

MAR 20 2013

# FLORIDA ATLANTIC UNIVERSITY™

## Graduate Programs—NEW COURSE PROPOSAL

UGPC APPROVAL \_\_\_\_\_  
 UFS APPROVAL \_\_\_\_\_  
 SCNS SUBMITTAL \_\_\_\_\_  
 CONFIRMED \_\_\_\_\_  
 BANNER POSTED \_\_\_\_\_  
 CATALOG \_\_\_\_\_

DEPARTMENT NAME: COMPUTER & ELECTRICAL ENGINEERING & COMPUTER SCIENCE  
 COLLEGE OF: Engineering and Computer Science

RECOMMENDED COURSE IDENTIFICATION:  
 PREFIX EEL COURSE NUMBER 5613 LAB CODE (L or C) \_\_\_\_\_  
 (TO OBTAIN A COURSE NUMBER, CONTACT M.JENNING@FAU.EDU)  
 COMPLETE COURSE TITLE MODERN CONTROL

**EFFECTIVE DATE**  
 THIS TERM COURSE WILL BE OFFERED:  
FALL 2013

CREDITS: 3 TEXTBOOK INFORMATION: LINEAR SYSTEM THEORY AND DESIGN, INTERNATIONAL 3RD. EDITION, C-T CHEN, OXFORD UNIVERSITY PRESS, FEBRUARY 9, 2009.

GRADING (SELECT ONLY ONE GRADING OPTION): REGULAR X SATISFACTORY/UNSATISFACTORY \_\_\_\_\_

COURSE DESCRIPTION, NO MORE THAN 3 LINES: FUNDAMENTALS OF LINEAR SYSTEMS THEORY AND PRACTICE AS APPLIED TO MULTI-INPUT AND MULTI-OUTPUT FEEDBACK CONTROL SYSTEMS: STATE VARIABLE MODELS, STABILITY, CONTROLLABILITY, OBSERVABILITY, STATE FEEDBACK AND ESTIMATION, LINEAR QUADRATIC REGULATORS, COMPUTER AIDED ANALYSIS AND DESIGN (USING MATLAB CONTROL SYSTEMS TOOLBOX)

PREREQUISITES: LINEAR ALGEBRA OR ENGINEERING GRADUATE STANDING  
 COREQUISITES: N/A  
 OTHER REGISTRATION CONTROLS (MAJOR, COLLEGE, LEVEL):

**PREREQUISITES, COREQUISITES & REGISTRATION CONTROLS SHOWN ABOVE WILL BE ENFORCED FOR ALL COURSE SECTIONS.**

MINIMUM QUALIFICATIONS NEEDED TO TEACH THIS COURSE: PHD IN ENGINEERING

Other departments, colleges that might be affected by the new course must be consulted. List entities that have been consulted and attach written comments from each. N/A

Hanqi Zhuang, zhuang@fau.edu, 73413  
 Faculty Contact, Email, Complete Phone Number

### SIGNATURES

### SUPPORTING MATERIALS

Approved by: \_\_\_\_\_  
 Department Chair: [Signature]  
 College Curriculum Chair: William T. Rhodes  
 College Dean: [Signature]  
 UGPC Chair: Nancy Kaye Parr  
 Dean of the Graduate College: [Signature]

Date: 9/12/12  
2/5/13  
3/7/2013  
3/22/2013  
4/3/13

Syllabus—must include all details as shown in the UGPC Guidelines.  
 To access Guidelines and download this form, go to: <http://www.fau.edu/graduate/facultyandstaff/programs/committee/index.php>  
 Written Consent—required from all departments affected.

Email this form and syllabus to [diamond@fau.edu](mailto:diamond@fau.edu) one week **before** the University Graduate Programs Committee meeting so that materials may be viewed on the UGPC website by committee members prior to the meeting.

