Advanced Control Engineer

Alternate Titles: Advanced Process Control Engineer, Optimization Engineer, Simulation Engineer

Description: Advanced Control Engineers develop control strategies and apply models and advanced control tools to improve production unit performance. Models are used for exploration, discovery, quantification, demonstration, testing, training, and implementation of advanced solutions for sustainable manufacturing. Some of the advanced solutions are adaptive control, batch profile control, dynamic scheduling, smart PID features and techniques, model based control, neural networks, multivariate statistical process control, and real time optimization. These engineers analyze the process for an increase in capacity, efficiency, environmental protection, flexibility, quality, and yield and devise advanced solutions that directly achieve the desired results.

Sources of Material: *Automation Body of Knowledge (ABoK), Advanced Control Unleashed, Advances in Bioprocess Modeling and Control, Plantwide Process Control* (Luyben et al.)

Performance Domains:

Domain I: Advanced PID control

Domain II: Modeling

Domain III: Model Based Control

Domain IV: Real Time Optimization

Domain I: Advanced PID Control

Task: Develop and apply PID control strategies and techniques to improve process performance.

Knowledge of:

First principle process relationships in unit operations
PID form and structures
Dynamic reset limiting

Self-regulating, integrating, and runaway process dynamics
Effect on process dynamics on PID tuning and loop performance
Equivalent deadtime from measurement lags, filters, update time, and threshold sensitivity
Equivalent deadtime from analyzer sample and cycle time
Equivalent deadtime from valve stiction and backlash and actuator-position threshold sensitivity
Automation system dynamics and the effect on PID tuning and loop performance
Feedforward Control
Override Control
Valve Position Control

Skill in:

Running process simulations to find process relationships
Selection of PID options
Tuning of PID parameters including filter time, gain, reset, rate, and velocity limits
Calculation of online process metrics
Using auto tuners and adaptive control
Calculation of rate of change signals for batch profile control and integrating processes
Calculation of feedforward signals
Estimation of process dynamics
Estimation of automation system dynamics
Estimation of loop performance metrics
Dynamic compensation of feedforward signals
Selection and pairing of manipulated and controlled variables
Configuration of control strategies
Configuration of feedforward, override, and valve position control

Domain II: Modeling

Task: Develop and apply models to identify opportunities to improve process performance, learn process relationships, develop and test process control strategies, predict product composition and quality, estimate batch end points and cycle time, identify abnormal conditions, provide inferential measurements, train operations, and provide model based control.

Knowledge of:

Physical properties
First principle material, energy, component, charge, and momentum balances
Process metrics for unit operations
Product quality analysis
Automation system dynamics location and quantification
Partial least squares
Step testing
Pseudo random binary sequence

Multivariate statistical process control
Neural Networks

Skill in:

Configuring and programming dynamic simulations
Calculating process metrics online
Calculating inferential measurements
Identifying and applying dynamic linear estimators
Using principle component analysis (PCA) software
Using projection to latent structures (PLS) software
Identifying and applying neural network software

Domain III: Model Based Control

Task: Develop and embed first principle and experimental models in process controllers. These controllers use specialized algorithms or industry packages for multivariable predictive control.

Knowledge of:

Modeling
Partial least squares
Linear superposition
Interactions
Matrix condition number
Matrix math
Control horizon
Final resting values
Penalty on move (move suppression)
Penalty on error
Vector rotation (integrating processes)

Skill in:

Configuring or programming models and special control algorithms
Designing multivariable control strategies
Using process identification software
Using multivariable predictive control software
Commissioning, tuning, and maintaining model based control applications

Domain IV: Optimization

Task: Use solutions of optimum operating point for supervisory control of PID setpoints or model based control targets.

Knowledge of:

Modeling
Model based control
Data reconciliation
Key Performance Indicators (KPI)
Optimization techniques
High fidelity process models
Open equation models
Logistics
Operations research
Forecasting
Energy markets
Stochastic processes

Skill in:

Software development
Setting up, commissioning, tuning, and maintaining mixed integer linear/nonlinear programs
Setting up, commissioning, reconciling, and maintaining real time optimization programs
Stochastic Optimization
Dynamic Scheduling

The writing of real time optimization programs is generally in the domain of process engineers specializing in high fidelity steady state process simulations but in some cases is an extension of high level multivariable predictive control skills.