EE 330 Energy Systems (Fall 2026) Quiz #6

Name __KEY A__

Instructions: Open book & notes (no homework). Place answers in indicated spaces and show all work for credit.

Answer the following:

a) The rotor of an 8000 V_{rms}, 4-pole, three-phase (3ϕ), Δ-connected, 5 kVA synchronous generator is rotated at 2100 RPM. What frequency (Hz) of electricity will it produce?

Per (4-23), $f_e = \dfrac{n_m P}{120} = \dfrac{2100\,(4)}{120} \Rightarrow$ **f_e = 70 Hz**,

frequency = **f_e = 70 Hz**

b) The rotor of a V_{LL} = 2400 V_{rms}, 2-pole, 3ϕ, **Y-connected**, 500 kVA synchronous generator is rotated at 2800 RPM. What is the mechanical rotor speed f_m (Hz)? What is the phase voltage (V_{rms})? How much magnetic flux must be supplied by the rotor through the armature coils (200 turns/each) under open circuit conditions to generate the rated line-to-line voltage?

Per (1-3a), $n_m = 60 f_m \Rightarrow f_m = n_m / 60 = 2800 / 60 \Rightarrow$ **f_m = 46.66667 Hz.**

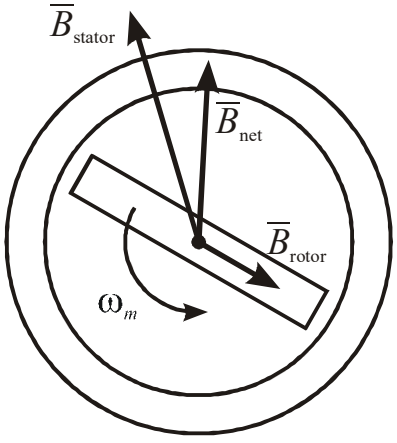
Per (2-11), $V_{LL} = \sqrt{3}\, V_\phi \Rightarrow V_\phi = V_{LL} / \sqrt{3} = 2400 / \sqrt{3} \Rightarrow$ **V_ϕ = 1385.64 V_{rms}.**

Per (4-39), $E_A = \sqrt{2}\,\pi\, N_C\, \phi\, f \Rightarrow \phi = \dfrac{E_A}{\sqrt{2}\,\pi\, N_C\, f} = \dfrac{1385.64}{\sqrt{2}\,\pi\,(200)\,46.6667}$

$\Rightarrow$ **ϕ = 0.033415577 Wb.**

f_m = **46.667 Hz** phase voltage = **1385.64 V_{rms}** magnetic flux = **33.416 mWb**

c) A different AC machine has the magnetic flux densities and machine rotation as shown on the figure. Looking into the page, will the induced torque of the machine try to push the rotor clockwise (CW) or counterclockwise (CCW)? Is the machine a generator or motor? Why?



Per (4-46)/(4-49), $\overline{\tau}_{ind} = k\,\overline{B}_R \times \overline{B}_S = k\,\overline{B}_R \times \overline{B}_{net} \Rightarrow$ in CCW dir.

clockwise (CW) or **counterclockwise (CCW)**? generator or **motor**? (Circle correct answers)

Why? **Induced torque in same direction as machine rotation means we have a motor.**

EE 330 Energy Systems (Fall 2026) Quiz #6

Name KEY B

Instructions: Open book & notes (no homework). Place answers in indicated spaces and show all work for credit.

Answer the following:

a) The rotor of a 480 V_{rms}, 6-pole, three-phase (3ϕ), Δ-connected, 3 MVA synchronous generator is rotated at 1500 RPM. What frequency (Hz) of electricity will it produce?

Per (4-23), $f_e = \frac{n_m P}{120} = \frac{1500\,(6)}{120} \Rightarrow$ **f_e = 75 Hz**,

frequency = **f_e = 75 Hz**

b) The rotor of a V_{LL} = 480 V_{rms}, 2-pole, 3ϕ, **Y-connected**, 100 kVA synchronous generator is rotated at 2200 RPM. What is the mechanical rotor speed f_m (Hz)? What is the phase voltage (V_{rms})? How much magnetic flux must be supplied by the rotor through the armature coils (180 turns/each) under open circuit conditions to generate the rated line-to-line voltage?

Per (1-3a), $n_m = 60 f_m \Rightarrow f_m = n_m / 60 = 2200 / 60 \Rightarrow$ **f_m = 36.66667 Hz.**

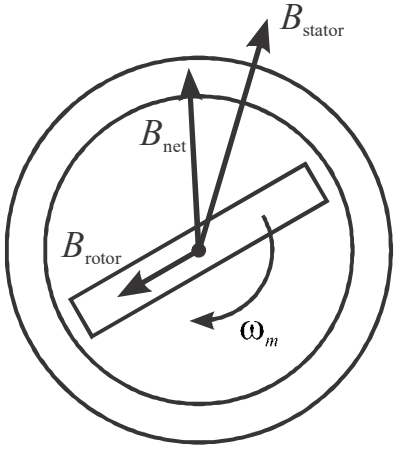
Per (2-11), $V_{LL} = \sqrt{3}\,V_\phi \Rightarrow V_\phi = V_{LL} / \sqrt{3} = 480 / \sqrt{3} \Rightarrow$ **V_ϕ = 277.128 V_{rms}.**

Per (4-39), $E_A = \sqrt{2}\,\pi\,N_C\,\phi\,f \Rightarrow \phi = \frac{E_A}{\sqrt{2}\,\pi\,N_C\,f} = \frac{277.128129}{\sqrt{2}\,\pi\,(180)36.6667}$

$\Rightarrow$ **ϕ = 0.00945087 Wb.**

f_m = **36.667 Hz** phase voltage = **277.13 V_{rms}** magnetic flux = **9.451 mWb**

c) A different AC machine has the magnetic flux densities and machine rotation as shown on the figure. Looking into the page, will the induced torque of the machine try to push the rotor clockwise (CW) or counterclockwise (CCW)? Is the machine a generator or motor? Why?



Per (4-46)/(4-49), $\tau_{ind} = k\,\overline{B}_R \times \overline{B}_S = k\,\overline{B}_R \times \overline{B}_{net} \Rightarrow$ in CW dir.

clockwise (CW) or counterclockwise (CCW)? generator or **motor**? (Circle correct answers)

Why? **Induced torque in same direction as machine rotation means we have a motor.**