University of Isfahan

Course outline
Structural Engineering
Graduate Program

Department of Civil Engineering
Faculty of Civil Engineering and Transportation
University of Isfahan

September 2024

1. Definition and goal

The graduate program in Structural Engineering leads to the awarding of Master of Science (MSc) and Doctor of Philosophy (Ph.D.) degrees. It comprises a coordinated set of educational and research activities in various fields of civil-structural engineering. The core focus of academic activities in this graduate program, depending on the subject, involves theoretical, experimental, or a combination of both research approaches, with education serving as a means to facilitate the achievement of research goals. The purpose of establishing the graduate program in Structural Engineering is to train competent individuals for conducting advanced educational and research activities in various areas of civil-structural engineering. The curriculum, educational, and research program are designed to provide students with the fundamental and advanced knowledge of structural engineering, along with the opportunity to engage in research on modern topics in diverse areas within the field.

The goal of the Structural Engineering graduate program is to train individuals with the necessary skills to design and supervise the execution of specialized projects in the field of structures, as well as sufficient research capabilities to solve the challenges they encounter in this field. These specialized projects may include high-rise buildings and relatively complex low-rise buildings, industrial structures such as factories and silos, hydraulic structures such as dams and water reservoirs, harbor construction, large bridges, tunnels, and similar structures.

2. Duration of Program and the structure

The duration of the Master and PhD programs in Structural Engineering is in accordance with the latest regulations and based on the educational guidelines for the Master and PhD programs approved by the Supreme Council for Planning of the Ministry of Science, Research, and Technology. The total number of credits for the Master program is 32 credits, while for the PhD program it is 36 credits, as outlined in Table 1.

Table 1: Number of Course and Research Credits

No.	Course Type	Master		PhD
		(Research-Oriented)	(Course-Based)	(Research-Oriented)
1	Core (Based on Table 2)	12	12	0
2	Elective (Based on Tables 2 and 3)	12	18	15
3	Research Method	1	1	0
4	Seminar	1	1	0
5	Thesis or Dissertation	6	0	21
	Total	*32*	*32*	*36*

3. Credits

Master's students in Structural Engineering (both research-oriented and course-based tracks) are required to successfully complete 12 credits of Core courses, as listed in Table 2. Their elective courses are selected based on Table 3.

For PhD students, no Core courses are required. All the credits needed for graduation are chosen based on Tables 2 and 3, upon the recommendation of their academic advisor. A PhD student cannot select elective courses from those they have already completed during their Master program.

For students entering the Master program in Structural Engineering from non-civil engineering disciplines, it is mandatory to take a number of remedial courses (up to 12 credits) as determined by the department, according to Table 4.

For students entering the PhD program in Structural Engineering from disciplines other than structural engineering, it is mandatory to take a number of remedial courses (up to 6 credits) as determined by the department, based on Tables 2 and 3.

Table 2: Core Courses for the Masters Program in Structural Engineering

Course No.	Course Title	Credits	Hours per week		
			Theory	Practical	Total
CN:3016380	Advanced Engineering Mathematics	3	48	0	48
CN:3016271	Structural Dynamics	3	48	0	48
CN:3016450	Theory of Elasticity	3	48	0	48
CN:3016216	Finite Element Method	3	48	0	48

Table 3: Elective Courses for the Graduate Program in Structural Engineering

Course No.	Course Title	Credits	Hours per week		
			Theory	Practical	Total
CN:3016258	Advanced Design of Concrete Structures	3	48	0	48
CN:3016451	Advanced Design of Steel Structures	3	48	0	48
CN:3016452	Bridge Design	3	48	0	48
CN:3016477	Pre-stressed Concrete	3	48	0	48
CN:3016453	Design of Industrial Structures	3	48	0	48
CN:3016257	Stability of Structures	3	48	0	48
CN:3016370	Tall Buildings	3	48	0	48
CN:3016454	Blast Theory and Design of Structures	3	48	0	48
CN:3016455	Advanced Structural Dynamics	3	48	0	48
CN:3016456	Experimental Analysis of Structures and Laboratory	3	32	32	64
CN:3016457	Inelastic Analysis of Structures	3	48	0	48
CN:3016458	Seismic Design of Structures	3	48	0	48
CN:3016459	Seismic Rehabilitation of Existing Structures	3	48	0	48
CN:3016390	Seismic Effect on Special Structures	3	48	0	48
CN:3016108	Soil-Structure Interaction	3	48	0	48
CN:3016366	Structural Control	3	48	0	48
CN:3016460	Health Monitoring of Structures	3	48	0	48
CN:3016348	Performance Based Design of Structures	3	48	0	48
CN:3016461	Destruction of Buildings	3	48	0	48
CN:3016478	Advanced Concrete Technology	3	48	0	48
CN:3016462	Theory of Plates	3	48	0	48
CN:3016217	Continuum Mechanics	3	48	0	48
CN:3016369	Mechanics of Composite Materials	3	48	0	48
CN:3016396	Theory of Plasticity	3	48	0	48
CN:3016375	Fracture Mechanics	3	48	0	48
CN:3016463	Theory of Shells	3	48	0	48
CN:3016368	Nonlinear Finite Element	3	48	0	48
CN:3016464	Boundary Element Method	3	48	0	48
CN:3016392	Optimization in Engineering	3	48	0	48
CN:3016367	Reliability Analysis of Structures	3	48	0	48
CN:3016465	Random Vibrations	3	48	0	48
CN:3016395	Soft Computation	3	48	0	48
CN:3016402	Cold Formed Steel Structures	3	48	0	48
CN:3016386	Basics of Marine Structural Design	3	48	0	48
CN:3016466	Analysis and Design of Adobe Structures	3	48	0	48
CN:3016467	Pathology and Restoration Technology of Traditional Structures	3	32	16	48
CN:3016468	Lifeline Earthquake Engineering	3	48	0	48
CN:3016469	Computational Plasticity	3	48	0	48
CN:3016470	Advanced Topics in Elasticity	3	48	0	48
CN:3016471	Micro- and Nano-Mechanics of Solids	3	48	0	48
CN:3016479	Special Topics in Structural Engineering	3	48	0	48

Note: A student may select up to two elective courses from related civil engineering subjects offered in other graduate programs, with the approval of the department's Graduate Studies Council.

