PURDUE UNIVERSITY
REQUEST FOR ADDITION, EXPIRATION,
OR REVISION OF A GRADUATE COURSE
(50000-59999 LEVEL)

DEPARTMENT: Engineering
EFFECTIVE SESSION: Fall 2010

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

- New course with supporting documents (complete proposal form)
- Add existing course offered at another campus
- Expiration of a course
- Change in course number
- Change in course title
- Change in course credit/grade
- Change in course attributes
- Change in instructional hours
- Change in course description
- Change in course requisites
- Change in semester offered
- Transfer from one department to another

PROPOSED:

Subject Abbreviation: ECE
Course Number: 60000
Long Title: Random Variables and Signals
Short Title: 

EXISTING:

Subject Abbreviation:
Course Number:
Long Title:
Short Title:

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

CREDIT TYPE

1. Fixed Credit: Cr. Hrs. [3]
2. Variable Credit Range:
   Minimum Cr. Hrs. (Check One) To Or
   Maximum Cr. Hrs.
3. Equivalent Credit: Yes [ ] No [ ]
4. Thesis Credit: Yes [ ] No [ ]

COURSE ATTRIBUTES: Check All That Apply

1. Pass/Not Pass Only
2. Satisfactory/Unsatisfactory Only
3. Repeatable
4. Credit by Examination
5. Special Fees
6. Registration Approval Type
   Department [ ] Instructor [ ]
7. Variable Title
8. Honors
9. Full Time Privilege
10. Off Campus Experience

Course Description (Include Requisites/Restrictions):

Engineering applications of probability theory. Problems on events, independence, random variables, distribution and density functions, expectations, and characteristic functions. Dependence, correlation, and regression; multi-variate Gaussian distribution. Stochastic processes, stationarity, ergodicity, correlation functions, spectral densities, random inputs to linear systems; Gaussian processes. Prerequisites: Graduate standing.

CUNH: [Signature] [Date]

Office of the Registrar

OFFICE OF THE REGISTRAR
To: Purdue University Graduate Council

From: Faculty Member: Carlos Pomalaza-Raez
Department: Engineering
Campus: Fort Wayne

Date: 6/30/2010

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: Don Mueller
Phone Number: 260-481-5707
E-mail: muellerd@ipfw.edu
Campus Address: ET 321 (Fort Wayne Campus)

Course Subject Abbreviation and Number: ECE 600
Course Title: Random Variables and Signals

For Reviewer's comments only
(Select One)

Reviewer:

Comments:
ECE 600 Random Variables and Signals

Credits: 3.

Graduate Area(s):
  Bioengineering
  Communications, Networking, Signal & Image Processing

Normally Offered: Each Fall, Spring

Prerequisites: Graduate Standing

Corequisites: None.

Catalog Description: Engineering applications of probability theory. Problems on events, independence, random variables, distribution and density functions, expectations, and characteristic functions. Dependence, correlation, and regression; multi-variate Gaussian distribution. Stochastic processes, stationarity, ergodicity, correlation functions, spectral densities, random inputs to linear systems; Gaussian processes.

Required Text(s):


Recommended Reference(s): None.

Lecture Outline:

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
</tr>
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</table>
| 1    | 1. The Meaning of Probability A. Preliminary Remarks B. The Various Definitions of Probability C. Determinism versus Probability  
      2. The Axioms of Probability A. Set Theory B. Probability Space C. Conditional Probabilities and Independent Events D. Summary  
      3. The Concept of a Random Variable A. Random Variables; Distributions, Densities B. Examples of Distribution and Density Functions C. Conditional Distributions and Densities D. Bayes' Theorem in Statistics (re-examined) |
| 2    | 4. Functions of One Random Variable A. Concept of a Function of One Random Variable B. Determination of the Distribution and Density of $y=g(x)$ C. Applications D. Expected Value; Dispersion; Moments E. Characteristic Functions |
| 3    | 5. Two Random Variables A. Joint Distribution and Density Functions B. Conditional Distributions and Densities C. Independent Random Variables D. Jointly Normal Random Variables  
      6. Functions of Two Random Variables A. One Function of Two Random Variables B. Two Functions of Two Random Variables C. Expected Value: Moments; Characteristic Functions D. Mean-square Estimation; the Orthogonality Principle E. More on Normal Random Variables |
| 4    | 7. Sequences of Random Variables A. General Concepts B. Mean; Mean-square Estimation; Moments; Characteristic Functions |
| 6    | RANDOM PROCESSES |


11. Linear Mean-square Estimation A. Introductory Remarks B. The Orthogonality Principle in Linear Mean-square Estimation C. The Wiener-Khinchin Theory

12. Linear Mean Square Estimation A. The Filtering Problem B. The Prediction Problem C. Wide-sense Markoff Sequences and Recursive Filtering

13. Nonstationary Processes; Transients in Linear Systems w/Stochastic Inputs A. Transients in Linear Systems with Stochastic Inputs B. Two-dimensional Fourier Transforms C. Time Averages


Three one-hour Exams plus Final Exam.
Supporting Document for a New Graduate Course

To: Purdue University Graduate Council
Reviewer:
From: Faculty Member: Dr. Carlos Pomalaza-Ráez
        Department: Engineering
        Campus: Fort Wayne
Date: June 30, 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: Dr. Don Mueller
                                           Phone Number: (260) 481-5707
                                           E-mail: muellerd@ipfw.edu
                                           Campus Address: ET 321 (Fort Wayne)

Proposed Course Number: ECE 600
Proposed Course Title: Random Variables and Signals
Credits: 3

A. Justification for the Course:
   • Need for the course

   This course focuses on the engineering applications of probability theory, which is
   critical to graduate students in Electrical Engineering and Computer Engineering areas.
   It is a follow-up course of ECE 302 (Probabilistic Methods in Electrical Engineering) on
   the graduate level.

