CE 529 Finite Element Analysis (4)

2023 Fall Semester — Course Syllabus

Lecture	Tuesday	4:00 p.m. to 7:20 p.m.	OHE 132
Lab	Friday	5:30 p.m. to 6:20 p.m.	OHE 100b
Professor	L. Carter Wellford		
Office	KAP 238B		
Office Hours	Two sessions a week – 1 hour each – online – time and dates to be determined		
Phone	(310) 968-1224 cell		
Email	wellford@usc.edu		
TA Office Hours			
Teaching Assistant	To be defined		
Email	To be defined		
Office	Three sessions a week – 1 hour each - online – time and dates to be determined		
Office Hours			
Emphasis	ABAQUS, ABAQUS Lab, HW and Exam Preparation Computer Implementation, Course Project		
Course Producer	To be defined		
Email	To be defined		
Office			
Office Hours	Course Project Office Hours – two 1 hour sessions a week – after 6th week project assignment – time and dates to be determined		
Emphasis	Computer Implementation, Matlab, ABAQUS, Course Project		
Prerequisites	Graduate Standing		
Textbook	Cook, et. al., "Concepts and Applications of Finite Element Analysis", Wiley		
Course Reader	Wellford, L.C., "CE 529 Class Notes", in the Content Section of the		

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Course Description	Typical engineering problems discussed on a physical basis. Setup and solution of problems by means of the existing mathematical tools	
Course Objectives	See description below	
Learning Objectives		
Policies on		
Late work	No late homework will be accepted	
Make-up work		
Incom-plete work		
Extra credit		
Final grade schema is based on the following percentages of graded coursework :		
Home-work	25 %	Homework assigned weekly, problems are due on the following week
Lab Home-work	5 %	
Midter m	25 %	10/13/2020
Final Project	20 %	Due 12/8/2020
Final Exam	25 %	12/8/2020 — 4:30—6:30pm
Total	100 %	

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Class Calendar (topic dates are subject to change)

Week	Date	Main Lecture Topics	Lectures	Due Dates
1	8/25	Potential Energy Formulations, Basic Finite Elements; Bar,Truss. Variational Principles, Calculus of Variations, Variational Models.	Lect. 1,2	
2	9/1	Galerkin Methods, Continuum Elements, Isoparametric formulations	Lect. 3,4	
3	9/8	Stress Calculations, Barlow Points; Constraints:La-grange, Penalty.	Lect. 5,6	
4	9/15	Elasticity Problems, 2-D and 3-D, Axisymmetric Problems	Lect. 7,8	
5	9/22	Plate Elements, Drilling DOF, Thick Beams/Plates, Kirchhoff, Mindlin elements	Lect. 8a,b,c	
6	9/29	DKQ Plate Elements, Shell Elements, Structural Dynamics	Lect, 9,10	
7	10/6	Computational Methods, Course Project	Lect. 18	
8	10/13	Midterm Exam		
9	10/20	Elastic Stability Buckling, Adaptive Nonlinear and Incom-pressible Problems	Lect. 11,12a,b	
10	10/27	Nonlinear Mechanics, Nonlinear Mechanics - Stress, Nonlinear Balance Laws, Total Lagrangian Method, Updated Lagrangian Method	Lect. 13a,b,c,d	
11	11/3	Plasticity - Basic Concepts, Formulations, Radial Return, Complete Inelastic Formulations	Lect. 14a,b 15a,b,c	
12	11/10	Contact and Impact Problems	Lect. 16a, 16b	
13	11/17	Material Nonlinearity – Hyperelastic Materials	Lect. 17	
14	11/24	Performance based Analysis, Fiber Elements, R/C Joint and Panel Zone Models	Lect. 19, 19a,b,20a,b	
	12/8	4:30-6:30 PM	Final Exam	Proj

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Lectures and Associated Topics

Lecture	Lecture Topics	Total Pages	
1	Introduction to Finite Elements	20	
2	Variational Principles	16	
3	Galerkin Direct Methods	26	
4	Continuum Elements Part 1, Isoparametric Elements	23	
5a	Part 1 Stress Calculations	25	
5b	Part 2 Barlow Points	41	
6	2-D and 3-D Elements	26	
7	Axisymmetric Problems	19	
8a	Plate Elements	42	
8b	Drilling Degrees of Freedom	23	
8c	Thick Beams and Plates	8	
9	Shell Elements	28	
10	Structural Dynamics	36	
11	Adaptive Nonlinear Problems	29	
12a	Elastic Stability Buckling	31	
12b	Incompresible Constrained Problems	31	
13a	Nonlinear Mechanics	14	
13b	Nonlinear Mechanics - Stress	9	
13c	Nonlinear Balance Laws	11	
13d	Total Lagrangian Method	17	
14a	Basic Concepts in Plasticity	30	
14b	Plasticity Formulations	30	
15a	Radial Return	1	
15b	Plasticity Radial Return	29	
15c	Complete Inelastic Formulations	36	
16a	Contact Problems	46	

16b	Contact and Impact	47	
17	Hyperelastic Materials	30	
18	Computational Methods	33	
19	Performance Based Analysis	23	
19a	Fiber Elements	9	
19b	Fiber Element Applications	6	
20a	R/C Joint and Panel Zone Models (Conc.)	34	
20b	Analytical Modeling of Inelastic Seismic Response	22	
20c	Modeling Reinforced Concrete Beam-Column Joints	12	
20d	Nonlinear Static Pushover Analysis	20	

Variational Models
Calculus of variations
Constraints – Lagrange multiplier
Constraints – penalty
Galerkin method
Continuum Finite Elements
1-D interpolation methods
2-D interpolation methods – rectangles and triangles
3-D interpolation methods – hexahedron, tetrahedron, prism
Isoparameteric Elements
Mappings – physical system and natural coordinate system
Numerical integration – Gauss quadrature
Numerical Implementation of the Finite Element Method
Column storage schemes
Assembly in active column form
Static column solvers
Mesh generation
Finite Elements for Elasticity Problems
Plane stress – plane strain
Stress calculation
Incompressible problems
Pressure, enforced displacement, and thermal loadings
Finite Elements for Axisymmetric Elasticity Problems
Finite Elements for Plate Problems
Finite Elements for Shell Problems
Finite Elements for Dynamic Problems
Introduction to Nonlinear Finite Element Analysis
Adaptive methods
Stability problems

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STATEMENT ON ACADEMIC INTEGRITY

USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one's own academic work from misuse by others as well as to avoid using another's work as one's own.

All students are expected to understand and abide by these principles. *SCampus,* the Student Guidebook, contains the Student Conduct Code in Section 11.00, while the recommended sanctions are located in Appendix A: http://www.usc.edu/dept/publications/SCAMPUS/gov/. Students will be referred to the Office of Student Judicial Affairs and Community Standards for further review, should there be any suspicion of academic dishonesty. The Review process can be found at: http://www.usc.edu/student-affairs/SJACS/.

STATEMENT FOR STUDENTS WITH DISABILITIES

Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to me (or to TA) as early in the semester as possible.

DSP Contact Information

Office location: **STU 301**

Hours open: **8:30 a.m. until 5:00 p.m. —** Monday through Friday.

Phone number: **(213) 740-0776**