Table 4: Remedial Courses for the Masters Program in Structural Engineering

Course No.	Course Title	Credits	Hours per week		
			Theory	Practical	Total
CN:3016128	Solids Mechanic 1	3	48	0	48
CN:3016129	Structural Analysis 1	3	48	0	48
CN:3016132	Concrete Structures 1	3	48	0	48
CN:3016135	Steel Structures 1	3	48	0	48
CN:3016131	Earthquake Engineering	3	48	0	48

ADVANCED DESIGN OF CONCRETE STRUCTURES

BASIC INFORMATION

Course prefix and semester: Elective, S2
Number of credits: 3

COURSE PREREQUISITES:

Reinforced concrete design 2 (BSc)

TEACHERS:

Person in charge: Dr. Maryam Daei
Office location: Faculty of Civil Engineering and Transportation, University of Isfahan, Hezar-Jerib av., Isfahan, Iran.
Phone Number: +98 (31) 37935310
Homepage: http://eng.ui.ac.ir/~m.daei
Email Address: m.daei@eng.ui.ac.ir

WEEKLY HOURS

Theory	Problem Solving	Laboratory	Guided learning
3 h	-	-	1 h

COURSE OBJECTIVES

Students are expected to:

- ✓ Be familiar with advanced concrete constructional systems and technology
- ✓ Design of specific concrete structures

REQUIRED STUDENT RESOURCES

Textbooks and references:

1- C. K. Wang , C. G. Salmon, J. A. Pincheira, "Reinforced Concrete Design", 7th edition, Wiley; 2006.
2- T. T. C. Hsu, "Unified Theory of Reinforced Concrete", 2nd edition, CRC-Press; 2010.
3- J. C. McCormac and R. H. Brown, "Design of Reinforced Concrete", 9 th edition, Wiley; 2013.

Web links:

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Computer Software:

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COURSE SCHEDULE/OUTLINE/CALENDAR OF EVENTS

Week	Topic
1	Introduction to advanced design of concrete structures
2	Analyze and design of precast concrete
3	Introductory to analyses and design of pre-stressed concrete beam
4	Analyze and design a grid floor system
5	Analyze and design of high-strength concrete
6	Analyze and design a flat slab system
7	Analyze and design a grid floor system
8	Analyze and design of concrete shell structures
9	Analyze and design of underground and elevated water storage tank
10	Analyze and design of chimneys
11	Analyze and design of bunkers and silos
12	Introductory to analyze and design of bridges
13	Ductile detailing of frames for seismic forces
14	Deflection of reinforced concrete beams and slabs
15	Estimation of crack width in reinforced concrete members
16	Design of reinforced concrete members for fire resistance

EVALUATION PROCEDURES AND GRADING CRITERIA

Assignments 20% of final grade

Mid-Term Exam	40% of final grade
Final Exam	40% of final grade
	100%

ATTENDANCE STATEMENT

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STUDENTS WITH DISABILITIES ACT FOR STUDENTS WITH SPECIAL NEEDS STATEMENT

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APPROVED ACADEMIC HONESTY STATEMENT

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SYLLABI ON WEB PAGES

Last update: September 2024.

ADVANCED ENGINEERING MATHEMATICS

Basic Information

Course prefix and semester: Core, S1 or S2
Number of credits: 3

Course prerequisites and co-requisites:

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Teachers:

Person in charge: Dr. Mahmoud Hashemi
Office location: Civil Engineering department, Faculty of Civil Engineering & Transportation, University of Isfahan, Hezar-Jerib av., Isfahan, Iran
Phone Number: +98 (31) 37935086
Homepage: http://eng.ui.ac.ir/~m.hashemi
Email Address: m.hashemi@eng.ui.ac.ir

Weekly hours

Theory	Problem Solving	Laboratory	Guided learning
3 h	-	-	1 h

Course Objectives

- The preparation of this course has been inspired by the following objectives:
- Advanced topics in engineering and applied mathematics
- Topics in differential equations, complex numbers theory, tensors and functional analysis

Required Student Resources

Textbooks and references:

1- P. V. O'Neil, “Advanced Engineering Mathematics”, 7th edition, Cengage-Engineering; 2011.
2- D. G. Zill and W. S. Wright, “Advanced Engineering Mathematics”, 4th edition, Jones & Bartlett Pub; 2009.
3- M. Greenberg, “Advanced Engineering Mathematics”, 2nd edition, Prentice Hall; 1998.
4- E. Kreyszig, “Advanced Engineering Mathematics”, 10th edition, Wiley, New York, 2011.
5- Hildebrand, FB. Methods of Applied Mathematics, Dover Publications, 1992.

