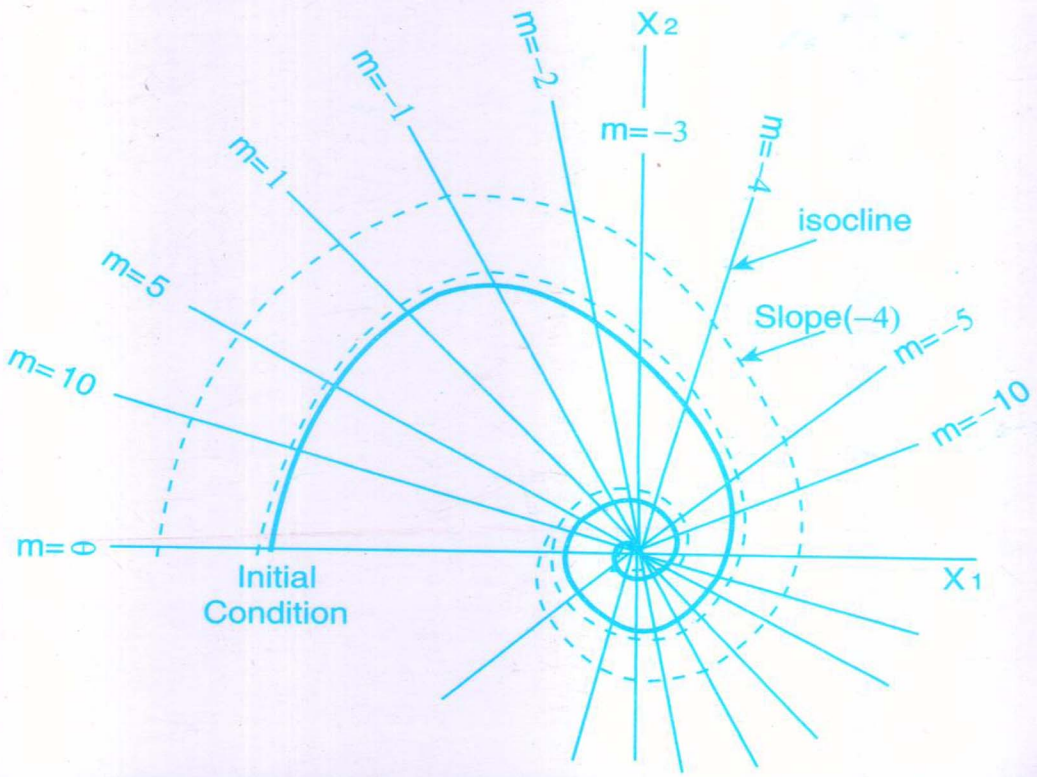
Control System Design

B.S. Manke



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CONTROL SYSTEM DESIGN

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To my grandsons
Aadhit
and
Abhyudit

Preface

The introductory course in Control System Analysis is covered in the final/prefinal year engineering classes. As per the development in the field of control systems this subject is shifted to lower semester classes. Additional concepts have been introduced for higher semester classes. The purpose of this book is to present these concepts in a simple and concise manner.

The matter presented in this book is in addition to the course contents of the subjects basic control systems and therefore this book serves as a companion book.

It is presumed that the reader is well versed with the knowledge of basic control systems. The contents of this book are suitably framed to meet requirements at a slightly higher level than that of introductory course on Control System Analysis.

The material contained in this book covers the course contents of the syllabus for the subject Control System II prescribed by Indian Universities. The book contains following chapters :

Chapter 1 deals with the compensation network design. Non-linear control systems, the method of analysis through phase-plane describing function method is given in chapter 2. The analysis and design aspects based on state variable approach are presented in chapter 3. The discrete time control systems form the basis for the study of digital control systems. Chapter 4 covers the frequency response, root locus analysis and stability considerations for discrete-time control systems. Introduction to state variable model formulation of discrete-time control systems have been included. The stability analysis based on Liapunov method is given in chapter 5. Theory is ably supported by suitable numerical examples.

The author wishes to express his thanks to all concerned who helped him in the preparation of this book.

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April 2007 B.S. MANKE

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1

Compensation of Feed Back Control Systems

1.1. INTRODUCTION

The design objective of the components of a control system is to meet the desired performance specification requirements which are concerning time response, accuracy and relative stability.

These specifications are generally given in terms of numerical values or in the form of qualitative data. During the design process these requirements may have to be marginally adjusted to some tolerable extent, because, it may not be conveniently possible to satisfy all the given specifications at one time. For example, if the steady state error has to be given preference, then the time response specification are to be modified to some extent. The ultimate purpose of the design process is to have optimal system for given purpose.

Once the preliminary analysis is done, the next step towards designing a system is to select one of many possible alternatives that meets the desired specifications.

To get the desired performance characteristic of a control system, it becomes necessary to insert a compensation network in the system. The design of a compensator is carried out in time domain or frequency domain, as decided by the specifications given. The root locus approach is used if the time response specifications are given. Bode plot approach is used if frequency domain specifications are given.

The time response specifications are :

(1) rise time, t_r

(2) settling time, t_s

(3) damping ratio, ζ

(4) steady state error, e_{ss}

(5) % maximum overshoot, $\% M_p$

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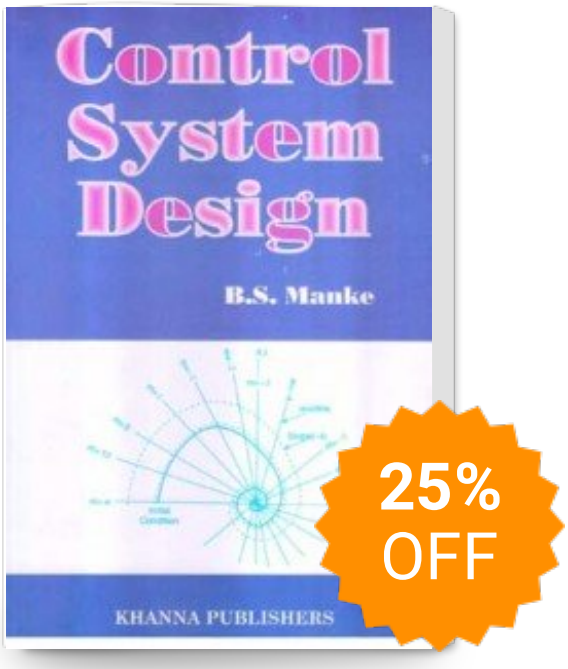

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