**Department of Computer & Electrical Engineering & Computer Science  
Florida Atlantic University  
Course Syllabus**

<i>Student learning outcomes &amp; relationship to ABET a-k objectives</i>	
<b>8. Course evaluation method</b>	
Homework: 20% Computer-aided Design Projects: 20% Tests: 60%	
<b>9. Course grading scale</b>	
Grading Scale: 90 and above: "A", 87-89: "A-", 83-86: "B+", 80-82: "B", 77-79: "B-", 73-76: "C+", 70-72: "C", 67-69: "C-", 63-66: "D+", 60-62: "D", 51-59: "D-", 50 and below: "F."	
<b>10. Policy on makeup tests, late work, and incompletes</b>	
<i>Makeup tests</i> are given only if there is solid evidence of a medical or other serious emergency that prevented the student from participating in the exam. Makeup exam will be administered and proctored by department personnel unless there are other pre-approved arrangements	
<i>Late work</i> is not acceptable.	
Unless there is solid evidence of medical or otherwise serious emergency situation incomplete grades will not be given.	
<b>11. Special course requirements</b>	
N/A	
<b>12. Classroom etiquette policy</b>	
University policy requires that in order to enhance and maintain a productive atmosphere for education, personal communication devices, such as cellular phones and laptops, are to be disabled in class sessions.	
<b>13. Disability policy statement</b>	
In compliance with the Americans with Disabilities Act (ADA), students who require special accommodations due to a disability to properly execute coursework must register with the Office for Students with Disabilities (OSD) located in Boca Raton campus, SU 133 (561) 297-3880 and follow all OSD procedures.	
<b>14. Honor code policy</b>	
Students at Florida Atlantic University are expected to maintain the highest ethical standards. Academic dishonesty is considered a serious breach of these ethical standards, because it interferes with the university mission to provide a high quality education in which no student enjoys unfair advantage over any other. Academic dishonesty is also destructive of the university community, which is grounded in a system of mutual trust and place high value on personal integrity and individual responsibility. Harsh penalties are associated with academic dishonesty. See University Regulation 4.001 at <a href="http://www.fau.edu/regulations/chapter4/4.001">www.fau.edu/regulations/chapter4/4.001</a> Code of Academic Integrity.pdf	

**Department of Computer & Electrical Engineering & Computer Science  
Florida Atlantic University  
Course Syllabus**

**15. Required texts/reading**

Linear System Theory and Design, International 3rd. edition, C.T. Chen, Oxford University Press, 2009.

**16. Supplementary/recommended readings**

Handouts, including journal articles

**17. Course topical outline, including dates for exams/quizzes, papers, completion of reading**

- Introduction to the mathematical description of systems: Linear vs. nonlinear, time-varying vs. time-invariant, continuous-time vs. discrete-time
- Review of Linear Algebra and Matrix Theory: Basis, representation and orthonormalization; linear algebraic equations, similarity transformation; diagonal form and Jordan form; functions of a square matrix; Lyapunov equation; quadratic form and positive definiteness; singular-value decomposition; norms of matrices
- Linear dynamic equations and state-space solutions and realizations
- Controlability and observability
- State Feedback and state estimators
- Stability of Linear Systems
- Linear Quadratic Regulators

**Tentative Schedule**

1. Introduction (1 lecture)
  - 1.1. What is modern control?
  - 1.2. Relationship of the subject with other related subjects
  - 1.3. Overview of the course
2. Mathematic Preliminaries (5 lectures)
  - 2.1. Linear space and linear independence
  - 2.2. Linear transformation, map, function, and operator
  - 2.3. Normed linear space and linear product
  - 2.4. Some facts from differential equations
  - 2.5. Eigenvalues and eigenvectors
  - 2.6. Other useful facts
3. System Representation (3 lectures)
  - 3.1. Linear differential systems
  - 3.2. State transition matrix
  - 3.3. State transition function
  - 3.4. Impulse response matrix
4. System Representation in Time-invariant Case (4 lectures)
  - 4.1. Time-invariant systems
  - 4.2. Solution of time-invariant system by Laplace Transform
  - 4.3. Equivalent transformation
  - 4.4. Use of coordinate transform of variables and block diagram
  - 4.5. Geometric view of free-state trajectory when A has distinct eigenvalues

Middle term will be given at this stage.

5. Controllability and Observability (6 lectures)
  - 5.1. Controllability
  - 5.2. Controllability in time-invariant case
  - 5.3. Observability
  - 5.4. Observability in time-invariant case
  - 5.5. Different form of realizations for SISO systems]

**Department of Computer & Electrical Engineering & Computer Science**  
**Florida Atlantic University**  
**Course Syllabus**

- 5.6. Canonical decomposition of time-invariant systems
- 5.7. Minimal realization
- 6. Stability of Linear Systems (2 lectures)
  - 6.1. BIBO stability
  - 6.2. Internal stability
  - 6.3. Lyapunov theorem
- 7. State Feedback and Estimator (4 lectures)
  - 7.1. State feedback in SISO case
  - 7.2. Pole assignment for multiple input systems
  - 7.3. State estimators (Observers)
  - 7.4. Connection of state feedback and estimator
- 8. A Glimpse of Linear Optimal Control (2 lectures)
  - 8.1. Performance measure (index, cost function)
  - 8.2. Linear quadratic regulators
  - 8.3. Minimum energy problem

Final will be given at this stage.


