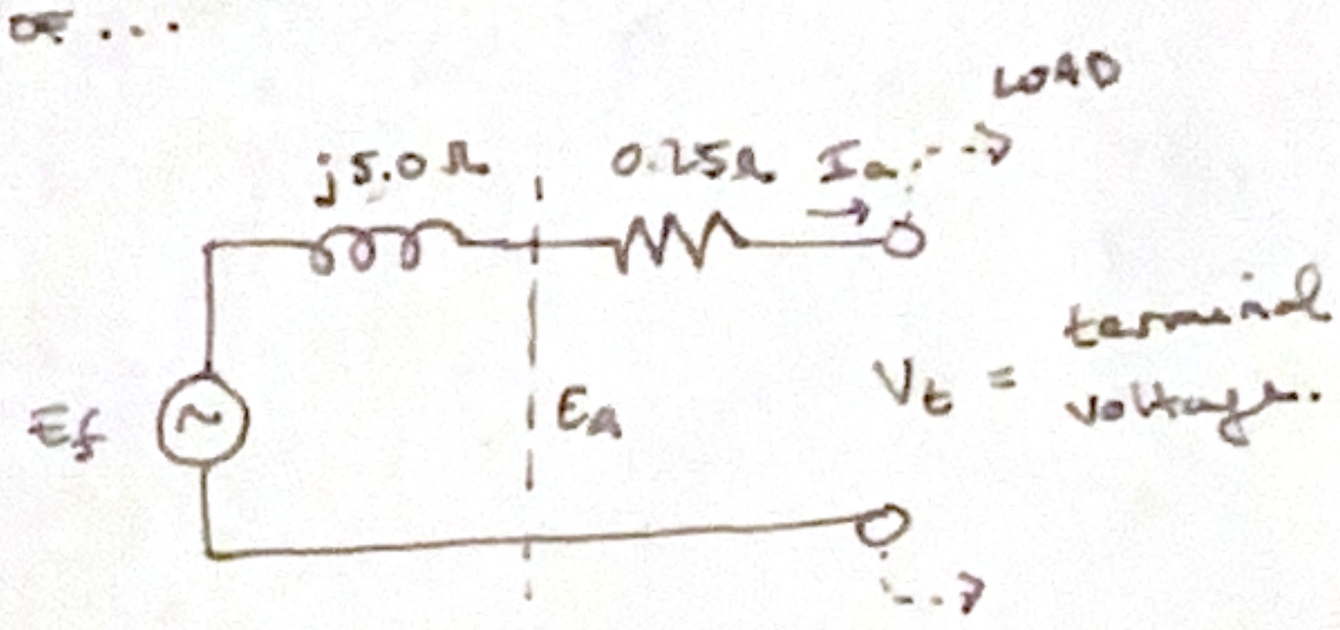
ECE385 — HW7 — CHASE LOTITO — 11/22/2024

(1) A 3ϕ, 10kVA, 220V, Y-CONNECTED SYNCHRONOUS GENERATOR HAS $R_a = 0.25\Omega$ PER PHASE AND $X_s = 5.0\Omega$ PER PHASE. DETERMINE THE EXCITATION VOLTAGE, E_f, WHEN THE GENERATOR IS DELIVERING FULL LOAD @ pf OF...



(A) pf = 0.85 lagging.

$S_{rated} = 10kVA$
$pf = 0.85$ lag.
$V_L = 220V$

FIRST, WE NEED THE PHASE VOLTAGE AT THE TERMINALS, V_t.

$$\underline{V_t} = \frac{1}{\sqrt{3}}(220V) = \underline{127V}.$$

FROM THIS WE CAN FIND THE CURRENT IN ONE PHASE, I_a, KNOWING THE RATED POWER 10kVA, and VOLTAGE $V_t = 127V$.

$$\Rightarrow \quad |S_{rated}| = 3|V_t||I_a| \rightarrow \underline{|I_a|} = \frac{|S_{rated}|}{3|V_t|} = \frac{10kVA}{3(127V)} = \underline{26.2A}$$

THE PHASE ANGLE $\rightarrow \theta = \cos^{-1}(0.85) = 31.8°$ $\rightarrow$ $\underline{\underline{I_a = 26.2\angle -31.8° A}}$

negative since current lags in lagging load.

