WORKSHEET — Request for a New Course

** Place your pointer on the underlined fields and start typing to fill in text, **
or use an X or a number to fill in “check-box” or numbered fields.

Provide information requested below that is not contained in the syllabus.
Please note the guidelines in the boxes.

Number (if known): _EE 118_  x Undergraduate  ___ Graduate  ___ Professional

Title/subtitle: _Radio Frequency Circuit Design_

Effective: _Winter 2018_ (Quarter and Year)

Offered:  x Fall  ___ Winter  ___ Spring  ___ Summer  ___ Once Only  ___ Other ___

Instructor(s): _TBD_

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Hours per week per unit of credit may not be less than but may exceed those listed below.

• One unit for each hour per week (1:1) of colloquium, consultation, discussion, lecture, seminar, or workshop

• One unit for each three hours per week (1:3) of activity, clinic, extra reading, fieldwork, individual study, internship, laboratory, practicum, research (scheduled and outside), screening, term paper, thesis, tutorial, written work, and similar assigned problems

• One unit for each two to three hours per week (1:2-3) of studio

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Units: _4_

Activities and hours per week: Indicate below the number of hours per week that students will spend in the activities listed (leave blank those that do not apply).

<table>
<thead>
<tr>
<th>Activity</th>
<th>Internship</th>
<th>Seminar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinic</td>
<td>3</td>
<td>Studio</td>
</tr>
<tr>
<td>Colloquium</td>
<td>3</td>
<td>Lecture</td>
</tr>
<tr>
<td>Consultation</td>
<td></td>
<td>Practicum</td>
</tr>
<tr>
<td>Discussion</td>
<td></td>
<td>Research (outside)</td>
</tr>
<tr>
<td>Extra Reading</td>
<td></td>
<td>Research (scheduled)</td>
</tr>
<tr>
<td>Field</td>
<td></td>
<td>Screening (outside)</td>
</tr>
<tr>
<td>Individual Study</td>
<td></td>
<td>Screening (scheduled)</td>
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<td></td>
<td></td>
<td>Other:</td>
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</tbody>
</table>

Prerequisite(s): _EE 116 with a grade of “D-” or better, EE100B with a grade of “D-” or better (can be taken concurrently)_.

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**Catalog description:** Studies design and analysis of radio frequency (RF) circuits. Topics include multiport networks, scattering matrix and S-parameters; transmission lines, matching networks; Smith Chart; RF electromagnetic analysis of waveguides, antennas, filters and couplers; RF transistor equivalent modeling, low-noise amplifier design, noise figure, oscillators and mixers, and phase lock loop.

**Grading:** __ Letter Grade or petition for Satisfactory/No Credit (S/NC) __ Letter Grade only __ In Progress (IP) __ Letter Grade or S/NC; no petition required __ S/NC only

The statements selected below will be added to the Catalog description by the Catalog office:

**Grading statement** (if required):
- _X_ Satisfactory (S) or No Credit (NC) grading is not available.
- ___ Graded Satisfactory (S) or No Credit (NC).
- ___ Normally graded Satisfactory (S) or No Credit (NC), but students may petition the instructor for a letter grade on the basis of assigned extra work or examination.
- ___ May be taken Satisfactory (S) or No Credit (NC) with consent of instructor and graduate advisor.
- ___ May be taken Satisfactory (S) or No Credit (NC) by students advanced to candidacy for the Ph.D.
- ___ Students who submit a term paper receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade.
- ___ Students who present a seminar receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade.
- ___ Students who present a seminar or submit a term paper receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade.
- ___ Other: ___

**Repeatability statement** (if required):
- ___ Course is repeatable.
- ___ Course is repeatable to a maximum of ____ units.
- ___ Course is repeatable as content changes.
- ___ Course is repeatable as content changes to a maximum of ____ units.
- ___ Course is repeatable as topics change.
- ___ Course is repeatable as topics change to a maximum of ____ units.
- ___ Other: ___

If the course is repeatable, may a student take more than one section of the course in a single quarter? ___ Yes ___ No

**Cross-listing statement:** Cross-listed with ___

**Credit statement** (to limit credit when course content overlaps):
Credit is awarded for only one of ____

Other ___
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**Breadth statement** (for CPAC, ETST, FVC, HASS, or WMST courses only):

- [ ] Fulfills the Humanities requirement for the College of Humanities, Arts, and Social Sciences.
- [ ] Fulfills the Social Sciences requirement for the College of Humanities, Arts, and Social Sciences.
- [ ] Fulfills either the Humanities or Social Sciences requirement for the College of Humanities, Arts, and Social Sciences.
- [ ] See the Student Affairs Office in the College of Humanities, Arts, and Social Sciences.
- [ ] Does not fulfill the Humanities or Social Sciences requirement for the College of Humanities, Arts, and Social Sciences.
- [ ] Other: ___

If the course **content overlaps or duplicates the content of another course**, describe the overlap or duplication: ____

If the course **affects degrees, minors, and/or programs**, list the affected degrees, etc. and explain how they are affected: ____

If the course **affects the prerequisites and/or descriptions of other courses**, list the affected courses and explain how they are affected: ____

**Justification** for establishing the course (insert or attach): **RF Circuit Design fills out the gap in the Electrical Engineering’s curriculum in the analysis and design of radio-frequency transmitting and receiving circuits and components. Computer modeling of electromagnetic fields using contemporary FEM software such as COMSOL is critical in the design of RF circuits and associated laboratory experiments will prepare undergraduate students to either continue studies or secure jobs in this field. The course will be a natural continuation to the series of courses already in place such as EE116 “Engineering Electromagnetics”, EE 001B “Engineering Circuits”, EE100 “Electronic Circuits”.

