### PURDUE UNIVERSITY
REQUEST FOR ADDITION, EXPIRATION, OR REVISION OF A GRADUATE COURSE (50000-60000 LEVEL)

**DEPARTMENT** Engineering  
**EFFECTIVE SESSION** Fall 2010

**INSTRUCTIONS:** Please check the items below which describe the purpose of this request.

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<tbody>
<tr>
<td>1.</td>
<td>New course with supporting documents (complete proposal form)</td>
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<td>2.</td>
<td>Add existing course offered at another campus</td>
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<td>3.</td>
<td>Expiration of a course</td>
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<td>4.</td>
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<td>Change in course title</td>
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<td>Change in instructional hours</td>
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<td>9.</td>
<td>Change in course description</td>
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<td>10.</td>
<td>Change in course prerequisites</td>
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<td>11.</td>
<td>Change in semesters offered</td>
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<td>12.</td>
<td>Transfer from one department to another</td>
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#### PROPOSED:

**Subject Abbreviation** ECE  
**Course Number** 58400

**Long Title** Linear Control Systems

**Short Title** Linear Control Systems

*Abbreviated title will be entered by the Office of the Registrar if omitted. (30 CHARACTERS ONLY)*

#### CREDITS TYPE

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<td>Maximum Cr. Hrs.</td>
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<td>3. Equivalent Credit:</td>
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<td>4. Thesis Credit: Yes</td>
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#### SCHEDULE TYPE

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#### TERMS OFFERED

Check All That Apply:

- Summer
- Fall
- Spring

**CAMPUS(ES) INVOLVED**

- Calumet
- Fort Wayne
- Indianapolis
- N. Central
- Tech Statewide
- W. Lafayette

#### COURSE ATTRIBUTES: Check All That Apply

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<td>9. Full Time Privilege</td>
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<td>10. Off Campus Experience</td>
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**COURSE DESCRIPTION (INCLUDE REQUISITES/RESTRICTIONS):**

Prerequisite: ECE/ME 333 or graduate standing

Linear spaces and linear operators, mathematical representations of linear systems, canonical forms, state space description, controllability, observability, realization, canonical decomposition, stability, introduction to Lyapunov methods, eigenstructure assignment, partial and full order observers, disturbance decoupling.

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**Signature and Date**

- Calumet Department Head  
  Signature: Donald Muld  
  Date: 8/3/10

- Calumet School Dean  
  Signature: Glen Wieland  
  Date: 4-2-10

- Calumet Undergrad Curriculum Committee  
  Signature:  
  Date:  

- Fort Wayne Department Head  
  Signature:  
  Date:  

- Fort Wayne School Dean  
  Signature:  
  Date:  

- Undergrad Curriculum Committee  
  Signature:  
  Date:  

- Indianapolis Department Head  
  Signature:  
  Date:  

- Indianapolis School Dean  
  Signature:  
  Date:  

- Grad Council Secretary  
  Signature:  
  Date:  

- North Central Faculty Senate Chair  
  Signature:  
  Date:  

- Vice Chancellor for Academic Affairs  
  Signature:  
  Date:  

- West Lafayette Department Head  
  Signature:  
  Date:  

- West Lafayette College/School Dean  
  Signature:  
  Date:  

- Graduate Dean  
  Signature:  
  Date:  

- West Lafayette Registrar  
  Signature:  
  Date:  

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OFFICE OF THE REGISTRAR
Supporting Document for a New Graduate Course

To: Purdue University Graduate Council

From: Faculty Member: Hossein Oloomi
Department: Engineering
Campus: Fort Wayne

Date: 31 March 2010

Subject: Proposal for New Graduate Course-Documentation Required by the Graduate Council to Accompany Registrar’s Form 40G

Contact for information if questions arise:
Name: Donald Mueller
Phone Number: 260-481-5707
E-mail: muellerd@ipfw.edu
Campus Address: ET 327H

Course Subject Abbreviation and Number: ECE 584
Course Title: Linear Control Systems
Proposed Course Number and Title: ECE 584 – Linear Control Systems

Justification for the Course:
The material covered is broad enough to give the students a clear picture of the dynamical behavior of linear systems and their controls. Fundamental results and topics essential to linear systems and linear control theory are emphasized. The emphasis is on time-invariant systems, both continuous- and discrete-time. The topics will include state-space description, controllability, observability, realization theory, stability analysis, state and output feedback, observers, and disturbance decoupling.

This course will be a core offering in our MSE program. It will be offered at least once every two years and will most likely be taken by all electrical, computer, and systems engineering students.

Learning Outcomes and Methods of Evaluation or Assessment:
- Understand the internal and external system descriptions
- Understand the stability, controllability, observability, and realizations concepts with an emphasis on fundamental results
- Understand the control systems design methods: state-feedback, state-estimation, and eigenstructure assignment

Method of Evaluation or Assessment:
The direct method of assessment is used to demonstrate that learning outcomes are achieved through examinations, assignments, and a project in control systems analysis and design.

