Washington State University
MAJOR CURRICULAR CHANGE FORM - - NEW/RESTORE COURSE

- ☐ **Please attach rationale for your request, a complete syllabus,** and explain how this impacts other units in Pullman and other campuses (if applicable).
- ☐ **Obtain all required signatures with dates.**
- ☐ **Provide original stapled packet of signed form/rationale statement/syllabus PLUS 10 stapled copies** of complete packet to the **Registrar's Office,** campus mail code 1035.
- ☐ **Submit one electronic copy of complete packet** to wsu.curriculum@wsu.edu.

Requested **Future** Effective Date: **Fall 2016** _____ (term/year) Course Typically Offered: **Fall** _____

DEADLINES: For fall term effective date: **October 1st**; for spring or summer term effective date: **February 1st**. See instructions.

NOTE: Items received after deadlines may be put to the back of the line or forwarded to the following year. Please submit on time.

■ **New Course**   ☐ Temporary Course   ☐ **Restore Course**

ECE	533	Advanced Antenna Design
course subject/crosslist	course no.	title

3   (3   -   )   ECE 370 and ECE 471

Credit hrs	lecture hrs per week	lab or studio hrs per week	prerequisite

Description for catalog: Advanced antenna types and design methods, small antennas, reconfigurable antennas, wideband microstrip antennas, millimeter-wave antennas, phased arrays, design of array feed, mutual coupling.
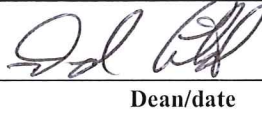

Additional Attributes: Check all that apply.

☐ Crosslisting (between WSU departments)*   ☐ Conjoint listing (400/500): _____

☐ Variable credit: _____   ☐ Repeat credit (cum. max. hrs): _____

Special Grading: ☐ S, F; ☐ A, S, F (PEACT only); ☐ S, M, F (VET MED only); ☐ H, S, F (PHARMACY, PHARDSCI only)

☐ Cooperative with UI   ☐ Other (please list request): _____

The following items require prior submission to other committees/depts. (SEE INSTRUCTIONS.)

☐ Request to meet Writing in the Major [M] requirement **(Must have All-University Writing Committee Approval.)**

☐ Request to meet UCORE in _____ **(Must have UCORE Committee Approval ›› See instructions.)**

☐ Special Course Fee _____ **(Must submit request to University Receivables.)**

Contact: Tutku Karacolak   Phone number: (360) 546-9185   Campus mail code: 98686

Email: tutku.karacolak@wsu.edu   Instructor, if different: _____

[signature] 8/28/15   _[signature]_ 8/31/15   _____
Chair/date   **Dean/date**   **All-University Writing Com / date**

_____   _____   _____
Chair (if crosslisted/interdisciplinary)*   **Dean (if crosslisted/interdisciplinary)***   **UCORE Committee Approval Date**

_____   _____   _____
Catalog Subcommittee Approval Date   **GSC or AAC Approval Date**   **Faculty Senate Approval Date**

*****If the proposed change impacts or involves collaboration with other units, use the additional signature lines provided for each impacted unit and college.**

Rationale: ECE 533 Advanced Antenna Design

ECE 533 Advanced Antenna Design is being proposed to provide electrical engineering graduate students with cutting edge antenna design techniques and applications to help them to become more competitive in their field of study. It aligns with WSU Vancouver's electrical engineering curriculum as a continuation of ECE 471, Antenna Design and Analysis. ECE 471 covers fundamentals of antenna theory and introduces traditional antenna types and will be a prerequisite for this course. ECE 533 also supports the proposed MSEE program's Lab-on-Chip (LoC) focus by teaching students the techniques necessary to design and analyze small size antenna systems of the LoC.

It does not affect other units in Pullman and other campuses.

WASHINGTON STATE UNIVERSITY
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ECE 533 Advanced Antenna Design
Course Syllabus

Description: Advanced antenna types and design methods, small antennas, reconfigurable antennas, wideband microstrip antennas, millimeter-wave antennas, phased arrays, design of array feed, mutual coupling, system level implications such as full-duplex and MIMO.

Credits: 3

Prerequisite: ECE 370 Electromagnetic Fields and Waves and ECE 471 Antenna Design and Analysis

Required Text: Constantine A. Balanis, *Antenna Theory: Analysis and Design, 3rd. Ed.*, John Wiley & Sons, 2005.

Instructor: Dr. Tutku Karacolak

Office: VECS 201N
Phone: (360) 546 9185
Email: tutku.karacolak@wsu.edu
Office hours: Open door policy
Lectures: VECS 104, MW 9:00-10:15 Am

Topics Covered

- Review of antenna and array theory
- Small antennas
- Wideband microstrip antennas
- Ultra-wideband antennas and arrays
- Phased arrays, design of array feed, mutual coupling
- Millimeter-wave antennas
- Reconfigurable antennas
- Metamaterial based antennas
- Antennas for wireless communications and related applications (medical, mobile handset, satellite, full-duplex, MIMO, underground antennas, etc.)

Course Procedures

There will be three hours of lecture each week. Reading from the required textbooks and journal articles from the literature will be assigned each week. There will be 6 or 7 homework assignments, approximately one every two weeks. Some of the homework assignments will involve using MATLAB software. In addition to the homework assignments, students will work on a term project utilizing one of advanced antenna types to design an antenna for wireless communication applications.