KVL

$$-E_f + I_a(0.25 + j5.0) + V_t = 0$$

$$\Rightarrow E_f = (26.2\angle -31.8°)(0.25 + j5.0) + 127$$
$$= \boxed{228.65\angle 28.2° V}$$

(B) pf = 1.0

$\theta = \cos^{-1}(1.0) = 0°$ $\therefore$ $I_a = 26.2\angle 0° A.$

$$\Rightarrow E_f = (26.2\angle 0°)(0.25 + j5.0) + 127$$
$$= \boxed{187.1\angle 44.4° V}$$

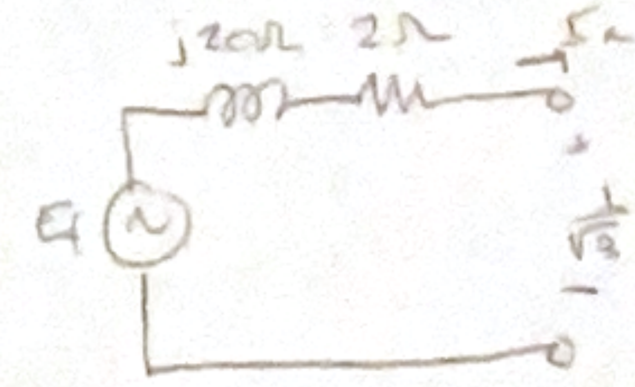
(C) pf = 0.8 leading

$\theta = \cos^{-1}(0.8) = 36.9°$, leading so current leads $\therefore$ $\theta_I = 36.9°$ as well $\therefore I_a = 26.2\angle 36.9° A$

$$\Rightarrow E_f = (26.2\angle 36.9°)(0.25 + j5.0) + 127$$
$$= \boxed{121.2\angle 63.8° A}$$

(2) A 3ϕ, 14 kV, 10 MVA, 60 Hz, 2 pole, 0.85 pf lagging, Y-CONNECTED SYNCHRONOUS GENERATOR HAS $X_s = 20\Omega$ PER PHASE AND $R_s = 2\Omega$ PER PHASE.

THE GENERATOR IS CONNECTED TO AN INFINITE BUS.



has no phase angle so really $V_t = 8.083\angle 0°$ kV

(A) DETERMINE THE EXCITATION VOLTAGE AT THE RATED CONDITION. DRAW THE PHASOR DIAGRAM.

