University of Tehran
School of Electrical and Computer Engineering

<table>
<tr><td>Course:</td><td colspan="10">8101291– Adaptive Filter Theory</td></tr>
<tr><td>Course type:</td><td colspan="10"><table>
<tr><td></td><td colspan="6">EE*</td><td colspan="3">CE*</td><td rowspan="2">Credit: 3</td></tr>
<tr><td></td><td>Com</td><td>E</td><td>P</td><td>B</td><td>Con</td><td>D</td><td>SW</td><td>HW</td><td>IT</td></tr>
<tr><td>Required</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td></td></tr>
<tr><td>Elective</td><td>☒</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td></td></tr>
</table></td></tr>
<tr><td>Level:</td><td colspan="10">Undergraduate ☐
Graduate ■</td></tr>
<tr><td>Co-requisite(s):</td><td colspan="10">Stochastic Processes(8101272)</td></tr>
<tr><td>Prerequisite(s):</td><td colspan="10">Digital Signal Processing (8101125)</td></tr>
<tr><td>Prerequisite by topic:</td><td colspan="10">Discrete-Time signals and systems, Discrete random processes</td></tr>
<tr><td>Textbook(s):</td><td colspan="10">[1] S. Haykin, Adaptive Filter Theory, 5th edition, Prentice-Hall, 2014.</td></tr>
<tr><td>Coordinator:</td><td colspan="10">A. Olfat, Associate Professor, School of ECE</td></tr>
<tr><td>Goals:</td><td colspan="10">In this course optimal filters are derived and consequently adaptive algorithms that can converge to those optimal filters are introduced. This course sets up a general framework for different adaptive algorithms and introduces the mathematical tools and techniques for analysis of adaptive filters.</td></tr>
<tr><td>Outcome:</td><td colspan="10">Upon successful completion of the course, students will be able
1. To understand different mathematical models for stochastic signals
2. To formulate Minimum Mean Square problems and obtain their closed form solutions such as wiener filters.
3. Formulate different multivariable consrained or unconstrained optimization problems and their solutions.
4. Obtain adaptive implementation for optimization problems.
5. Investigate the performance, convergence and computational trade-offs of adaptive algorithms.</td></tr>
<tr><td>Topics:</td><td colspan="10">1. Review of DSP and random processes
2. Properties and Eigen-structure of non-negative definite matrices.
3. Optimal mean square error filters.
4. Linearly constrained minimum variance (LCMV) filtering</td></tr>
</table>

	5. Array processing applications, generalized sidelobe canceller. 6. Steepest descent algorithm and its convergence properties. 7. Least mean square (LMS) algorithms and its performance analysis. 8. Normalizes LMS and affine projection adaptive filters. 9. Transform-domain adaptive filtering. 10. Linear prediction; Levinson - Durbin algorithm. 11. Method of least square and recursive least square (RLS) algorithm. 12. Singular value decomposition(SVD). 13. Lattice structures and fast RLS algorithms. 14. Tracking properties of adaptive filters.
Computer usage:	MATLAB
Assignments:	7 to 8 assignments
Projects:	Term project on a related topic
Grading:	Assignments: 25% Project: 25% Midterm exams: 25% Final exam: 25%
Further readings:	[1] B. Farhang-Boroujeny, *Adaptive Filters: Theory and Applications,* 2nd edition, Wiley, 2015. [2] A. H. Sayed, *Adaptive Filters*, Wiley, 2008. [3] A. H. Sayed, *Fundamentals of Adaptive Filtering*, Wiley, 2003. [4] D. Manolakis, V. Ingle and S. Kogon, *Statistical and Adaptive Signal Processing,* Artech House, 2005. [5] B. Widrow and S. Stearns, *Adaptive Signal Processing,* Prentice-Hall, 1985.
Prepared by:	Ali Olfat
Date:	December 9, 2017.

*EE: Electrical Engineering		CE: Computer Engineering	
Com	Communications	SW	Software
E	Electronics	HW	Hardware
P	Power	IT	Information Technology
B	Bioelectronics		
Con	Control		
D	Digital System		