Technical Elective/First Year Graduate Course

Catalog Data:  (3-0.5) 3.5 credits. Prerequisites: EE 451 or equivalent completed with a grade of –C or better. This course acts as an introduction to multivariate control system design for continuous time systems. Topics covered include: state variables, controllability, observability, stabilization, response shaping, and linear observers for multivariate systems.

Prerequisites: EE 451 and background in:
- Basic matrix operations
- Basic understanding of State Space representations
- Basic knowledge of stability analysis
- Block diagrams
- Frequency domain modeling and Laplace analysis


Chapter Order: Linear Algebra Overview, {1, 2}(quick review), 3, 4, 5, 6, 7, 8.


Instructor: Dr. C. R. Tolle   EP 323 394-6133 charles.tolle@sdsmt.edu

Office Hours: MWF 3:00pm-4:00pm, T 8:00am-9:00am, or by appointment.

Lecture: Section 01 EP 342 9:00pm-9:50pm MWF

Goals: The student completing the course should be able to understand basic concepts of Multivariate control systems, e.g. observability, controllability, full state feedback stabilization, basic observers, etc.
**Tentative Grading:**

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<tr>
<th>Component</th>
<th>Percentage</th>
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<tr>
<td>Attendance, Participation, and Professionalism</td>
<td>5%</td>
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<td>Homework/Labs/Quizzes</td>
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<td>Term Project</td>
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<td>3 Mid Terms (20% each)</td>
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The instructor reserves the right to modify this grading breakdown if warranted.

Grades will be assigned according to natural grade groupings. However, it is anticipated that the following scale will be used to assign final grades.

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<th>Grade</th>
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The instructor reserves the right to modify this scale if warranted.

**Topics:**

- State Space Representations
- Dynamics of Linear Systems
- Frequency-Domain Analysis
- Controllability and Observability
- Shaping a System’s Dynamic Response
- Linear Observers
- The Separation Principle for Compensator Design

**General Policies:** Students are encouraged to work together on assigned homework problems. However, all homework, projects, and tests must not be plagiarized (from any source – even your classmates). Plagiarism is on the rise and it is not acceptable in any form! If caught plagiarizing, you will receive an F for the course and referred to the Department Head and Dean for further action. In short, you are expected to accomplish your own work! When using other's works, cite them! Make-up tests will not be given unless a prior arrangement is made with the instructor. Students have two weeks following the return of any graded material to appeal the score.

Note that according to “Policy Governing Academic Integrity” in the SDSM&T Undergraduate Catalog, the instructor of record for this course has discretion of how acts of academic dishonesty are penalized, subject to the appeal process, and that “Penalties may range from requiring the student to repeat the work in question to failure in the course” (72-73).

Assigned work will be due on at the start of class on the due date unless otherwise stated. Late work will receive up to ½ credit within one week of due date, i.e. up to the start of class one week later. After that time, late homework will not be accepted without the permission of the instructor.

**Freedom in learning:** Students are responsible for learning the content of any course of study in which they are enrolled. Under Board of Regents and University policy, student academic performance shall be evaluated solely on an academic basis and students should be free to take reasoned exception to the data or views offered in any course of study. Students who believe that an academic evaluation is unrelated to academic standards but is related instead to judgment of their personal opinion or conduct should contact the dean of the college which offers the class to initiate a review of the evaluation.

**ADA note:** Students with special needs or requiring special accommodations should contact the instructor and/or the campus ADA coordinator, Ms. Jolie McCoy, at 394-1924 at the earliest opportunity.
OUTCOMES:
Upon completion of this course, students should demonstrate the ability to:
1. Use state variable models to represent a system.
2. Understand the state transition matrix
3. Convert a system between the various state-space canonical forms
4. Understand meaning of singular values within the context of a multivariable input multivariable (MIMO) state-space system
5. Determine the controllability of a MIMO state-space system
6. Determine the observability of a MIMO state-space system
7. Reshape a system's dynamic response using full state-feedback
8. Design and construct linear observers
9. Be comfortable using Matlab as an analytical tool.
10. Using the separation principle design full-state observes combined with full-state controllers to compensate controllable and observable systems.
* as time permits

RELATION OF COURSE TO PROGRAM OBJECTIVES:
These course outcomes fulfill the following program objectives:
(a) An ability to apply knowledge of mathematics, science, and engineering.
(b) An ability to design and conduct experiments, as well as to analyze and interpret data.
(c) An ability to design a system, component, or process to meet desired needs.
(d) An ability to function on multi-disciplinary teams.
(e) An ability to identify, formulate, and solve engineering problems.
(f) An understanding of professional and ethical responsibility.
(g) An ability to communicate effectively.
(h) The broad education necessary to understand the impact of engineering solutions in a global and societal context.
(i) A recognition of the need for, and an ability to engage in life-long learning.
(j) A knowledge of contemporary issues.
(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
The following table indicates the relative strengths of each course outcome in addressing the program objectives listed above (on a scale of 1 to 4 where 4 indicates a strong emphasis).

<table>
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<tr>
<th>Outcomes Objectives</th>
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**ABET category** contents estimated by faculty member who prepared this course description:
- Engineering Science – 1.5 credits, or 50%
- Engineering Design - 1.5 credits, or 50%

**Prepared By:**
Charles R. Tolle, Date: last update Aug. 28, 2010