《Automatic Control Systems》

1 Basic Concepts about Control System and Control Engineering

1.1 History of development of control theory;

1.2 Introduction to the course;

1.3 Basics about linear time invariant (LTI) systems;

2 Models of Control System

2.1 Linearization of a nonlinear system;

2.2 Ordinary differential equation (ODE) of a LTI system;

2.3 Laplace transformation and its properties;

2.4 Definition of a transfer function;

2.5 Obtaining the transfer function from system's ODE;

2.6 Drawing a block diagram;

2.7 Commonly used typical control blocks and their transfer functions;

2.8 Block diagram transformation;

2.9 signal-flow graph;

2.10 Mason Formula;

2.11 State space model of a linear control system;

2.12 Similarity transformation of a state equation;

2.13 State equation versus transfer function: from SE to TF;

2.14 Proof of the invariability of transfer function;

2.15 State equation versus transfer function: from TF to SE;

2.16 Controllability canonical form (CCF) and observability canonical from (OCF);

2.17 State diagram;

2.18 Using TF to solve the dynamic response of a system;

2.19 How to solve a state equation;

3 Time Domain Analysis of Control System

3.1 Introduction to basic concepts about system stability analysis;

3.2 Definition of Liapunov stability and its condition;

3.3 Definition of BIBO stability and its condition；

3.4 Routh-Hurwits criterion

3.5 Introduction to time domain analysis and definition of time response；

3.6 Test signals for time-domain response;

3.7 Performance specifications of steady-state response: steady-state error;

3.8 Type of control systems；

3.9 steady-state error of different systems under different test signals；

3.10 Impact of disturbance to steady-state error;

3.11 Impact of parameter variation to steady-state error;

3.12 Index of transient response；

3.13 Transient response of 1^{st} and 2^{nd} –Order system;

3.14 How to use Matlab to plot the dynamic response curve;

3.15 Approximation of High-Order systems;

3.16 Basic concept about root loci;

3.17 Magnitude condition and angle condition for being a root locus;

3.18 Properties and construction of root loci;

3.19 How to use Matlab to plot root loci;

3.20 Impact of poles and zeros to root loci;

4 Frequency Domain Analysis of Control System

4.1 Baics about frequency domain analysis and concepts of phase-frequency and magnitude-frequency curves;

4.2 Principle of Argument and Nyquist path;

4.3 Nyquist plot;

4.4 Nyquist criterion;

4.5 Definition of Bode plot;

4.6 Composing the Bode plot of a system;

4.7 How to sketch the magnitude-frequency plot;

4.8 How to sketch the angle-frequency plot;

4.9 Minimum-phase system;

4.10 Introduction to the relationship between frequency response and system stability;

4.11 Gain margin and phase margin on Bode plot;

4.12 Calculation of stability margin according to Bode plot;

4.13 Bode plots and properties of minimum-phase systems

5 Design of Control System

5.1 Design specifications;

5.2 Commonly used controller configuration;

5.3 Series compensation;

5.4 PID controller、phase-lag controller、phase-lead controller、lead-lag controller;

5.5 Control system design based on root loci, including:

5.6 How to determine the expected time-domain performance indices and desirable poles;

5.7 How to use root loci to design a controller;

5.8 Control system design based on frequency-domain methods, including how to determine the expected frequency-domain performance indices and desirable frequency response;

5.9 How to use frequency-domain characteristics to design a controller;

6 State Feedback Control System

6.1 Definition of controllability;

6.2 Controllability condition;

6.3 Controllability does not change after non-singular linear transformation;

6.4 Definition of observability;

6.5 Observability condition;

6.6 Controllability and observability versus Zero-Pole cancellation;

6.7 Controllability and observability decomposition;

6.8 Pole placement design through state feedback;

6.9 State observer;

6.10 The state feedback controller with feedback states from an observer;

7 Discrete Control System

7.1 Sample-and-hold of digital control system;

7.2 Definition, properties and calculation of Z transformation;

7.3 Modeling of discrete control system, including:
difference equation, pulse-transfer function and discretization of a continuous system;

7.4 Analysis of a discrete-data system, including:
Stability of a discrete-data system; Steady-state error of a discrete-data system;Dynamic response of a discrete-data system; Controllability and observability;

7.5 Design of a discrete-data system controller, including methods for continuous systemand discrete-data system;

7.6 Pole placement through state feedback;