Student Learning Outcomes (SLO) and Assessment

Student Learning Outcomes for this Course: At the end of this course, students should be able to:	Course Topics/Dates: The following topic(s)/date(s) will address this outcome :	Evaluation of Outcome : This outcome will be evaluated primarily by:
Have an understanding of advanced antenna concepts such as small antennas, millimeter-wave antennas, reconfigurable antennas, and metamaterial based antennas	Small antennas (week 4); millimeter-wave antennas (week 9); reconfigurable antennas (week 10); metamaterial based antennas (week 14)	Exams, homework
Design antenna arrays and analyze mutual coupling among antennas	Phased arrays, design of array feed, mutual coupling (week 8)	Exams, homework
Use numerical techniques to design and analyze wideband antennas	Wideband microstrip antennas (week 5); frequency independent antennas (week 6)	Homework, Design Project
Formulate and execute a research plan to design advanced antenna types including simulations and measured results	Small antennas, wideband microstrip antennas (weeks 4, 5); antennas for advanced applications (weeks 11-14)	Design project

Website
All course materials (lecture notes, assignments, etc.) will be available on the course Blackboard website at https://learn.wsu.edu/.

Attendance Policy
Lecture attendance is highly encouraged but not required. Students are nevertheless responsible for knowing any and all material presented in lecture.

Composition of final grade
The course grade will be determined as follows:

Homework:	20%
Midterm Exam:	20%
Final Exam:	25%
Design Project:	35%
Total	100%

Grading Scale (% of total score)
A 95-100; A- 90-94; B+ 85-89; B 80-84; B- 75-79; C+ 70-74; C 65-69; C- 60-64; D+ 55-59; D 50-54; F <50

Make-up Exam/Assignment Policy

No make-up exam, assignments or quizzes will be given unless a medical or other emergency was the reason for missing the exam or the assignment. For any other reason you must first contact the instructor **before** missing an exam, a quiz or an assignment.

Late Homework Submission Policy

Late homework will not be entertained unless dire circumstances warrant it. Without a valid reason, there will be a 10% deduction grade for submitting late by a day. If the submission is two days late, a 20% deduction in grade will be enforced. The homework will not be accepted after three days of original submission.

Design Project

During the semester, students will work on a term project utilizing one of advanced antenna types to design an antenna for wireless communication applications. Consistent with the frequencies assigned by FCC (Federal Communications Commission), you may pick any frequency bands (you can choose more than one for a single antenna) for your antenna. You will work in groups of 2-3 students and each group is expected to identify a problem of their interest. You will start with performing a literature survey in that topic and develop research type questions of your own. Following the design, students will fabricate and test their antennas and compare with simulations. A project report will be submitted.

- The project teams will be formed and topics will be chosen during *third and fourth weeks*.
- You will use ANSYS HFSS during the design process for the simulations.
- Dielectric substrate (**FR4: $\varepsilon_r = 4.4, \tan\delta\,(loss\ tangent) = 0.02, thickness = 1.5\ mm$**) will be provided for fabrication. The antennas will be fabricated in VECS 322 (RF Research Laboratory) using LPKF Protomat S63 Circuit Board Plotter.
- Computer simulations and experimental results should match, and they should be around the preselected design specifications. Measurements will be performed in VECS 322.
- The device that you manufacture should be solid enough such that same results must be obtained in many consecutive measurements.
- A formal report will be submitted *due week 14*. Report will include the sections of abstract, theoretical background (introduction), antenna design process, layout of the design with its picture, results and analysis (computer simulations vs. measurements), and conclusion. Project success depending on the antenna performance as well as novelty of design will be taken into account.

Academic Integrity

Academic integrity is the cornerstone of the university and will be strongly enforced in this course.
Any student found in violation of the academic integrity policy will be given an "**F**" for the course and will be referred to the Office of Student Conduct. For additional information about WSU's academic integrity policy/procedures, please contact (360) 546 9573.

Student with Disabilities

Reasonable accommodations are available for students with a documented disability. If you have a disability and need accommodations to fully participate in this class, please call the Access Center at (360) 546-9238 or van.access.center@wsu.edu. Accommodations may take some time to implement so it is critical that you contact the Access Center as soon as possible.

Emergency Notification System

WSU has made an emergency notification system available for faculty, students, and staff. Please register at zzusis with emergency contact information (cell, email, text, etc.). You may have been prompted to complete emergency contact information when registering for classes at RONet. In the event of a building evacuation, a map at each classroom entrance shows the evacuation point for each building. Please refer to it. Finally, in case of class cancellation campus-wide, please check local media, the WSU Vancouver web page and/or http://www.flashalert.net/. Individual class cancellations may be made at the discretion of the instructor. Each individual is expected to make the best decision for their personal circumstances, taking safety into account. Safety plan website.

Audio, video, digital, commercial note-taking and other recording during class

Copyright 2015 <instructor name> covers this syllabus, all lectures, and course-related written materials. During this course students are prohibited from making audio, video, digital, or other recordings during class, or selling notes to or being paid for taking notes by any person or commercial firm without the permission of the faculty member teaching this course.

ECE 533 Tentative Weekly Schedule

Week	Topics	Homework / Exam
1	Review of fundamental parameters of antennas	
2	Friis transmission equation and radar range equation	HW # 1
3	Review of array theory	Project teams formed
4	Small antennas	Projects assigned, HW #2
5	Wideband microstrip antennas	
6	Frequency independent antennas	HW # 3
7	**Review and Midterm Exam**	Midterm
8	Phased arrays, design of array feed, mutual coupling	
9	Millimeter-wave antennas	HW # 4
10	Reconfigurable antennas	HW # 5
11	Antennas for medical applications	
12	Antennas for MIMO / Full-Duplex Systems	HW # 6
13	Antennas for mobile communications	
	Thanksgiving holiday – no class	
14	Metamaterial based antennas	Project report due
15	Review	
16	FINAL EXAM	