   • Level of the course:

   Anticipated enrollments of undergraduate and graduate students.
   - Anticipated Percentage of Graduate Student Enrollment: 100%
   - Anticipated Percentage of Undergraduate Student Enrollment: 0%

B. Learning Outcomes and Method of Evaluation or Assessment

   • Learning outcomes:

   After taking the course, students are expected to be familiar with the following:
   Problems on events, independence, random variables, distribution and density
   functions, expectations, and characteristic functions. Dependence, correlation, and
   regression; multi-variate Gaussian distribution. Stochastic processes, stationarity,
   ergodicity, correlation functions, spectral densities, random inputs to linear systems;
   Gaussian processes.
• Method of evaluation or assessment

20% Midterm Exam 1  
20% Midterm Exam 2  
20% Midterm Exam 3  
10% Homework  
30% Final exam

C. Prerequisite(s):

Graduate Standing

D. Course Instructor(s):

Dr. Chao Chen, Dr. Carlos Pomalaza-Ráez.  
Members of the Graduate Faculty. CVs attached.

E. Course Outline:

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### RANDOM PROCESSES

<table>
<thead>
<tr>
<th>Week</th>
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</tr>
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<tbody>
<tr>
<td>7</td>
<td>General Concepts A. Introductory Remarks B. Special Processes C. Definitions D. Stationary Processes E. Transformation of Stochastic Processes (Systems) F. Stochastic Continuity and Differentiation G. Stochastic Differential Equations H. Stochastic Integrals; Time Averages; Ergodicity</td>
</tr>
<tr>
<td>10</td>
<td>Linear Mean-square Estimation A. Introductory Remarks B. The Orthogonality Principle in Linear Mean-square Estimation C. The Wiener-Kolmogoroff Theory</td>
</tr>
<tr>
<td>11, 12</td>
<td>Linear Mean Square Estimation A. The Filtering Problem B. The Prediction Problem C. Widesense Markov Sequences and Recursive Filtering</td>
</tr>
<tr>
<td>13</td>
<td>Nonstationary Processes; Transients in Linear Systems w/Stochastic Inputs A. Transients in Linear Systems with Stochastic Inputs B. Two-dimensional Fourier Transforms C. Time Averages</td>
</tr>
<tr>
<td>14</td>
<td>Harmonic Analysis of Stochastic Processes A. Series Expansions B. Approximate Fourier Expansion with Uncorrelated Coefficients C. Fourier Transforms of Stochastic Processes D. Generalized Harmonic Analysis</td>
</tr>
</tbody>
</table>

### F. Reading List:

- **Text:**


### G. Library Resources:

The IPFW Walter E. Helmke Library currently has reference books available for students to borrow in the subject area.
Name: Carlos Pomañaza-Raéz, Ph.D.

Degrees:  
B.S.E.E., B.S.M.E. Universidad Nacional de Ingeniería, Lima, Perú, 1974  
M.S.E.E. Purdue University, West Lafayette, Indiana, 1977  
Ph.D. Purdue University, West Lafayette, Indiana, 1980

Appointments:  
1994- Professor of Radio Frequency Communications, IPFW  
2007-2009 Associate Dean of Computer Science and Engineering, IPFW  
1998-2008 Chair, Department of Engineering, IPFW  
2003-2004 Nokia-Fulbright Scholar Professor, University of Oulu, Department of Electrical Engineering, Oulu, Finland  
1997-1998 Visiting Professor, University of Oulu, Department of Electrical Engineering, Oulu, Finland  
1989-1994 Associate Professor of Radio Frequency Communications, IPFW  
1983-1989 Assistant Professor, Department of Electrical and Computer Engineering, Clarkson University, Potsdam, New York  
1984-1985 Member of the Technical Staff, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California  
1981-1983 Lecturer, University of Limerick, Limerick, Ireland

Refereed publications related to the proposed courses to be taught (ECE 600 & ECE 608)


**Synergistic Activities**

During the last twelve years Professor Pomalaza-Ráez has been closely associated with the Centre for Wireless Communications (CWC) at the University of Oulu, Finland. The CWC is a world class research organization in the area of wireless communications. That experience includes:

2. Supervisor of Master and PhD theses.
3. Member of Steering Committees and Technical Program Committee Member of numerous international conferences in the area of wireless communications.

**Thesis Advisor (last 5 years):**

**M.S.E.**
1. A. Marcum, *Department of Engineering, Indiana University – Purdue University Fort Wayne.*

**M.S.E.E.**
2. F. Martelli. *University of Bologna, Bologna, Italy.*

**Ph.D.**
2. Z. Shelby. *Sensinode, Oulu, Finland.*
4. T. Sukuvaara. *Arctic Research Centre, Finnish Meteorological Institute, Sodankylä, Finland.*