

ME 481: Control Systems

This is a cooperative course taught jointly by WSU and the University of Idaho.

<i>Course description:</i>	Analysis and design of feedback control systems.
<i>Number of credits:</i>	3
<i>Course Coordinator:</i>	M. Luo
<i>Prerequisites by course:</i>	ME 348
<i>Prerequisites by topic:</i>	<ol style="list-style-type: none">1. Ordinary differential equations and their solutions.2. Matlab
<i>Postrequisites:</i>	None
<i>Textbooks/other required materials:</i>	Gene F. Franklin, J. David Powell, and Abbas Emami-Naeini, <i>Feedback Control of Dynamic Systems, 8th Ed.</i> , Upper Saddle River, NJ: Pearson Prentice-Hall, 2018. ISBN: 978-0134685717.
<i>Course objectives:</i>	<ol style="list-style-type: none">1. Become familiar with using Laplace transforms to create transfer functions of dynamic systems comprised of electrical and mechanical components.2. Investigate stability and response characteristics of a system by inspection of the transfer function.3. Use basic control approaches including Proportional-Integral-Derivative (PID) control and lead-lag compensation to meet closed-loop performance specifications.4. Analyze dynamic systems and develop controllers using root locus techniques.5. Determine the frequency response of a system and use Bode plots and other visualization tools to synthesize appropriate controllers and test stability.6. Obtain intuition for how mathematical descriptions of control system relate to physical behaviors.7. Achieve the system identification with data acquisition toolbox.8. Achieve online feedback control with microcontroller (Arduino/Teensy).
<i>Topics covered:</i>	<ol style="list-style-type: none">1. Control systems, advantages and disadvantages of open loop, feed-forward and feedback controls.2. Review of Laplace Transformations, Inverse Laplace transformations.3. Mechanical modeling of dynamics systems in terms of input-output and state-space models.4. Transfer functions, Block diagram representations in Laplace and time domains.5. Transient response of first and second order systems.6. Proportional, integral, and derivative control actions.7. Stability of feedback systems, Routh stability analysis.8. Root Locus Analysis.9. Series and parallel compensation.10. Bode diagrams.11. State space representations, and conversions from one representation to another.12. State transition matrix and its properties.13. Controller design by pole placement.

Expected student outcomes:

1. Model simple mechanical, electrical, hydraulic and other systems with ordinary differential equations.
2. Graphically represent these models by block diagrams in time and frequency domain.
3. Represent these models in input-output, transfer function or transfer matrix and various state-space forms.
4. Transform or convert given model representations into a different canonical form.
5. Determine system parameters from given performance specifications for a second order system.
6. Determine impulse, step, and ramp response and infer system performance from these.
7. Perform Routh stability and relative stability analysis.
8. Plot root-locus diagram and infer system behavior from it.
9. Design PID controller.
10. Design lead, lag, or lead-lag compensator using root-locus or Bode plots.

Class schedule:

Three 50-minute lecture sessions per week, for one semester.

Laboratory schedule:

None.

Contribution to meeting the professional component:

Engineering Topics

Relationship of course to program objectives:

Meets:
ABET EC2024, Criterion 3 program outcomes: 1, 2, 7

Reviewed by: Teresa Fuller and M. Luo

Date: Sep 20, 2024