University of Tehran
School of Civil Engineering

Course:	**8102457 - Adaptive Finite Element Method**		
Course type:	Optional		Credit: 3
Level:	PhD and MSc students		
Co-requisite(s):	-		
Prerequisite(s):	Finite Element Method		
Prerequisite by topic:	-		
Textbook(s):	[1] A posteriori error estimation in finite element analysis; M. Ainsworth, J.T. Oden, Wiley, 200. . [2] Finite Element Methods, 6th Edition; ORC Zienkiewicz and R. Taylor, 2006. [3] Adaptive finite and boundary element methods; C.A. Brebbia, M.H. Aliabadi, Elsevier, 1993. [4] Grid generation; J.F. Thompson, B.K. Soni, N.P. Weatherill, CRC Press, 1999. [5] Numerical grid generation, foundations and applications; J.F. Thompson, Z.U.A. Warzi, C.W. Mastin, North-Holland Publishers. [6] Modelling, mesh generation and adaptive numerical methods for partial differential equations; W.D. Henshaw, I. Babuska, Springer, 2001.		
Coordinator:	S. Mohammadi, Professor of Computational Mechanics, School of Civil Engineering		
Goals:	The main objectives are to introduce the concepts of mesh generation, error estimation and adaptive finite element solutions, and to discuss advantageous and disadvantageous of available numerical techniques for both efficient and reliable analysis of complex engineering models.		
Outcome:	1. A historical review of available techniques. 2. Mesh generation techniques a. Analytical curve generation methods b. Analytical surface generation methods c. Numerical mesh generations 3. Error estimations a. Conceptual means of errors b. Basic finite element errors c. Numerical interpolation errors d. Discretization errors e. Error indicators/estimators 4. Adaptive finite element analysis a. Gradient based methods		

	b. Residual based methods c. Recovery based methods
Topics:	1. A historical review of available techniques. 2. Mesh generation techniques a. Analytical curve generation methods b. Analytical surface generation methods c. B-Splines and NURBS d. Structured mesh generations e. Unstructured Delaunay mesh generator f. Unstructured Advancing Front mesh generator 3. Error estimations a. Mathematical bases of errors b. Basic finite element errors c. Numerical interpolation errors d. Discretization errors e. Error indicators f. Error estimators g. Superconvergent Patch Recovery (SPR) technique h. Recovery by Equilibrium on Patches (REP) i. Wavelet technique 4. Adaptive finite element analysis a. Estimation of error b. Remeshing techniques c. Old to new mesh transformation techniques d. Nonlinear problems e. Effects of boundary conditions 5. Advanced topics a. Error estimation based on fundamental solutions b. Isogeometric analysis (IGA)
Computer usage:	Necessary for assignments and final project
Assignments:	15 homework assignments (programming and theoretical)
Projects:	1 final programming project
Grading:	Assignments: 35 % Project: 35 % Final exam: 30 %
Further readings:	[1] Several papers published on the subject every year.
Prepared by:	Soheil Mohammadi
Date:	February 9, 2014