$P = 2$
$pf = 0.85$ lag
$S_{rated} = 10$ MVA
$V_L = 14$ kV

$$V_t = \frac{1}{\sqrt{3}}(14kV) = 8083\,V$$

$$|I_a| = \frac{|S_{rated}|}{3|V_t|} = \frac{10MVA}{3(8.083kV)} = 412.4\,A$$

$$\theta_I = -\theta = -\cos^{-1}(0.85) = -31.8°$$

b/c lagging

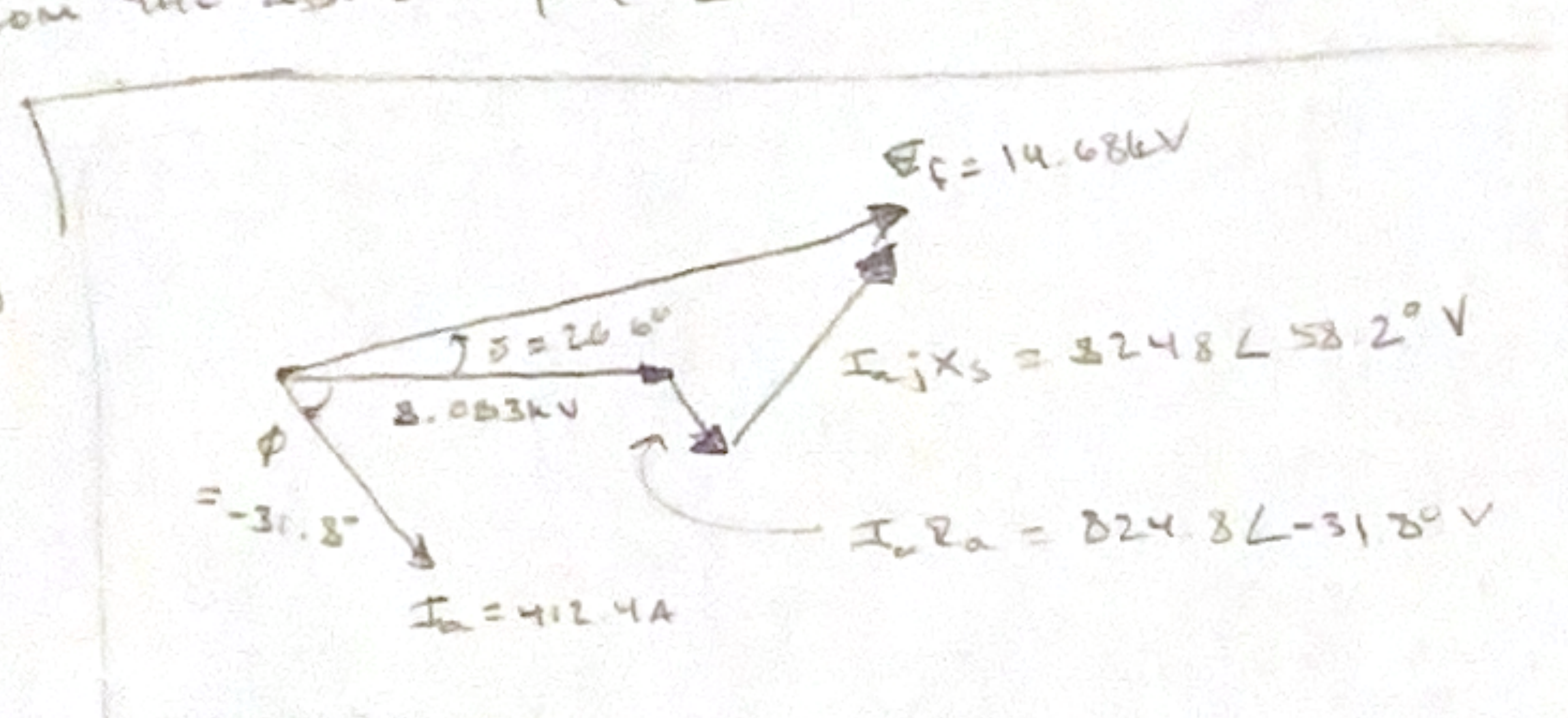
$$\underline{I_a = 412.4\angle -31.8°\ A}$$

$\boxed{KVL}$

$$E_f = (412.4\angle -31.8°)(2+j20) + 8.083kV$$
$$= \boxed{14.68\angle 26.6°\ kV}$$

FROM THE ABOVE $|E_f|\angle\delta° \Rightarrow |E_f| = 14.68kV,\ \delta = 26.6°$

$\boxed{\text{PHASOR DIAGRAM}}$



(B) DETERMINE POWER (TORQUE) ANGLE AT RATED CONDITION.

δ IS THE POWER TORQUE ANGLE, WHICH ABOVE $\boxed{\delta = 26.6°}$

(C) IF FIELD CURRENT IS CONSTANT, DETERMINE THE MAX POWER THE GENERATOR CAN SUPPLY.

$$P_{max} = \frac{3E_f V_t}{X_s} = \frac{3(14.68kV)(8.083kV)}{20\Omega} = \boxed{17.8\,MW}$$