Web links:

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Computer Software:

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Course Schedule/Outline/Calendar of Events

Week	Topic
1	course introduction, objectives, references, assignments; preliminary definitions; Fourier series; Euler’s formula
2	Fourier series convergence theorem; periodic functions of arbitrary period; Fourier series for even and odd functions; half-range expansion; solution of differential equations with Fourier series
3	approximation with trigonometric polynomials; Gibb’s phenomenon; Sturm-Liouville problems; orthogonality of functions; Fourier-Bessel and Fourier-Legendre series
4	Fourier integral; Fourier sine and cosine integral; Fourier transform; Fourier sine and cosine transforms; Fourier transform of derivatives of a function
5	complex Fourier integral; complex Fourier transform; introduction to partial differential equations; definitions for linear, non-linear, homogenous, inhomogeneous differential equations
6	wave equation; separation of variables method; D'Alembert’s method; heat transfer equation; Dirichlet and Neumann problems; solution of heat transfer problems with Fourier series
7	solution of heat transfer problems with Fourier integral; solution of membrane problem (2D wave equation); 2D Fourier series
8	mid-term exam; complex numbers in Cartesian and polar coordinates; basic algebra on complex numbers; integer powers of a complex number; integer roots of a complex number
9	limits and derivatives of complex functions; analytic function; Cauchy-Riemann equations; exponential function; trigonometric functions; logarithm and general power

Week	Topic
10	an introduction to complex integration; indefinite integration; Cauchy integral theorem; derivatives of analytic functions
11	series and sequences; convergence tests; power series; convergence of power series; functions given by power series
12	Taylor series; Maclaurin series; Taylor series convergence; functions given by Taylor series; uniform convergence
13	residue theorem; residue integration method; residue integration of real integrals; residue integration of improper integrals
14	conformal mapping; properties of conformal mappings in harmonic equations; using conformal mapping in solution of partial differential equations
15	an introduction to tensor calculus; properties of tensors; indicial notation; Cartesian tensors; tensor operations
16	an introduction to functional analysis; Euler-Lagrange equation; application of functional analysis in numerical methods such as Rayligh-Ritz

EVALUATION PROCEDURES AND GRADING CRITERIA

Assignments	10% of final grade
Mid-Term Exam	40% of final grade
Final Exam	50% of final grade
	100%

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SYLLABI ON WEB PAGES

Last update: September 2024.

ADVANCED DESIGN OF STEEL STRUCTURES

BASIC INFORMATION
Course prefix and semester: Elective, S1 or S2
Number of credits: 3

COURSE PREREQUISITES AND CO-REQUISITES:
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TEACHERS:
Person in charge: Dr. Hossein Amoushahi
Office location: Department of Civil and Transportation Engineering, University of Isfahan, Hezar-Jerib av., Isfahan, Iran
Phone Number: +98 (31) 37935285
Email Address: h.amoushahi@eng.ui.ac.ir

WEEKLY HOURS

Theory	Problem Solving	Laboratory	Guided learning
3 h	-	-	1 h

COURSE OBJECTIVES
In this course, students learn the basics of designing steel structures such as the principles of stability of compression components, bending and plates.

- ✓ The principles of stability of compressive components in elastic and inelastic buckling, the effect of residual stresses, the design of the compressive members, the effective length of the compression components, the study of the basics of the rules and codes
- ✓ Torsion in beams, Torsion in different sections and profiles
- ✓ Torsional buckling, Torsional-bending buckling, statues of columns design
- ✓ Plastic analysis
- ✓ Lateral-torsional buckling, the basis of the rules of the codes
- ✓ Principles of stability of plates in elastic and inelastic buckling, examination of the basics of the rules of the codes
- ✓ Local buckling of steel sections, shear buckling, rules of regulations
- ✓ Beam-column design, methods for analyzing the stability of members in different axial load conditions and lateral loads, examination of rules of regulations
- ✓ the design of columnar columns with variable cross-section
- ✓ Design and analysis of prequalified moment frame joints
- ✓ Design and attention to fatigue, member and joints design
- ✓ Reminder notes about industrial structures: heavy industrial halls, bunkers and silos, tanks stable high-pressure tanks

REQUIRED STUDENT RESOURCES
Textbooks:

1. Azhari M., Amoushahi H., Mirghaderi R., Design of Steel Structures, Vol.5, 16th edition, Arkan Danesh Pub., 2016.
2. Steel profiles tables, Stahl.

References:

3. 1- C. G. Salmon, J. E. Johnson and F. Malhas, Steel Structures: Design and Behavior, 5th edition, Prentice Hall; 2013.
4. 2- L. F. Geschwindner, Unified Design of Steel Structures, 2nd edition, Wiley; 2011.
5. 3- N. S. Trahair, M. A. Bradford, D. Nethercot and L. Gardner The Behaviour and Design of Steel Structures to EC3, 4th edition, Taylor & Francis; 2008.
6. 4- E. H. Gaylord, C. N. Gaylord and J. E. Stallmeyer, Design of Steel Structures, 3rd edition, McGraw-Hill Companies; 1991.

COURSE SCHEDULE/OUTLINE/CALENDAR OF EVENTS

Week	Topic
1	Principle of design of steel structures
2	The principles of stability of compressive components in elastic and inelastic buckling
3	The effect of residual stresses, the design of the compressive members
4	Design of compressive members

Week	Topic
5	Torsion in beams, Torsion in different sections and profiles
6	Torsional buckling, Torsional-bending buckling, statues of columns design
7	Plastic analysis
8	Lateral-torsional buckling
9	Lateral-torsional buckling
10	Local buckling of steel sections, shear buckling, rules of regulations
11	Midterm exam
12	Methods for analyzing the stability of members in different axial load conditions and lateral loads
13	Beam-column design
14	Design and analysis of prequalified moment frame joints
15	Design and attention to fatigue, member and joints design
16	Projects presentation

EVALUATION PROCEDURES AND GRADING CRITERIA

Assignment	15% of final grade
Project	25% of final grade
Mid-Term Exam	30% of final grade
Final Exam	30% of final grade
	100%

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SYLLABI ON WEB PAGES

Last update: September 2024.

