ECEN 460 SPRING 2023 (Birchfield) Quiz 15 13 Apr 2023

Name: ______________________ UIN: __________ Section: _______ Score: _________

A 60 Hz generator is supplying 100 MW and 0 Mvar to an infinite bus (with 1.0 per-unit) through two parallel transmission lines. Each transmission line has a per-unit impedance (with 100 MVA base) of j0.06. The per-unit transient reactance for the machine is j0.02, and its inertia constant is 8 seconds. A fault occurs at time = 0 halfway down one of the lines. There is no damping.

$$\dot{\delta} = \omega$$

$$\frac{2H}{\omega_s}\dot{\omega} = T_M - \frac{E'V_s}{X_d' + X_{ep}}\sin(\delta - \theta_{vs}) - D \cdot \omega$$

Using the classical generator model with equations given above, determine the pre-fault internal voltage magnitude and angle of the generator $E'\angle\delta$, and find the pre-fault initial values of ω and the mechanical torque T_M. You do not need to write the equations after the fault or solve.

Before the event

The generator connects to a Thev. equiv. with $V_s\angle\theta_{vs} = 1.0\angle 0$ and $X_{ep} = j0.06||j0.06 = j0.03$

Solve the circuit for the generator internal voltage, which will give you E' and initial value of δ:

$I = \left(\frac{S}{V}\right)^* = \left(\frac{1.0}{1.0}\right)^* = 1.0$

$E'\angle\delta = 1.0 + (1.0)(j0.02 + j0.03) = 1.00125\angle 0.04996\ (rad)$

Now consider steady-state, to get $\omega = 0$

And $T_M = \frac{E'V_s}{X_d' + X_{ep}}\sin(\delta - \theta_{vs}) = \frac{1.00125 \cdot 1}{0.02+0.03}\sin(0.0499) = 1.0$