

## Final Assignment for 《Automatic Control Systems》

The simplified excitation system of a generator is depicted in Fig.1. The excitation system is to keep the generator terminal voltage  $U_c$  at a certain value.

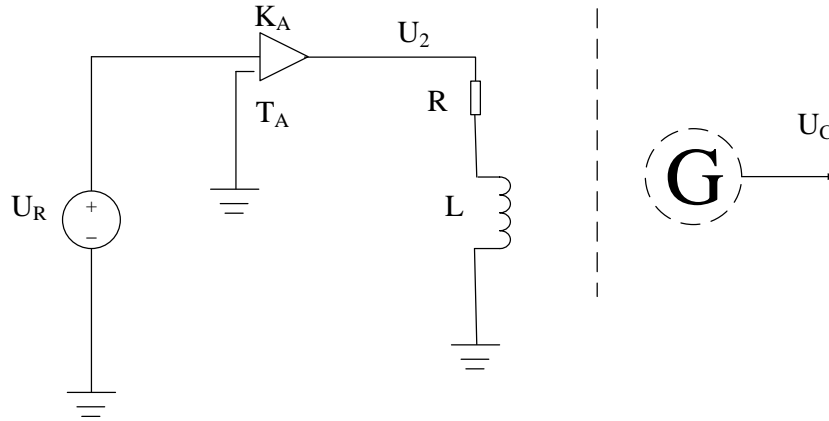
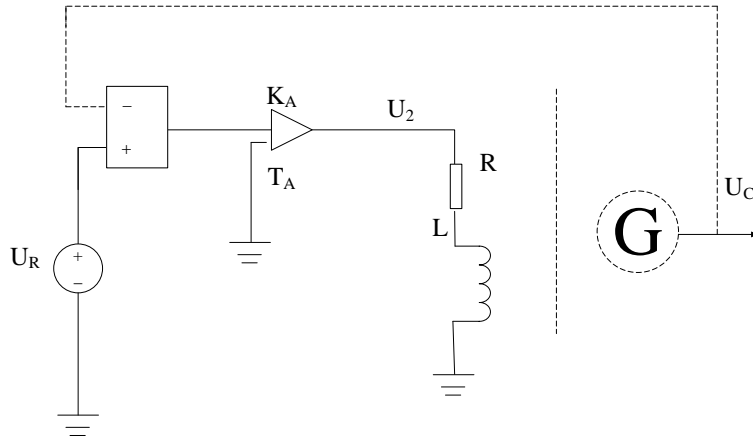


Fig 1 the excitation system of a generator

**The system is described as follows:**

- I : The  $U_R$  block represents a DC reference whose voltage is  $U_1(t)$  and its Laplace transform is  $U_1(s)$ .
- II : The exciter block is a proportional component. Due to its time delay, it should be regarded as an inertial block.  $U_2(s) = \frac{K_A}{1+T_A s} U_1(s)$ . ( $K_A=2$ ,  $T_A=0.02$ )
- III: The exciting coils block is described as  $U_2(t) = L \frac{di(t)}{dt} + Ri(t)$ . ( $L=5\text{mH}$ ,  $R=0.001 \Omega$ )
- IV: The generator is an inertial block  $\frac{K_G}{1+T_G s}$ . The input is the exciting current and the output is terminal voltage. ( $K_G=0.1$ ,  $T_G=4\text{s}$ )
- V: When a negative feedback from  $U_c$  to  $U_R$  is introduced, the system is shown as follows:



The feedback loop is represented as  $\frac{K_R}{1 + T_R s}$ . ( $K_R = 0.01$ ,  $T_R = 1$ )

### Please complete the following tasks:

- 1) Find the open loop transfer function from  $U_R$  to  $U_C$ ;
- 2) When the negative feedback is considered, please find the closed loop transfer function and construct the block diagram of the whole system;
- 3) Assess the stability of the system utilizing the Routh Criterion;
- 4) Obtain the impulse response and the step response of the whole system with MATLAB, and get the dynamic performance indices (including maximum overshoot, rise time, peak time, settling time and the steady-state error) of the system based on the step response.
- 5) Draw the root loci of the system utilizing MATLAB. Pay attention to the differences between the open loop transfer function and the closed loop transfer function.
- 6) Draw the Nyquist plot of the system utilizing MATLAB;
- 7) Draw the Bode plot of the system utilizing MATLAB;
- 8) To make the system's steady-state error be zero, please add a proper block to the system and design the appropriate parameters for the block. Then, reconstruct the block diagram of the whole system.

### Reference

- 1、 For question 1) and 2), please refer to chapter 2 of the textbook;
- 2、 For question 3) 4) and 5), please refer to chapter 3 of the textbook;
- 3、 For question 6) and 7), please refer to chapter 4 of the textbook;