COLD FORMED STEEL STRUCTURES

BASIC INFORMATION

Course prefix and semester: Elective, S1 or S2
Number of credits: 3

COURSE PREREQUISITES:

• Static analysis of structures
• Structural design
• Rigid-body dynamics
• Mathematics

TEACHERS:

Person in charge: Dr. Mehran Zeynalian
Office location: Civil Engineering department, Faculty of Civil Engineering & Transportation, University of Isfahan, Hezar-Jerib av., Isfahan, Iran
Phone Number: +98 (31) 37935270
Email Address: m.zeynalian@eng.ui.ac.ir
Others: m.zeynalian@eng.ui.ac.ir

WEEKLY HOURS

Theory	Problem Solving	Laboratory	Guided learning
3 h	-	-	1 h

COURSE OBJECTIVES

Students are expected to:

✓ Be familiar with the construction methods of cold formed steel (CFS) structures
✓ Design cold formed steel structures including: structural members, connections, lateral bracing systems, and etc.
✓ Inspect the manufactured steel structures according to available codes and standards

REQUIRED STUDENT RESOURCES

Textbooks:

1. Yu, W.W. and R.A. LaBoube, Cold-Formed Steel Design. 2010: Wiley.
2. Hancock, G.J., D.S. Ellifritt, and T.M. Murray, Cold-Formed Steel Structures to the AISI Specification. 2001: Marcel Dekker Incorporated.
3. Ghersi, A., R. Landolfo, and F.M. Mazzolani, Design of Metallic Cold-Formed Thin-Walled Members. 2002: Spon Press

References:
AISI Standards, ASTM Standards
Web links:
-
Computer Software:
CUFSM

COURSE SCHEDULE/OUTLINE/CALENDAR OF EVENTS

Week	Topic
1	Introduction, advantages and disadvantages of CFS structures
2	Construction styles of CFS buildings
3	Mechanical properties of CFS sections, residual stress, imperfections
4	Local buckling in CFS sections
5	Distortional and global buckling in CFS elements
6	Introducing available codes and standards on CFS structures worldwide; different approach to design CFS structures
7	Design of CFS Elements – Tension and compression
8	Design of CFS Elements – Bending
9	Design of CFS Elements – Shear
10	Design of CFS Elements – Torsion

Week	Topic
11	Design of lateral resistant systems for CFS structures
12	Screwed connection design
13	Riveted connection design
14	Welded connection design
15	Technical issues of CFS structures (design and construction)
16	Introducing some available software related to CFS structures

EVALUATION PROCEDURES AND GRADING CRITERIA

Assignments	10% of final grade
Course project	20% of final grade
Mid-Term Exam	30% of final grade
Final Exam	40% of final grade
	100%

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SYLLABI ON WEB PAGES

Last update: September 2024.

COMPUTATIONAL PLASTICITY

BASIC INFORMATION
Course prefix and semester: Elective, S2
Number of credits: 3

COURSE PREREQUISITES AND CO-REQUISITES:
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TEACHERS:
Person in charge: Dr. Maryam Daei
Office location: Department of Civil Engineering and Transportation, University of Isfahan, Hezar-Jerib av., Isfahan, Iran
Phone Number: +98 (31) 37935310
Homepage: http://eng.ui.ac.ir/~m.daei
Email Address: m.daei@eng.ui.ac.ir

WEEKLY HOURS

Theory	Problem Solving	Laboratory	Guided learning
3 h	-	-	1 h

COURSE OBJECTIVES
The preparation of this course has been inspired by the following objectives:
• An introduction to materially non-linear behavior of structures
• Using the finite element method in solution of elastoplastic problems of solid mechanics and structures

REQUIRED STUDENT RESOURCES
Textbooks and References:
1- W. F. Chen, D. J. Han, “Plasticity for Structural Engineers”, Springer New York, 2011.
2- D. R. J. Owen and E. Hinton, “Finite Elements in Plasticity Theory and practice”, Pineridge Press, Swansea, 1980.
3- M. A. Crisfield, “Non-linear Finite Element Analysis of Solids and structures”, John Wiley & Sons, 2012.
4- J. Chakrabarty, “Theory of Plasticity”, 3rd Edition, Butterworth-Heinemann; 2006.
5- J. C. Simo and T. Hughes, “Computational Inelasticity”, Springer, 2000.

Web links:
-
Computer Software:
-
COURSE SCHEDULE/OUTLINE/CALENDAR OF EVENTS

Week	Topic
1	course introduction, objectives, references, assignments; preliminary definitions; governing equations; stiffness and softness methods; different causes for non-linear behavior of structures
2	Equilibrium equation; real and pseudo time; incremental analysis; Newton-Raphson method; Newton-Raphson method in solution of system of equations resulting from finite element method
3	introduction to theory of plasticity; literature; one-dimensional problems (loading, unloading, reloading, reverse loading); Bauschinger effect; incremental constitutive equations; hardening
4	Haigh-Westergaard stress space; yield function; yield functions independent of hydrostatic stress; Tresca yield function; von-Misses yield function
5	yield functions dependent on hydrostatic stress; Rankine yield function; Mohr-Coulomb yield function; Drucker-Prager yield function
6	constitutive equations for elastic materials; Hook’s law in different forms; constitutive equations for non-linear elastic materials; internal energy density; complementary internal energy density
7	Drucker’s stability postulate; stable and unstable materials; normality, convexity, existence and uniqueness of solution; incremental constitutive equations for elastic materials
8	introduction of perfect plastic materials; loading and unloading criteria; plastic potential; flow rule; associated flow rule for von-Mises, Tresca, Mohr-Coulomb
9	normality, convexity, existence and uniqueness of solution; example; incremental constitutive equations for perfect plastic materials; Prandtl-Reuss theory; Drucker-Prager theory; isotropic

