total reactive power generated.

NOTE: This number is unrealistically big.

c) The operators are told to double the generated power, what do they do?

Use this new power for the rest of the problem.

d) The operators are told to generate the same reactive power as before (part b) what do they adjust?

e) After making the adjustment of the previous part, find the new magnitude of the generator emf

f) The power angle, $\delta$. 
4. (31 pts) The following information is for a 3-phase, Δ-connected, induction motor:

\[ X_M = 80 \Omega \quad R_C = \infty \quad n_m = 1128 \text{rpm} \quad \tau_{sh} = 52 \text{N-m} \]

\[ E_1 = 200 \text{V} \quad I_2 = 12 \text{A} \quad P_{RCL} = 420 \text{W} \]

a) Below is a drawing the circuit model of one phase. Label all the parts and arrows and add known values.

b) Find the slip. Make a reasonable assumption as necessary.

c) Find \( R_2 \)

d) Find \( X_2 \)

If you can't find \( X_2 \), or doubt your value, mark here _____ and use \( X_2 = 4 \Omega \) for the rest of the problem.

e) The magnitude of the line current. I advise you to assume the phase angle of \( E_1 \) is 0°.

f) The air-gap power

g) The power converted from electrical to mechanical form.

h) Find the mechanical power losses (all lumped together).

Answers

1. a),b) \[ 9 \text{A} \leftarrow 3 \text{A} \rightarrow 9 \text{A} \rightarrow 12 \text{A} \rightarrow 100 \text{V} \rightarrow 300 \text{V} \leftarrow 12 \text{A} \rightarrow 3.6 \text{kVA} \]

2. a) 12 \Omega \quad b) 287.7 \text{V} \quad c) 75.7 \% \quad d) no

3. a) 3001 \text{V} \quad b) 85.96 \text{kVAR} \quad c) Same connections \quad d) The DC field current from the prime mover

e) Increase the shaft torque from the prime mover

4. b) 6 \% \quad c) 0.972 \Omega \quad d) 3.90 \Omega \quad e) 22.2 \text{A} \quad f) 7 \text{kW} \quad g) 6.58 \text{kW} \quad h) 437.6 \text{W} \quad i) 3205 \text{V} \quad f) 23.9 \text{o}