**Syllabus** (insert or attach and include the information below): attached below.

**Course requirements** (e.g., term papers and examinations)

If an activity selected above under “Activities and Hours” **does not involve faculty contact** (e.g., extra reading, individual study, and outside research), describe the activity and explain how it will be evaluated.

If one of the activities selected above is **consultation hours**, explain how these hours will be implemented and monitored.

For further information about course guidelines, see the General Rules and Policies Governing Courses of Instruction at senate.ucr.edu/Committees/courses/guidelines.pdf
Instructor: TBD

Department of Electrical and Computer Engineering
University of California, Riverside
Riverside, CA 92521-0429

EE 118 - RF Circuit Design

S Y L L A B U S

Quarter: Winter 2018
Units: Units: 4, Lecture: 3 hours, Laboratory: 3 hours
Prerequisite(s): EE 116 with a grade of “D-“ or better, EE 100B with a grade of “D-“ or better (can be taken concurrently)
Lab:
   Sect 021   TBD

Teaching Assistant(s): TBD

CATALOG DESCRIPTION

Studies design and analysis of radio frequency (RF) circuits. Topics include multiport networks, scattering matrix and S-parameters; transmission lines, matching networks; Smith Chart; RF electromagnetic analysis of waveguides, antennas, filters and couplers; RF transistor equivalent modeling, low-noise amplifier design, noise figure, oscillators and mixers, and phase lock loop.

TOPICS

Review of AC Analysis and Network Simulation
   - Voltage and current phasors, impedance, admittance;
   - Power transfer and losses;
   - RLC models;
   - Network simulation

Matching Networks and LC Resonators

Distributed Circuit Design
   - Transmission lines
   - Power losses
   - Telegrapher equations

Smith Chart
   - Basis of the Smith Chart
   - Impedance matching, single and multi-element, wideband
   - Bandwidth estimation

Single-, and Multiport Networks
   - Interconnecting networks
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- Network properties and application
- Scattering and Transmission matrices
- Definition and application of S-parameters
- Using the Smith Chart for evaluating the reflection coefficients

Electromagnetic Fields and Waves
- Review of EM fields and waves
- Skin effect
- EH fields on transmission lines
- Waveguides
- Fundamentals of antennas and radiation patterns

RF Filter Design

Directional Couplers

RF Transistor Modeling
- Equivalent RF Transistor Models
- Low-Noise Amplifier Design
- Noise Figure

Oscillators and Mixers
- Phase lock loop

<table>
<thead>
<tr>
<th>Week</th>
<th>Lecture Content</th>
<th>Required Reading from Course Textbook [1]</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Review of AC Analysis and Network Simulation</td>
<td>Lecture Notes</td>
</tr>
<tr>
<td>2</td>
<td>Matching Networks and Distributed Circuit Design</td>
<td>Lecture Notes</td>
</tr>
<tr>
<td>3</td>
<td>Smith Chart and Applications</td>
<td>Chapter 3</td>
</tr>
<tr>
<td>4</td>
<td>Single-, and Multiport Networks, S-parameters</td>
<td>Chapter 4</td>
</tr>
<tr>
<td>5</td>
<td>EM Fields and Waves, Skin Effect, Transmission Lines</td>
<td>Chapter 2</td>
</tr>
<tr>
<td>6</td>
<td>Waveguides, Antennas</td>
<td>Chapter 5</td>
</tr>
<tr>
<td>7</td>
<td>RF Filter Design, Microstrip Filters, Directional Couplers</td>
<td>Chapter 5, Appendix G</td>
</tr>
<tr>
<td>8</td>
<td>RF Transistor modeling, LNA Design, Noise Figure</td>
<td>Chapter 9, Lecture Notes</td>
</tr>
<tr>
<td>9</td>
<td>Oscillators and Mixers</td>
<td>Chapter 10</td>
</tr>
<tr>
<td>10</td>
<td>Phase Lock Loop</td>
<td>Lecture notes and recommended book [2]</td>
</tr>
</tbody>
</table>

HOMEWORK

Homework will be assigned every other week. Discussion of homework problems with the instructor, TAs, and/or classmates is highly encouraged. Nevertheless, all homework must be completed independently.

No late homework will be accepted.
LABORATORY EXPERIMENTS

All labs will be held in the Electrical Engineering Control Systems Laboratory (Chung 125). Discussion of lab experiments with the instructor, TAs, and/or other students is encouraged. Lab work will be done in groups of two. It is allowed to submit a single lab report per group.

You are expected to read the lab descriptions, and complete the pre-lab before scheduled lab session.

Each lab report is due one week after each experiment. Guidelines for the lab report must be followed. The emphasis will be placed on 1) the proper operation of the circuit designs, 2) the neatness of the implementation. It is required to keep a lab notebook by each student individually.

The labs will be software based: RF circuit design and analysis will be based on Spice and Matlab simulation software and electromagnetic RF analysis and applications will be based on COMSOL finite-element analysis (FEM) modeling software.

Laboratory’s content:

1) network simulations using Spice
2) design of matching networks and Smith Chart using Spice and Matlab;
3) modeling of multiport networks with S-parameters using Spice and Matlab;
4) electromagnetic modeling with COMSOL software;
5) modeling of waveguides and their characterization with COMSOL software
6) microstrip filter design with COMSOL software

EXAMS

Midterm: approximately the 5th week
Final: TBD

All exams are open book and open notes. Communication gadgets must be off (including laptops), and lecture notes’ sharing is strongly prohibited. Make-up exams are possible only under circumstances of sickness or personal emergency.

GRADING POLICY

Letter grade (4 units) is required:

   Homework: 10%
   Experiments: 25%
   Midterm: 30%
   Final: 35%

COURSE TEXTBOOK AND REFERENCES