Week	Topic
	material
10	mid-term exam; work-hardening materials; loading surface; hardening rule; Drucker's stability postulate; normality, convexity, existence and uniqueness of solution; non-associated flow rule
11	effective stress; effective strain; incremental constitutive equations for work-hardening materials; loading criterion as a function of strain increment; example
12	introduction to computational plasticity; elastoplastic matrix for 2D and 3D problems; an overview of the finite element formulation
13	formulation of finite element method for elastoplastic problems; numerical methods for solution of non-linear systems of equations; convergence criteria
14	numerical implementation of elastoplastic constitutive equations; related algorithms; integration of constitutive equations
15	satisfaction of consistency condition in numerical implementation; step-by-step algorithm for numerical solution of plasticity problems
16	an introduction to programming the finite element method in linear and non-linear problems; discussion of the final project

EVALUATION PROCEDURES AND GRADING CRITERIA

Assignments	10% of final grade
Mid-Term Exam	30% of final grade
Final Exam	30% of final grade
Final project	30% of final grade
	100%

ATTENDANCE STATEMENT

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SYLLABI ON WEB PAGES

Last update: September 2024.

CONTINUUM MECHANICS

BASIC INFORMATION
Course prefix and semester: Elective, S1
Number of credits: 3

COURSE PREREQUISITES:
Strength of Materials

TEACHERS:
Person in charge: Dr. Hamed Haftbaradaran
Office location: Faculty of Civil Engineering and Transportation, University of Isfahan, Hezar-Jerib av., Isfahan, Iran
Phone Number: +98 (31) 37935616
Homepage: https://eng.ui.ac.ir/~h.haftbaradaran
Email Address: h.haftbaradaran@eng.ui.ac.ir

WEEKLY HOURS

Theory	Problem Solving	Laboratory	Guided learning
3 h	-	-	1 h

COURSE OBJECTIVES
Students are expected to:
- ✓ become familiar with the vector and tensor representation of the traction, stress, and strain; and to be able to work with tensor operations
- ✓ become familiar with the description of large deformation in solids, and various stress measures
- ✓ become familiar with the fundamental principles including energy conservation

REQUIRED STUDENT RESOURCES
Textbooks and references:
1. M. Lai, E. Krempl, D. Ruben, Introduction to Continumm Mechanics, 4th ed., Elsevier, 2010.
2. J. N. Reddy, An Introduction to Continuum Mechanics with Applications, Cambridge University Press, 2008.

Web links:
-
Computer Software:
ABAQUS
COURSE SCHEDULE/OUTLINE/CALENDAR OF EVENTS

Week	Topic
1	Vectors and tensors, summation convention
2	Tensors, basis vectors, transformation of the basis vectors, operation of a tensor on a vector, tensorial operations
3	Dot, cross and dyadic products of two vectors: examples, Kronecker delta, and permutation symbol
4	Invariants of a tensor, Eigenvalues and Eigenvectors
5	Vector field, Divergence and curl in Cartesian and curvilinear coordinates
6	Kinematics: reference and current configurations, Eulerian and Lagrangian descriptions, displacement, velocity, acceleration
7	Rate of change of a material element, Rate of deformation tensor, Spin tensor
8	Infinitesimal deformation, strain, rotation, compatibility conditions
9	Deformation gradient tensor, Polar decomposition, Left and right Cauchy-Green deformation tensor: examples
10	Right and left Cauchy deformation tensor: examples
11	Lagrangian and Eulerian strain measures for large deformation
12	Area and volume elements, Continuity equation
13	Stress measures: Cauchy, first and second PK stress tensors
14	Stress power, energy equation
15	Rate of heat flow, second law of thermodynamics
16	Elastic solids, Navier equations

EVALUATION PROCEDURES AND GRADING CRITERIA

Assignments	10% of final grade
Project	10% of final grade
Mid-Term Exam	30% of final grade
Final Exam	50% of final grade
	100%

ATTENDANCE STATEMENT

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STUDENTS WITH DISABILITIES ACT FOR STUDENTS WITH SPECIAL NEEDS STATEMENT

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APPROVED ACADEMIC HONESTY STATEMENT

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SYLLABI ON WEB PAGES

Last update: September 2024.

CONTROL OF STRUCTURES

BASIC INFORMATION

Course prefix and semester: Elective, S1 or S2

Number of credits: 3

COURSE PREREQUISITES AND CO-REQUISITES:

-

TEACHERS:

Person in charge: Dr. Hossein Tajmir Riahi

Office location: Faculty of Civil Engineering and Transportation, University of Isfahan, Hezar-Jerib av., Isfahan, Iran

Phone Number: +98 (31) 37935307

Email Address: tajmir@eng.ui.ac.ir

WEEKLY HOURS

Theory	Problem Solving	Laboratory	Guided learning
3 h	-	-	1 h

COURSE OBJECTIVES

In this course, students will learn theories governing a variety of structures control methods. This course also explains the principles governing various structures control systems including passive control, semi-active control, active control and hybrid control.

REQUIRED STUDENT RESOURCES

Textbooks and references:

1- I. Takewaki, Building Control with Passive Dampers: Optimal Performance-based Design for Earthquakes, Wiley; 2009.
2- F.Y. Cheng, H. Jiang and K. Lou, Smart Structures: Innovative Systems for Seismic Response Control, CRC Press; 2008.
3- S.Y. Chu, T.T. Soong and A.M. Reinhorn, Active, Hybrid, and Semi-active Structural Control: A Design and Implementation Handbook, Wiley; 2005.
4- T.T. Soong and M.C. Costantinou, Passive and Active Structural Vibration Control in Civil Engineering, Springer; 2002.

