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

DEPARTMENT  Engineering  EFFECTIVE SESSION  001  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/type
- Change in course attributes
- Change in Instructional hours
- Change in course description
- Change in course prerequisites
- Change in semesters offered
- Transfer from one department to another

PROPOSED:
Subject Abbreviation  ECE
Course Number  54900
Long Title  Software-Defined Radio
Short Title

EXISTING:
Subject Abbreviation
Course Number

TERMS OFFERED
Check All That Apply:
- Summer
- Fall
- Spring

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

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.  
   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. Maximum Repeatable Credit: 
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  Clinical  Experiential  Research  Ind. Study  Pract/Observe
Minutes Per Mto 75  Meetings Per Week 2
Weeks Offered 15  % of Credit Allocated 100

COURSE DESCRIPTION (INCLUDE REQUISITES/RESTRICTIONS):
The course covers all aspects of SDR technology. Specifically it includes an overview of modern wireless systems, transceiver architectures, baseband signal processing algorithms, analog-to-digital converters, radio front-end components, digital hardware architectures, software architectures, middleware and the Software Communications Architecture (SCA), cognitive devices and networks, standardization bodies, software-defined radio products and services. Prerequisites: 1. Senior or graduate standing in either an engineering or science degree program, 2. ECE428 - Modern Communication Systems and ECE 436 Digital Signal Processing.

Calumet Department Head
Calumet School Dean
Fort Wayne Department Head
Fort Wayne School Dean
Indiana Department Head
Indianapolis School Dean
North Central Faculty Senate Chair
Vice Chancellor for Academic Affairs
West Lafayette Department Head
West Lafayette College/School Dean
Graduate Area Committee Convener
Graduate Dean

Calumet Undergrad Curriculum Committee
Fort Wayne Undergrad Curriculum Committee
Undergrad Curriculum Committee

Date Approved by Graduate Council
Graduate Council Secretary
West Lafayette Registrar

OFFICE OF THE REGISTRAR
Supporting Document for a New Graduate Course

To: Purdue University Graduate Council
From: Faculty Member: Todor Cooklev
Department: Engineering
Campus: Fort Wayne
Date: 4/2/2010
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: Todor Cooklev
Phone Number: 260-481-0151
E-mail: cooklev@ipfw.edu
Campus Address: ET 229 (Fort Wayne Campus)

Course Subject Abbreviation and Number: ECE 54900
Course Title: Software-Defined Radio
Proposed Course Number: ECE 54900
Proposed Course Title: Software-Defined Radio
Credits: 3

A. Justification for the Course:

This course is intended primarily for students within the Department of Engineering at Indiana University – Purdue University Fort Wayne.
This course is on Software Defined Radio (SDR) technology. It is designed for graduate students/advanced undergraduate students interested in wireless communication and mobile computing.
The course covers all aspects of SDR technology. Specifically it includes device architectures, baseband signal processing, analog front-end, digital hardware architectures, software architectures, cognitive devices and networks.
The anticipated enrollment is around 20 students whenever the course is offered. Percentage of Undergraduate Student Enrollment: 10%. Percentage of Graduate Student Enrollment: 90%.

B. Learning Outcomes and Method of Evaluation or Assessment

A student who successfully fulfills the course requirements will have demonstrated:

1. a knowledge of design considerations for software-defined radio technology and products (a, e)
2. knowledge of software development methods for embedded wireless systems (a, k)
3. knowledge of modern wireless systems and smart antenna algorithms (a, e, k)
4. knowledge of digital hardware architectures and understanding of development methods (a, e, k)
5. an understanding of middleware in SDR and the SCA (a, e, k)
6. understanding of analog RF components (a, e, k)
7. understanding of ADC and DAC technology (a, e, k)
8. an awareness of current industry trends (a, k)

Method of Evaluation or Assessment:

20% Project involving Universal Software Radio Peripheral (USRP) or another hardware platform with the permission of the instructor. USRPs will be provided, but must be returned at the end of the semester. Those that do not return the USRP platform will not be assigned a grade. (A 10% bonus will be awarded on excellent projects).
20% Homework
10% Attendance
20% Mid-term exam
30 % Final exam

The primary method of instruction will be regular lectures.
C. Prerequisites

1. Admitted graduate student in either an engineering or science degree program;
2. ECE 428 Modern Communication Systems (or equivalent)
3. ECE 436 Digital Signal Processing (or equivalent)

D. Course Instructor

Dr. Todor Cooklev. Member of the Graduate Faculty. CV Attached.

