

---

Practical

# MOTION CONTROL

for Engineers & Technicians



## YOU WILL LEARN HOW TO:

- Design and troubleshoot a complete motion control system
- Apply their new knowledge of servo's to motion control applications
- Troubleshoot servo systems
- Size and select the appropriate drives/amplifiers/servos/steppers for your application
- Apply the concepts of load, inertia, force and real time to motion control problems
- Understand concepts such as backlash, static/running friction, resolution, stiffness, speed and torque
- Design and troubleshoot six basic motor types for motion control

## WHO SHOULD ATTEND:

- Control and Instrumentation Engineers and Technicians
- Electrical Engineers
- Instrumentation and Control Engineers/Technicians
- Process Control Engineers
- Electronic Engineers
- System Integrators
- Designers
- Design Engineers
- Systems Engineers
- Test Engineers
- Electronic Technicians
- Consulting Engineers



*Technology Training that Works*

## THE WORKSHOP

This workshop is designed for personnel who need to apply motion control technology as productively and economically as possible. This practical course initially examines the basic building blocks and design tools to implement motion control systems. Fundamental concepts of load, inertia, force and real time will be discussed. The various factors such as performance limitations and costs that impact the selection of electro hydraulic, pneumatic, electromechanical technologies are examined. Servo basics are then examined in detail giving you the practical tools in which to work with these systems.

The electrical and mechanical characteristics important in tying together the drive and motor to the mechanical device are then reviewed from a practical perspective. The basic motors used in motion control such as DC and AC motors, stepper and servo motors and their applications, are also examined. These motors range from small instrumentation motors to the robust ac induction motors to the stepper motors used in open loop control.

### PRE-REQUISITES

This is not an advanced course, but one aimed at the fundamentals. A basic working knowledge of electrical engineering concepts is useful but not essential as there will be a brief revision at the commencement of the class.

## WORKSHOP OBJECTIVES

At the end of this workshop participants will be able to:

- design and troubleshoot a complete motion control system
- apply their new knowledge of servo's to motion control applications
- troubleshoot servo systems
- size and select the appropriate drives/amplifiers/servo's/steppers for your application
- apply the concepts of load, inertia, force and real time to motion control problems
- understand concepts such as backlash, static/running friction, resolution, stiffness, speed and torque
- design and troubleshoot six basic motor types for motion control

## PRACTICAL SESSIONS

There are four practical exercises which you will undertake over the two days.

## THE PROGRAM

### DAY ONE

#### FUNDAMENTALS OF MOTION CONTROL

- Definition of Motion Control
- Fundamental concepts
- Engineering practices and techniques

#### MOTION CONTROL TECHNOLOGIES

- Hydraulics
- Pneumatics
- Electromechanical
- Mechanical

#### MOTION CONTROL SYSTEM LOOPS

- Open and closed systems
- Block Diagrams
- Implementation of a control system
- Event controlled systems  
PID Controls

#### SELECTION OF THE FEEDBACK

- Analog vs digital, incremental vs absolute feedback
- Resolution and bandwidth considerations

#### MECHANICAL TRANSFORMATION DEVICES

- Reflecting loads through the transformer
- Other transforming devices
- Gears
- Conveyers-Elevators
- Inertia at the shaft
- Belts and pulleys

#### LOAD/SYSTEM ANALYSIS

- Motor/Load Considerations
- Stability/Bandwidth Considerations
- Inertia Calculations
- Estimating Design Alternatives
- PWM vs analog vs linear

### DAY TWO

#### SERVO BASICS

- Basic Gain Equations
- Selecting System Components of a servo system
- Criteria for Motor
- Criteria for Amplifier
- Criteria for Encoder
- Criteria for Coupling
- Criteria for Controller
- Command Generation
- Feedback
- Type 0,1,2 Servo's
- Bode diagrams made easy
- Predicting servo response
- Characteristics of a motor for servo's

#### SERVO RESPONSES

- Sinusoidal inputs
- Step inputs
- Performance Prediction
- Importance of gain setting
- Feedforward
- Type 2 Systems
- PID in a servo
- Stability criteria in a servo
- Load effects on Stability
- S Curves and their application

### DAY TWO cont.

#### INTRODUCTION TO BASICS OF DRIVES

- DC/AC - Analog/Digital
- Drive classifications
- Drive Motor characteristics
- Drive Motor equations
- Amplifiers and types
- Compensating techniques
- Drive Speed and Acceleration
- Drive thrust and torque
- Drive inertia considerations
- Drive ratios

#### ADVANCED CONSIDERATIONS OF DRIVES

- Performance, stiffness, resolution, friction
- Duty Cycle
- Drive sizing

#### OPERATION OF ELECTRIC MOTORS

- Types of Motors
- DC Motors  
(permanent/armature/field/commutation/brush vs brushless)
- AC Motors  
(induction/synchronous/universal)
- Stepper Motors  
(indexers/sequencers/microstepping)
- Miscellaneous Types
- Characterising motors (torque-speed/data sheets)

#### BRUSH AC MOTORS

- Commutation
- Figures of Merit
- Motor Drivers
- Performance
- Data Sheets
- Applications

#### AC INDUCTION MOTORS

- Commutation
- Figures of Merit
- Motor Drivers
- Performance
- Data Sheets
- Applications

#### BRUSHLESS DC MOTORS

- Commutation
- Figures of Merit
- Motor Drivers
- Performance
- Data Sheets
- Applications

#### STEPPER MOTORS

- Commutation
- Figures of Merit
- Motor Drivers
- Performance
- Data Sheets
- Applications

#### LINEAR MOTORS

- Commutation
- Figures of Merit
- Motor Drivers
- Performance
- Data Sheets
- Applications

#### MULTI AXIS CONTROL

- Splines, circles and linear motion coordination
- Multi axis data handling - software

#### LATEST DESIGN APPLICATIONS AND TECHNIQUES

- Solving your real time systems motion control problem
- Position control
- Linear and circular Motion motion
- Master/slave control
- Electronic Gearing
- Dual Loops to eliminate backlash
- Tension Control Systems