Course grading criteria:
- Homework (20%)
- Project (10%)
- Two Exams: (40%)
- Final Exam: (30%)

Prerequisites: ECE/ME 333 Automatic Control Systems or graduate standing

Course Instructor:
Hossein M. Oloomi, Professor of Electrical Engineering
Is the instructor currently a member of Graduate Faculty? Yes

Course Outline:
1. Mathematical descriptions of systems, 5 classes
2. Response of linear systems, 5 classes
3. Stability, 5 classes
4. Controllability, observability, and canonical forms, 6 classes
5. Realization theory and algorithms, 4 classes
6. State feedback, 6 classes
7. State observation, 6 classes
8. Polynomial fraction description and applications, 4 classes

Reading List:

Text

Other References

Library Resources: The current library resources are sufficient to support the course.
ECE 584  LINEAR CONTROL SYSTEMS

Credit:  3
Area:  Electrical and Computer Engineering
Specialization:  Automatic Control
PIC:  Hossein M. Oloomi
Prerequisite:  ECE/ME 333 or graduate standing

Description:  Linear spaces and linear operators, mathematical representations of linear systems, canonical forms, state space description, controllability, observability, realization, canonical decomposition, stability, introduction to Lyapunov methods, eigenstructure assignment, partial and full order observers, disturbance decoupling.


Outline:

1. Mathematical descriptions of systems
   A. Examples
   B. State space description of continuous-time and discrete-time systems
   C. Linearization and state equation implementation
   D. Existence, uniqueness, and continuity of solutions to initial data
   E. Input-output descriptions of linear systems

2. Response of linear systems
   A. Solutions of linear state equations
   B. Transition matrix properties
   C. Time-invariant and periodic systems

3. Stability
   A. Internal stability
   B. Lyapunov stability

4. Controllability, observability, and canonical forms
   A. Controllability and stabilizability
   B. Observability and detectability
   C. Canonical forms

5. Realization theory and algorithms
   A. Minimal realization
   B. Realizations from Markov parameters

6. State Feedback
   A. Eigenvalue and eigenstructure assignments
   B. Noninteracting control

7. State observation
   A. Observers
   B. Output feedback stabilization
   C. Reduced-dimension observers

8. Polynomial fraction description and applications

9. Geometric theory
   A. Controlled invariant subspaces
   B. Disturbance decoupling
   C. Maximal controlled invariant subspace computation

10. Exams

Lectures
5.0

5.0

5.0

5.0

4.0

5.0

5.0

4.0

3.0
Hossein M. Oloomi, Ph.D.

Professional Preparation:

University of Missouri-Rolla  Electrical Engineering  B.S., 1979-1983
Wichita State University  Electrical Engineering  M.S., 1983-1985
Wichita State University  Mathematics  M.S., 1985-1987
Wichita State University  Electrical Engineering  Ph.D., 1985-1989

Appointments:

2009-  Director of Graduate Program in Engineering, IPFW
2008-  Professor, Electrical Engineering, IPFW
1996-2008  Associate Professor, Electrical Engineering, IPFW
1999-2000  Visiting Scientist, ITT Industries Aerospace/Communications Division
1996-1998  Visiting Professor & Consultant, Universiti Teknologi of Malaysia
1990-1996  Assistant Professor, Electrical Engineering, IPFW
1989-1990  Research Fellow, Applied Mathematics, Wichita State University
1985-1989  Research Fellow/Lecturer, Electrical Engineering, Wichita State University
1985-1989  Research Assistant, Electrical Engineering, Wichita State University

Publications:


Synergistic Activities:

3. Lilly Endowment Inc.: Opportunity for Indiana’s Future; Project: Development of a Sequence for High School Students in Entrepreneurship and Robotics, 2004

Collaborators & Other Affiliations:

(a) Collaborators and Co-Editors
- Vahid Badii, Senior Staff Engineer, Meggitt Safety Systems
- Sami M. Fadali, Professor of Electrical Engineering, University of Nevada
- Bongso Kang, Associate Professor of Mechanical Engineering, IPFW
- Donald W. Mueller, Associate Professor of Mechanical Engineering & Chair, IPFW
- Mehrdad Saif, Professor & Director of School of Engineering Science, Simon Fraser University
- G. Reza Sarhangi, Professor of Mathematics, Towson University
- M. Edwin Sawan, Emeritus Professor of Electrical Engineering, Wichita State University
- Bahram Shafai, Professor of Electrical Engineering, Northeastern University

(b) Past Graduate Students

(c) Membership in Scientific & Professional Societies
- IEEE – Institute of Electrical and Electronics Engineers
- SIAM – Society for Industrial and Applied Mathematics