Web links:

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Computer Software:

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COURSE SCHEDULE/OUTLINE/CALENDAR OF EVENTS

Week	Topic
1	General concepts of structural control including passive control, semi-active control, active control and hybrid control
2	Investigation of the performance of viscous dampers
3	Design of structures equipped with viscous dampers
4	Investigation of the performance of viscoelastic dampers
5	Design of structures equipped with viscoelastic dampers
6	Investigation of the performance of metallic dampers
7	Design of structures equipped with metallic dampers
8	Investigation of friction damper performance
9	Design of structures equipped with friction dampers
10	Study of passive control mechanisms such as TMD and TLD
11	Base-isolation systems
12	Design of structures equipped with base-isolation
13	Active control, classical control theory
14	Optimal classical control theory for various situations such as Open-Loop, Closed-Loop, Open-Closed-Loop, numerical solution of the corresponding equations
15	Instantaneous optimal control theory for Open-Loop and Closed-Loop, numerical solution of related equations
16	Semi-active control, performance evaluation of MR and ER dampers, smart materials such as

	piezoelectric materials and SMA

EVALUATION PROCEDURES AND GRADING CRITERIA

Assignment	20% of final grade
Project	30% of final grade
Final Exam	50% of final grade
	100%

ATTENDANCE STATEMENT

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STUDENTS WITH DISABILITIES ACT FOR STUDENTS WITH SPECIAL NEEDS STATEMENT

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APPROVED ACADEMIC HONESTY STATEMENT

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SYLLABI ON WEB PAGES

Last update: September 2024.

DYNAMICS OF STRUCTURES

BASIC INFORMATION
Course prefix, title and semester: Core, S2
Number of credits: 3

COURSE PREREQUISITES:
• Static analysis of structures,
• Structural design
• Rigid-body dynamics
• Mathematics

TEACHERS:
Person in charge: Dr. Mehrdad Hejazi
Office location: Department of Civil Engineering, Faculty of Civil Engineering and Transportation, University of Isfahan, Hezar-Jerib av., Isfahan, Iran
Phone Number: +98 (31) 37935308
Homepage: http://eng.ui.ac.ir/~m.hejazi
Email Address: m.hezaji@eng.ui.ac.ir

WEEKLY HOURS

Theory	Problem Solving	Laboratory	Guided learning
3 h	-	-	1 h

COURSE OBJECTIVES
The preparation of this course has been inspired by several objectives:
• Relate the structural idealizations studied to the properties of real structures.
• Present the theory of dynamic response of structures in a manner that emphasizes physical insight into the analytical procedures.
• Illustrate applications of the theory to solutions of problems motivated by practical applications.
• Interpret the theoretical results to understand the response of structures to various dynamic excitations, with emphasis on earthquake excitation.
• Apply structural dynamics theory to conduct parametric studies that bring out several fundamental issues in the earthquake response, design, and evaluation of multistory buildings.

REQUIRED STUDENT RESOURCES
Textbooks and references:
1- J. L. Humar, "Dynamics of Structure", 3nd edition, Taylor & Francis; 2012.
2- A. K Chopra, "Dynamics of Structures", 4th edition, Prentice Hall; 2011.
3- W. Leigh and M. Paz, "Structural Dynamics: Theory and Computation", 5th edition, Springer; 2006.
4- R. W. Clough and J. Penzien, "Dynamics of Structures", 2nd edition, Computers & Structures, Inc.; 2010.
5- M. Paz and W. Leigh, "Structural Dynamics: Theory and Computation", 5th Edition, Springer, 2005.

Web links:
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Computer Software:
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COURSE SCHEDULE/OUTLINE/CALENDAR OF EVENTS

Week	Topic
1	**PART I SINGLE-DEGREE-OF-FREEDOM SYSTEMS** ***Equations of Motion, Problem Statement, and Solution Methods*** Simple Structures Single-Degree-of-Freedom System Force–Displacement Relation Damping Force Equation of Motion: External Force Mass–Spring–Damper System Equation of Motion: Earthquake Excitation

Week	Topic
	Problem Statement and Element Forces Combining Static and Dynamic Responses Methods of Solution of the Differential Equation Study of SDF Systems: Organization
2	***Free Vibration*** Undamped Free Vibration Viscously Damped Free Vibration Energy in Free Vibration Coulomb-Damped Free Vibration
3	***Response to Harmonic and Periodic Excitations*** **Part A: Viscously Damped Systems: Basic Results** Harmonic Vibration of Undamped Systems Harmonic Vibration with Viscous Damping
4	**Part B: Viscously Damped Systems: Applications** Response to Vibration Generator Natural Frequency and Damping from Harmonic Tests Force Transmission and Vibration Isolation
5	Response to Ground Motion and Vibration Isolation Vibration-Measuring Instruments Energy Dissipated in Viscous Damping Equivalent Viscous Damping
6	**Part C: Systems with Nonviscous Damping** Harmonic Vibration with Rate-Independent Damping Harmonic Vibration with Coulomb Friction **Part D: Response to Periodic Excitation** Fourier Series Representation Response to Periodic Force
7	***Response to Arbitrary, Step, and Pulse Excitations*** **Part A: Response to Arbitrarily Time-Varying Forces** Response to Unit Impulse Response to Arbitrary Force **Part B: Response to Step and Ramp Forces** Step Force Ramp or Linearly Increasing Force Step Force with Finite Rise Time
8	**Part C: Response to Pulse Excitations** Solution Methods Rectangular Pulse Force Half-Cycle Sine Pulse Force Symmetrical Triangular Pulse Force Effects of Pulse Shape and Approximate Analysis for Short Pulses Effects of Viscous Damping Response to Ground Motion
9	***Numerical Evaluation of Dynamic Response*** Time-Stepping Methods Methods Based on Interpolation of Excitation Central Difference Method Newmark's Method Stability and Computational Error Nonlinear Systems: Central Difference Method Nonlinear Systems: Newmark's Method
10	***Generalized Single-Degree-of-Freedom Systems*** Generalized SDF Systems Rigid-Body Assemblages Systems with Distributed Mass and Elasticity
11	Lumped-Mass System: Shear Building