Note: There will be six homework assignments and two tests: middle term and final. Homework will be assigned at a two-week interval, starting at the second week. After three homework assignments, the middle term will be given, which is at 8<sup>th</sup> week of the term. The remaining three homework assignments will be given after the middle term, and the final will be given at the final week, with the date/time announced by the university.

The course outlines are in parallel to the chapters of the textbook. Readings and homework assignments are thus synchronized accordingly.



COLLEGE OF ENGINEERING & COMPUTER SCIENCE  
Department of Computer & Electrical Engineering & Computer Science  
777 Glades Road, SE43/Rm 300  
Boca Raton, FL 33431  
tel: 561.297.3855, fax: 561.297.2800  
[www.ceecs.fau.edu](http://www.ceecs.fau.edu)

## MEMORANDUM

**TO:** Ali Zilouchian  
**FROM:** Bill Rhodes   
**SUBJECT:** New Course Proposal: Modern Control (Hanqi Zhuang)  
**DATE:** Wednesday, February 06, 2013

Attached please find a proposal for a new course, Modern Control, submitted by CEECS Professor. Hanqi Zhuang. I have reviewed it a final time and think it is complete and ready to send to the University Graduate Programs Committee.

## Nancy Diamond

---

**From:** Charles Roberts  
**Sent:** Monday, April 08, 2013 9:02 AM  
**To:** Hanqi Zhuang; Stewart Glegg  
**Cc:** Nancy Diamond; Nancy Poulson; Lee Klingler  
**Subject:** RE: EEL 5613 Modern Control Memo of Support from Science

Memo

To the Faculty Senate and Faculty Senate Steering Committee

The College of Science supports the course EEL 5613 Modern Control being proposed by engineering. The mathematics department requests that the course name be changed to reflect the applied nature of the course, which is otherwise too close to the control theory courses offered by mathematics. (see memo from Lee Klingler, below). We want to see this course added to the catalog in the next few months, so the name change can be processed next year after the course has been placed in the catalog. The course author Hanqi Zhuang has no problem with the idea of changing the course name next year, after it has been placed in the catalog.

1

Dr. Charles Roberts  
UGPC Representative, College of Science  
Associate Dean of Graduate Studies  
Charles E Schmidt College of Science  
Florida Atlantic University

-----Original Message-----

**From:** Hanqi Zhuang [<mailto:zhuang@fau.edu>]  
**Sent:** Sunday, April 07, 2013 10:49 PM  
**To:** Charles Roberts; Stewart Glegg  
**Subject:** Re: EEL 5613 Modern Control Memo from Science

Charles and Stewart,

I don't have problem with the new title.

Thanks for the effort.

2

Hanqi

----- Original Message -----

From: "Charles Roberts" <[croberts@fau.edu](mailto:croberts@fau.edu)>

To: "Stewart Glegg" <[sglegg@fau.edu](mailto:sglegg@fau.edu)>

Cc: "Hanqi Zhuang" <[zhuang@fau.edu](mailto:zhuang@fau.edu)>

Sent: Friday, April 5, 2013 1:54:22 PM

Subject: EEL 5613 Modern Control Memo from Science

Hello Steward and Hanqi;

I showed this course to mathematics and they send me the following memo about it:

Charles,

3

Thanks. Yuan Wang and Yuandan Lin (our control theorists) looked through the new course proposal, and we have no opposition to the new course. It is rather mathematical but also focuses on applications to engineering, which is appropriate. We do request, however, that the title be changed to emphasize the fact that this is intended as an engineering course. We suggest something like "Modern Control for Engineers".

Regards,

Lee

The faculty senate steering committee meets on Tuesday. Since we have already had the last UGPC meeting of the year, there is no way to change the name this year, the course would be stopped. For the course to be approved, I have to send a memo stating that there is no conflict with anyone in the science college.

4

I am requesting that you consider doing a name change next fall, and adding a title that reflects the engineering orientation of the course. If you agree that this is appropriate, send me a memo that I can add to the course folder, stating that you will do a name change next year. This will allow the course to go through this spring, and into the catalog by fall, and yet will satisfy Mathematics that the conflict with their curriculum will be removed. Please call or email me about this. It must be resolved before the meeting on Tuesday.

Dr. Charles Roberts

Associate Dean of Graduate Studies

Charles E Schmidt College of Science

Florida Atlantic University

297-3254