PURDUE UNIVERSITY
REQUEST FOR ADDITION, EXPIRATION,
OR REVISION OF A GRADUATE COURSE
(50000-50099 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)
- [X] Add existing course offered at another campus
- [ ] Expiration of a course
- [ ] Change in course number
- [ ] Change in course title
- [ ] Change in course credit/type
- [ ] Change in course attributes
- [ ] Change in instructional hours
- [ ] Change in course description
- [ ] Change in course requisites
- [ ] Change in semesters offered
- [ ] Transfer from one department to another

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

EXISTING:
Subject Abbreviation: 
Course Number: 

TERMS OFFERED:
Check All That Apply:
- [ ] Summer
- [X] Fall
- [X] Spring

CAMPUS(ES) INVOLVED:
- Calumet
- Cont Ed
- Ft. Wayne
- Indianapolis
- N. Central
- Tech Statewide
- W. Lafayette

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. Maximum Repeatable Credit:
5. Credit by Examination
6. Registration Approval Type Department Instructor
7. Variable Title
8. Honors
9. Full Time Privilege
10. Off Campus Experience

SCHEDULE TYPE
Lecture
Recitation
Presentation
Laboratory
Lab Prep
Studio
Distance
Clinic
Experiential
Research
Ind. Study
Prac/Observ
Minutes Per Min 75
Meetings Per Week 2
Weeks Offered 15
% of Credit Allocated 100

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.

Cross-Listed Courses

Calumet Department Head
Calumet School Dean

Date
Date
Donald Muller
Hansberg

Ft. Wayne Department Head
Ft. Wayne School Dean

Date
Date

Indianapolis Department Head
Indianapolis School Dean

Date
Date

North Central Faculty Senate Chair
Date

Vice Chancellor for Academic Affairs
Date

West Lafayette Department Head
West Lafayette College/School Dean

Date
Date

Graduate Area Committee Convener
Graduate Dean

Date
Date

Calumet Undergrad Curriculum Committee
Date

Ft. Wayne Undergrad Curriculum Committee
Date

Calumet Undergrad Curriculum Committee
Date

Ft. Wayne Undergrad Curriculum Committee
Date

OFFICE OF THE REGISTRAR
Supporting Document for a New Graduate Course

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

For Reviewer’s comments only
(Select One)

Reviewer:
Comments:

Contact for information if questions arise:
Name: Don Mueller
Phone Number: 260-481-5707
E-mail: muellerd@lpfw.edu
Campus Address: ET 321 (Fort Wayne Campus)

Course Subject Abbreviation and Number: ECE 600
Course Title: Random Variables and Signals
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>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1. The Meaning of Probability A. Preliminary Remarks B. The Various Definitions of Probability C. Determinism versus Probability</td>
</tr>
<tr>
<td></td>
<td>2. The Axioms of Probability A. Set Theory B. Probability Space C. Conditional Probabilities and Independent Events D. Summary</td>
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<td></td>
<td>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)</td>
</tr>
<tr>
<td>2</td>
<td>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</td>
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<tr>
<td></td>
<td>5. Two Random Variables A. Joint Distribution and Density Functions B. Conditional Distributions and Densities C. Independent Random Variables D. Jointly Normal Random Variables</td>
</tr>
<tr>
<td></td>
<td>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</td>
</tr>
<tr>
<td>3</td>
<td>7. Sequences of Random Variables A. General Concepts B. Mean; Mean-square Estimation; Moments; Characteristic Functions</td>
</tr>
</tbody>
</table>

RANDOM PROCESSES
9. 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

10. Correlation and Power Spectrum of Stationary Processes  
    A. Correlation  
    B. Power Spectrum  
    C. Linear Systems  
    D. Hilbert Transforms; Shot Noise; Thermal Noise  
    E. Mean-square Periodicity and Fourier Series  
    F. Band-limited Processes  
    G. An Estimate of the Variation of a Band-Limited Process

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

14. 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

Three one-hour Exams plus Final Exam.
Course Number: ECE 600
Course Title: Random Variables and Signals
Credits: 3

A. 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.

B. Method of Evaluation or Assessment
20% Midterm Exam 1
20% Midterm Exam 2
20% Midterm Exam 3
10% Homework
30% Final exam

C. Prerequisites
Graduate Standing

D. Corequisites
None

E. Course Instructors
Dr. Chao Chen, Dr. Pomalaza-Ráez. Members of the Graduate Faculty. CVs Attached.

F. Course Outline

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<td>Functions of Two Random Variables A. One Function of Two Random</td>
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<td>Variables B. Two Functions of Two Random Variables C. Expected</td>
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<tr>
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<td>Value: Moments; Characteristic Functions D. Mean-square Estimation;</td>
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<td>square Estimation; Moments; Characteristic Functions</td>
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<tr>
<td></td>
<td>Variables C. Convergence Concepts and the Law of Large Numbers D.</td>
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<td>The Central-limit Theorem</td>
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**RANDOM PROCESSES**

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<td></td>
<td>Definitions D. Stationary Processes E. Transformation of Stochastic</td>
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<tr>
<td></td>
<td>Processes (Systems) F. Stochastic Continuity and Differentiation G.</td>
</tr>
<tr>
<td></td>
<td>Stochastic Differential Equations H. Stochastic Integrals; Time</td>
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<tr>
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<td>Averages; Ergodicity</td>
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<tr>
<td>8, 9</td>
<td>Correlation and Power Spectrum of Stationary Processes A. Correlation</td>
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<td>B. Power Spectrum C. Linear Systems D. Hilbert Transforms; Shot</td>
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<td>Wiener-Kolmogoroff Theory</td>
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<td>Prediction Problem C. Widesense Markov Sequences and Recursive</td>
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<td>Inputs A. Transients in Linear Systems with Stochastic Inputs B.</td>
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<tr>
<td></td>
<td>Analysis</td>
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</table>

**G. Text**

Name: Carlos Pomalaza-Ráez, 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.
3. J. Piltinen. Sensinode, Oulu, Finland.

Ph.D.
2. Z. Shelby. Sensinode, Oulu, Finland.
3. J. Prokkola. VTT Technical Research Centre of Finland.
4. T. Sukuvaara. Arctic Research Centre, Finnish Meteorological Institute, Sodankylä, Finland.