** 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 231  ___ Undergraduate  ___ Graduate  ___ Professional

Title/subtitle: Convex Optimization in Engineering Applications

Effective: Winter 2014  (Quarter and Year)

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

Instructor(s): Dr. Hamed Mohsenian-Rad

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

Units: ___

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>___</td>
<td>___</td>
</tr>
<tr>
<td>Colloquium</td>
<td>___</td>
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<tr>
<td>Consultation</td>
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<tr>
<td>Discussion</td>
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<tr>
<td>Extra Reading</td>
<td>___</td>
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<tr>
<td>Field</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>Individual Study</td>
<td>___</td>
<td>___</td>
</tr>
</tbody>
</table>

Prerequisite(s): EE 230 or a Similar Course
Read the guidelines in this box before writing the Catalog description.

Write the description in the present tense and limit it to 50 words (do not count grading information, repeatability information, or a list of E-Z subtitles). If possible, do not use complete sentences. However, use sentences that contain more than a list of items or topics.

Examples:
Instead of "This course will introduce students to the history of . . .," use one of the following formats:
- Introduces the history of . . .
- An introduction to the history of . . .
- Introduction to the history of . . .

Instead of “Functions, equations, and graphs,” use a format similar to one of the following examples:
- Explores functions, equations, and graphs . . .
- Topics include functions, equations, and graphs . . .
- A study of functions, equations, and graphs . . .


Grading: __ Letter Grade or petition for Satisfactory/No Credit (S/NC)  X  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):
- 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 ___NA___

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

Other ___

**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: __NA__

If the course affects degrees, minors, and/or programs, list the affected degrees, etc. and explain how they are affected: __This course is expected to be an “advanced course” for the Intelligent Systems, Control Systems, as well as Communications and Signal Processing tracks.__

If the course affects the prerequisites and/or descriptions of other courses, list the affected courses and explain how they are affected: __There is currently a very brief discussion of convex sets and functions in EE 230. They will be removed and included in the new course.__

**Justification** for establishing the course (insert or attach): __1) There is currently no graduate level course on optimization at UCR. 2) The only existing optimization course is MATH 120 that covers the most simple case of linear optimization while EE 231 will cover nonlinear convex optimization. 3) EE 231 will be application oriented and covers solving a variety of convex optimization problems in engineering disciplines, with more focus on communications, signal processing, power engineering, control engineering, and information theory. These applications are not (cannot be) covered in an undergraduate course such as MATH 120. 4) The topics covered can particularly help graduate students in tackling advanced optimization problems that they may face in their MS and Ph.D. research work.__

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

**Course requirements** Mid-Term Exam, Final Exam, Homework, Term Paper

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:
Dr. Hamed Mohsenian-Rad
Assistant Professor, Department of Electrical Engineering
Office: WCH 436
Email: hamed @ee.ucr.edu

Course Purpose:

Textbook:

Course Topics:

• Introduction [Chapter 1 & Appendix A]:
  o Mathematical optimization
  o Linear programming
  o Convex optimization

• Convex Sets [Chapter 2]:
  o Affine and convex sets
  o Examples: Hyperplanes, halfspaces, Ellipsoids, Norms, Polyhedra, PSD cones
  o Operations that preserve convexity

• Convex Function [Chapter 3]:
  o Basic properties and examples
  o Operations that preserve convexity
  o Log-concave and log-convex functions
  o Composition theorem and examples

• Convex optimization problems [Chapters 4 and 6]:
  o Convex optimization problems
  o Linear optimization problems
  o Quadratic optimization problems
  o Geometric programming
- Generalized inequality constraints
- Approximations and Fitting
- Equivalent convex problems and examples

- **Solving Convex Optimization Problems – Part I [Papers & Chapters 6-8]:**
  - Introduction to CVX
  - Using CVX to solve multiple engineering optimization problems

- **Duality [Chapter 5]**
  - The Lagrange dual function
  - The Lagrange dual problem
  - Geometric interpretation
  - Saddle-point interpretation
  - Optimality conditions

- **Solving Convex Optimization Problems – Part II [Chapters 9-11]:**
  - Numerical linear algebra background
  - Unconstrained minimization
  - Equality constrained minimization
  - Interior-point methods

**Pre-requisites:**

EE 230: Mathematical Methods for Electrical Engineering

*Note: Similar courses in other departments will be accepted upon the instructor’s approval.*

**Grading (Percentage):**

- Homework – 25%
- Midterm Exam: 25%
- Final Exam – 40%
- Final Project Report and MATLAB code* – 10%

*One page showing the formulation of an example convex optimization problem in the students’ area of research together with a MATLAB code to solve it using CVX toolbox.