COURSE NUMBER: Vm461	**COURSE TITLE:** Automatic Control
CREDIT: 3	**PREREQUISITES:** Vm360
TEXTBOOKS/REQUIRED MATERIAL: Feedback Control of Dynamic Systems (8th edition), 2018, ISBN: 978-01346857173, by Franklin, Powell & Emami-Naeini; Control Tutorials for Matlab & Simulink by Messner & Tilbury (ctms.engin.umich.edu/)	**PREPARED BY:** Lei Shao **DATE OF PREPARATION:** July, 2018 **DATE OF UC APPROVAL: July, 2018**
INSTRUCTOR(S): Lei Shao	**SCIENCE/DESIGN:** n/a
CATALOG DESCRIPTION: Feedback control design and analysis for linear dynamic systems with emphasis on mechanical engineering applications such as autonomous vehicles, drones, motors, nano/micro-mechanical systems; transient and frequency response; root locus, Nyquist and Bode plot; stability; system performance; control modes; state space; digital control; computer methods for simulation of control systems.	**COURSE TOPICS:** 1. Introduction and review of mathematical foundation 2. Modeling of systems and control specifications 3. PID controllers 4. Stability 5. Root locus method for control design 6. Frequency response methods 7. Controller design techniques 8. State-space method 9. Digital control 10. Computer methods for analysis and simulation of dynamic systems
COURSE STRUCTURE/SCHEDULE: Lecture: two times per week; each time 90 minutes	

COURSE OBJECTIVES [Course Outcomes in brackets]	1. To teach students develop mathematical models of mechanical, electrical, thermo-fluid, and multi-physics systems; [1, 2, 3, 6, 7] 2. To introduce concepts for expressing control specifications; [4, 5] 3. To teach various design skills of feedback compensators to achieve control specifications; [6, 7, 8, 9] 4. To teach students determine system performance including stability, sensitivity, robustness, etc.; [8, 9, 10, 12] 5. To provide basic concepts of digital implementation of feedback control systems; [11, 12] 6. To teach the use of software tools to model, analyze, and simulate control system performance. [11, 12, 13] 7. To promote students' interest in real-world control applications and prepare for postgraduate career. [1, 2, 13]
COURSE OUTCOMES [Program Outcomes in brackets]	After completing Vm461, students should be able to: 1. Identity a linear, time-invariant control application given a real-world single-physics or multi-physics mechanical system; [a, d, e, j, k] 2. Obtain the differential equation and transfer function of a control application; [a, e, k] 3. Draw block diagram with feedback and find closed-loop transfer function; [a, e, k] 4. Translate descriptions of desired performance characteristics of a mechanical system into control specifications; [a, e, k] 5. Translate time-domain specifications into frequency-domain requirements; [a, e, k] 6. Determine steady-state error to step and ramp inputs with disturbances; [a, e, k] 7. Given a system transfer function, find time-domain behaviors (impulse, step and frequency response); [a, e, k] 8. Design PI, PD, PID, lead, and lag compensators to meet control goals; [a, c, e, k] 9. Use root locus, Nyquist and Bode techniques to modify properties of a control system; [a, c, e, k] 10. Design state-space controllers to meet control goals; [a, e, k] 11. Use software tools to translate continuous-time controllers into digital equivalent; [a, e, k] 12. Simulate system behavior using software tools; [a, e, k] 13. Work on a real-world engineering problem and present a complete engineering solution with introduction, motivation, method, results, discussion, and conclusion. [a, c, d, e, g, i, j, k]
ASSESSMENT TOOLS [Course Outcomes in brackets]	1. Homework problems; [1-12] 2. Course projects; [1-5, 8-13] 3. Exams. [1-10]