Week	Topic
	Natural Vibration Frequency by Rayleigh's Method Selection of Shape Function *Appendix 8*: Inertia Forces for Rigid Bodies
12	**PART II MULTI-DEGREE-OF-FREEDOM SYSTEMS** ***Equations of Motion, Problem Statement, and Solution Methods*** Simple System: Two-Story Shear Building General Approach for Linear Systems Static Condensation Planar or Symmetric-Plan Systems: Ground Motion One-Story Unsymmetric-Plan Buildings Multistory Unsymmetric-Plan Buildings Multiple Support Excitation Inelastic Systems Problem Statement Element Forces Methods for Solving the Equations of Motion: Overview
13	***Free Vibration*** **Part A: Natural Vibration Frequencies and Modes** Systems without Damping Natural Vibration Frequencies and Modes Modal and Spectral Matrices Orthogonality of Modes Interpretation of Modal Orthogonality Normalization of Modes Modal Expansion of Displacements **Part B: Free Vibration Response** Solution of Free Vibration Equations: Undamped Systems Systems with Damping Solution of Free Vibration Equations: Classically Damped Systems
14	***Damping in Structures*** **Part A: Experimental Data and Recommended Modal Damping Ratios** Vibration Properties of Millikan Library Building Estimating Modal Damping Ratios **Part B: Construction of Damping Matrix** Damping Matrix Classical Damping Matrix Nonclassical Damping Matrix
15	***Dynamic Analysis and Response of Linear Systems*** **Part A: Two-Degree-of-Freedom Systems** Analysis of Two-DOF Systems Without Damping Vibration Absorber or Tuned Mass Damper **Part B: Modal Analysis** Modal Equations for Undamped Systems Modal Equations for Damped Systems Displacement Response Element Forces Modal Analysis: Summary
16	**Part C: Modal Response Contributions** Modal Expansion of Excitation Vector $\mathbf{p}(t) = \mathbf{s}p(t)$ Modal Analysis for $\mathbf{p}(t) = \mathbf{s}p(t)$ Modal Contribution Factors Modal Responses and Required Number of Modes

EVALUATION PROCEDURES AND GRADING CRITERIA

Assignments	10% of final grade
Mid-Term Exam	40% of final grade
Final Exam	50% of final grade

100%

ATTENDANCE STATEMENT

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STUDENTS WITH DISABILITIES ACT FOR STUDENTS WITH SPECIAL NEEDS STATEMENT

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APPROVED ACADEMIC HONESTY STATEMENT

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SYLLABI ON WEB PAGES

Last update: September 2024.

FINITE ELEMENT METHOD

BASIC INFORMATION
Course prefix and semester: Core, S1
Number of credits: 3

COURSE PREREQUISITES:
• Static analysis of structures
• Theory of elasticity
• Mathematics

COURSE PREREQUISITES AND CO-REQUISITES:
-

TEACHERS:
Person in charge: Dr. Mahdi Zandi
Office location: Faculty of Civil Engineering and Transportation, University of Isfahan, Hezar-Jerib av., Isfahan, Iran
Phone Number: +98 (31) 3793 5305
Homepage: http://eng.ui.ac.ir/~m.zandi
Email Address: s.m.zandi@eng.ui.ac.ir

WEEKLY HOURS

Theory	Problem Solving	Laboratory	Guided learning
3 h	-	-	1 h

COURSE OBJECTIVES
The preparation of this course has been inspired by several objectives:
• Relate the structural idealizations studied to the properties of real structures.
• Present the theory of dynamic response of structures in a manner that emphasizes physical insight into the analytical procedures.
• Illustrate applications of the theory to solutions of problems motivated by practical applications.
• Interpret the theoretical results to understand the response of structures to various dynamic excitations, with emphasis on earthquake excitation.
• Apply structural dynamics theory to conduct parametric studies that bring out several fundamental issues in the earthquake response, design, and evaluation of multistory buildings.

REQUIRED STUDENT RESOURCES
Textbooks and references:
1- O.C. Zienkiewicz and R. L. Taylor, “The Finite Element Method”, 7th edition, Butterworth-Heinemann; 2013.
2- O.C. Zienkiewicz and R. L. Taylor, “The Finite Element Method for Solid and Structural Mechanics”, 7th edition, Butterworth-Heinemann; 2013.
3- K.H. Huebner and D.L. Dewhirst, “The Finite Element Method for Engineers”, 4th edition, Wiley-Interscience; 2001.
4- I. M. Smith and D.V. Griffiths, “Programming the Finite Element Method”, 4th edition, Wiley; 2004.

