Homework #5

Questions 1-3: Problems 12.9-12.11 Saddat's "Power System Analysis" book

12.9. A generating unit has a simplified linearized AVR system as shown in Figure 12.52.

(a) Use the Routh-Hurwitz array (Appendix B.2.1) to find the range of K_A for control system stability.

(b) Use *MATLAB* **rlocus** function to obtain the root-locus plot.

(c) The amplifier gain is set to $K_A = 40$. Find the system closed-loop transfer function, and use *MATLAB* to obtain the step response.

(d) Construct the *SIMULINK* block diagram and obtain the step response.

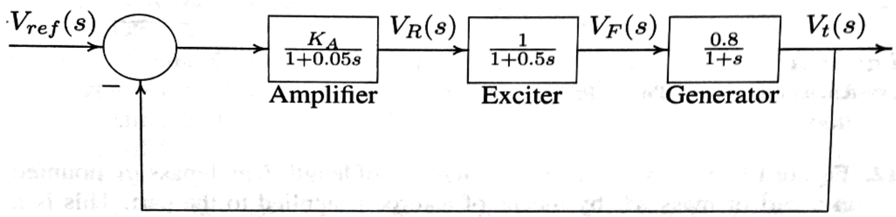

FIGURE 12.52
AVR system of Problem 12.9.

12.10. A rate feedback stabilizer is added to the AVR system of Problem 12.9 as shown in Figure 12.53. The stabilizer time constant is $\tau_F = 0.04$ second, and the derivative gain is adjusted to $K_F = 0.1$.

(a) Find the system closed-loop transfer function, and use *MATLAB* to obtain the step response.

(b) Construct the *SIMULINK* model, and obtain the step response.

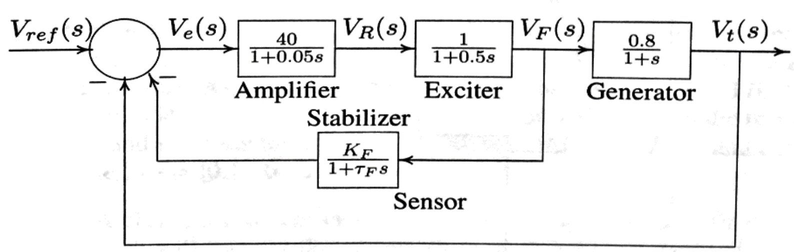

FIGURE 12.53
AVR system with rate feedback for Problem 12.10.

12.11. A PID controller is added in the forward path of the AVR system of Problem 12.9 as shown in Figure 12.54. Construct the *SIMULINK* model. Set the proportional gain K_P to 2.0, and adjust K_I and K_D until a step response with a minimum overshoot and a very small settling time is obtained (suggested values $K_P = 1$, $K_I = 0.15$, and $K_D = 0.17$).

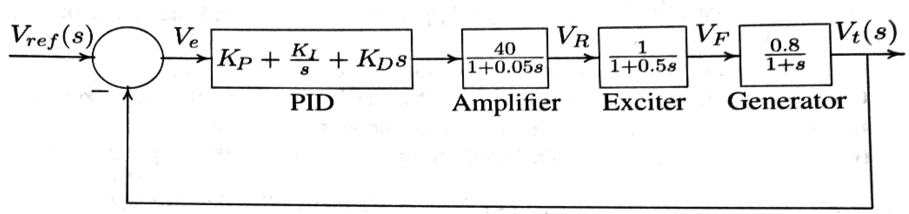

FIGURE 12.54
AVR system with PID controller for Problem 12.11.

Question 4: Assume the following parameters:

K_1=2.0 K_2=1.0 K_3=1.0 K_4=2.0 T_3=1.0 (s)

K_5= -0.1 K_6=0.3 T_R=0.02 (s) K_A=100 H=5.0 (s) K_D=0.0

T_W=10.0 (s) K_{STAB}=5

1) Calculate $K_{S(\Delta\psi fd)}$ and $K_{D(\Delta\psi fd)}$ without PSS for 0.4Hz oscillation frequency.
2) Design T_1 and T_2 for the PSS to satisfy both conditions below and prove your design by Bode plots about, e.g., G_{PSS}(s) and $G_{PSS}(s)\times K_AK_2K_3/(1+sT_3)$
   - At least +30° phase-lead compensation for the frequency range of 0.1Hz (0.63 rad/s) to 2.0Hz (6.3 rad/s)
   - Enabling a complete phase compensation for oscillation at the frequency of 0.4Hz.