E. Course Outline

1. Radio technology evolution
2. Transceiver architectures
   a. Superheterodyne
   b. Direct-conversion (zero-IF)
   c. Digital IF architecture
   d. Direct digital synthesis (DDS)
   e. Sampling architectures
   f. Multi-band and multi-mode architectures
   g. Transceiver architectures supporting cognitive radio techniques
   h. Measurement techniques for transceivers
3. Antennas and radio front-end
   a. Antennas
   b. Diplexor (switchplexor, roofing filter)
   c. LNA and NF analysis
   d. Mixers and quadrature upconverters and downconverters
   e. PA and linearity analysis
   f. Measurement techniques for radio front-end
4. Multirate DSP
   a. DSP fundamentals review
   b. Sampling rate conversion, decimation, and interpolation
   c. Efficient implementations of decimators and interpolators
   d. Two-channel and N-channel digital filter banks
5. Direct digital synthesis (DDS)
   a. ROM LUT method and parameters
   b. DDS products
6. Analog to digital and digital to analog conversion
   a. Parameters
   b. Architectures
7. Baseband algorithms
   a. Receive diversity
   b. Transmit diversity and space-time coding
   c. Beamforming algorithms and architectures
   d. OFDM
8. Baseband digital hardware
a. Digital hardware solution space
b. Low-speed hardware: DSPs, DSP architectures, C programming and DSP compilers
c. High-speed digital signal processing hardware: FPGA, ASIC
d. New digital baseband hardware technologies
e. SDR test-bed architectures

9. Software methods
   a. Software techniques: from spaghetti code to object-oriented design
   b. Middleware
   c. Software Communications Architecture

10. Cognitive networking
    a. Over-the-air software download
    b. Security in software radios
    c. Cognitive networking use cases and the need for a metalanguage
    d. Reconfigurable networking and networking description language

11. Current industry trends
    a. Standardization bodies
    b. Government regulations
    c. Products and services involving SDR technology, case studies
    d. Likely future directions

F. Reading List


G. Library Resources

The IPFW library provides online access to all the publications by the IEEE and the ACM. These are important sources of information for SDR topics.

H. Course Syllabus

It is attached.
ECE 549 Software-Defined Radio

Syllabus

Instructor: Dr. Todor Cooklev

Office: ET 229
Phone: 481-0151
E-mail: cooklevt@ipfw.edu

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The course will include a hardware project. Two students can work in a group on the hardware project.

It is designed for graduate students/advanced undergraduate students interested in wireless communication.

Credit Hours: (3)

Textbook:

M. Cummings & T. Cooklev, Software-Defined Radio Technology, 2010 (to be published)

Course Outline:

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2. Transceiver architectures
   a. Superheterodyne
   b. Direct-conversion (zero-IF)
   c. Digital IF architecture
   d. Direct digital synthesis (DDS)
   e. Sampling architectures
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   h. Measurement techniques for transceivers
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   a. Antennas
b. Diplexor (switchplexor, roofing filter)
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  d. Mixers and quadrature upconverters and downconverters
  e. PA and linearity analysis
  f. Measurement techniques for radio front-end

4. Multirate DSP
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   b. Sampling rate conversion, decimation, and interpolation
   c. Efficient implementations of decimators and interpolators
   d. Two-channel and N-channel digital filter banks

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    c. Products and services involving SDR technology, case studies
    d. Likely future directions

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Assessment:

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   20% Homeworks
   10% Attendance
   20% Mid-term exam
   30% Final exam

Students with disabilities:

If you have a disability and need assistance, special arrangements can be made to accommodate most needs. Contact the Director of Services for Students with Disabilities (Walb Union, Room 113, 481-6658) as soon as possible to work out the details. Once the Director has provided you with a letter attesting to your needs for modification, bring the letter to me. For more information, please visit the web site at http://www.ipfw.edu/sss/.

Grading policy

>90% A
90% A-
85% B+
80% B, etc.

Other policies:

The use of cell phones in class is not allowed; please put your cell phones in vibrate or silent mode, or turn them off.

Activities that can be distractions, such as eating in class, are not allowed.
Course Outcomes

A student who successfully fulfills the course requirements will have demonstrated:

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7. understanding of ADC and DAC technology (a, e, k)
8. an awareness of current industry trends (a, k)

**ABET category:** Engineering science: Engineering design: 0 credits or 0% 3 credits or 100%
Biographical sketch: T. Cooklev

Education
Ph.D. in electrical engineering, Tokyo Institute of Technology, Tokyo, Japan, 1995.

Recent appointments
- Director, IPFW Wireless Technology Center, Indiana University – Purdue University Fort Wayne
- Assistant Professor, San Francisco State University, 2003-2008.
- Member of the Technical Staff, Aware, Inc., Bedford, MA and Lafayette, CA, 1999-2002
- Member of the Technical Staff, US Robotics Corp., now 3Com Corporation, Salt Lake City, UT, 1997-1999; received 3Com Inventor Award.

Publications

Related
- T. Cooklev and A. Abedi, “Teaching the wireless communication standards,” 2007 Frontiers in Education Conference, Milwaukee, WI.

Additional
Synergistic activities:
- Member, IEEE Standards in Education Committee (SEC), a committee jointly sponsored by the IEEE Standards Association and the IEEE Educational Activities Board.

Collaborators in the last five years

<table>
<thead>
<tr>
<th>Name</th>
<th>Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fernando Ramires</td>
<td>ITAM, Mexico</td>
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<tr>
<td>Sudhanshu Gaur</td>
<td>Hitachi America Ltd., San Jose, CA</td>
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<td>Pierre Siohan</td>
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<tr>
<td>Renato J. Cintra</td>
<td>Federal University of Pernambuco, Brazil</td>
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<tr>
<td>Ali Abedi</td>
<td>University of Maine, ME</td>
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Thesis advisor:
A. Nishihara, Tokyo Institute of Technology