Web links:
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Computer Software:
-
COURSE SCHEDULE/OUTLINE/CALENDAR OF EVENTS

Week	Topic
1	Introduction to the FEM
2	Mathematical preliminaries
3	Different methods for function approximation
4	Approximate solution of differential equations
5	Weak form formulation of problems
6	2D & 3D elasticity formulation

Week	Topic
7	Variational and energy methods
8	Shape functions, continuity, connectivity, …
9	Mapping and Jacobian
10	1D, 2D and 3D shape functions
11	Error in finite element method
12	Numerical integration
13	Domain and boundary integration
14	Plates and shells
15	Axisymmetric problems
16	FEM programing

EVALUATION PROCEDURES AND GRADING CRITERIA

Assignments	10% of final grade
Project	30% of final grade
Mid-Term Exam	30% of final grade
Final Exam	30% of final grade
	100%

ATTENDANCE STATEMENT

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APPROVED ACADEMIC HONESTY STATEMENT

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SYLLABI ON WEB PAGES

Last update: September 2024.

FRACTURE MECHANICS

BASIC INFORMATION
Course prefix and semester: Elective, S2
Number of credits: 3

COURSE PREREQUISITES:
Strength of Materials, Theory of Elasticity

TEACHERS:
Person in charge: Dr. Hamed Haftbaradaran
Office location: Faculty of Civil Engineering and Transportation, University of Isfahan, Hezar-Jerib av., Isfahan, Iran
Phone Number: +98 (31) 37935616
Homepage: https://eng.ui.ac.ir/~h.haftbaradaran
Email Address: h.haftbaradaran@eng.ui.ac.ir

WEEKLY HOURS

Theory	Problem Solving	Laboratory	Guided learning
3 h	-	-	1 h

COURSE OBJECTIVES
Students are expected to:
- ✓ be able to describe the general principles governing structural fracture subject to mechanical loading
- ✓ be able to apply the fundamental principles of fracture mechanics to predict crack growth
- ✓ become familiar with various fracture mechanics models

REQUIRED STUDENT RESOURCES
Textbooks and references:
1. Gdoutos E. E. Fracture Mechanics: An introduction, 2nd ed. Springer, 2005.
2. T. L. Anderson, Fracture Mechanics: Fundamentals and Applications, 3rd ed., Taylor & Francis, 2005.

Web links:
-
Computer Software:
ABAQUS
COURSE SCHEDULE/OUTLINE/CALENDAR OF EVENTS

Week	Topic
1	Elementary concepts, stress concentration around an elliptic hole, Inglis problem, energy considerations
2	Elasticity solution for a wedge, Williams problem, square root stress singularity
3	K-filed solutions for displacement and stresses, mode I and II cracks
4	Potential energy, Free energy, Surface energy, Griffith fracture criterion, Fracture energy
5	Potential energy calculations subject to fixed-loading or fixed-grips conditions
6	Surface energy, implications in liquids and solids
7	Giffith's experiments, size effects, theoretical strength vs. experimentally measured strength
8	Griffith fracture criterion applied to elastic solids, G-K Irwin's relationship
9	Applications of Griffith criterion: double-cantilever beam, and other examples
10	Application of Griffith criterion for fracture energy calculations
11	Small-scale yielding, Irwin-Orowan correction to the Griffith conditions, fracture process zone
12	Size of the plastic zone ahead of a crack tip, Strip yield model, Cohesive zone models, Equivalence of the Griffith criterion and cohesive models
13	Mode III fracture problem, Anti-plane elasticity problems, Laplace eqauion and its solutions using complex potentials, K-field solution in terms of complex potentials
14	Solution of some anti-plane problems in fracture mechanics using complex methods
15	J-integral and applications
16	Empirical Paris law for fatigue and life prediction

Evaluation Procedures and Grading Criteria

Assignment	10% of final grade
Project	10% of final grade
Mid-Term Exam	30% of final grade
Final Exam	50% of final grade
	100%

Attendance Statement

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Students with Disabilities Act for Students with Special Needs Statement

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Approved Academic Honesty Statement

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Syllabi on Web Pages

Last update: September 2024.

MECHANICS OF COMPOSITE MATERIALS

BASIC INFORMATION
Course prefix and semester: Elective, S2
Number of credits: 3

COURSE PREREQUISITES AND CO-REQUISITES:
-

TEACHERS:
Person in charge: Dr. Mehrdad Hejazi
Office location: Department of Civil Engineering, Faculty of Civil Engineering and Transportation, University of Isfahan, Hezar-Jerib av., Isfahan, Iran
Phone Number: +98 (31) 37935308
Homepage: http://eng.ui.ac.ir/~m.hejazi
Email Address: m.hezaji@eng.ui.ac.ir

WEEKLY HOURS

Theory	Problem Solving	Laboratory	Guided learning
3 h	-	-	-

COURSE OBJECTIVES
Students are expected to:
- ✓ become familiar with governing principles on behaviour of composite materials

REQUIRED STUDENT RESOURCES
Textbooks and references:
1. R. M. Christensen, "Mechanics of Composite Materials", Dover Publicaitons, 2005.
2. R. F. Gibson, " Principles of Composite Materials Mechanics", 3rd Editions, CRC Press, 2016.
3. L. P. Kollár, and G. S. Springer, G. S., "Mechanics of Composite Materials", Cambridge University Press, 2009.

Web links:
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COURSE SCHEDULE/OUTLINE/CALENDAR OF EVENTS

Week	Topic
1	Fibre reinforces polymers (FRP), types of ribres, types of matrices
2	Ply stiffness analysis: isotropic ply, specially orthotropic ply, generally orthotropic ply, transformation of elastic constants, elastic properties
3	Ply stiffness analysis: isotropic ply, specially orthotropic ply, generally orthotropic ply, transformation of elastic constants, elastic properties
4	Ply strength analysis: isotropic ply, orthotropic ply, failure criteria, choice of failure criterion, strength properties
5	Ply strength analysis: isotropic ply, orthotropic ply, failure criteria, choice of failure criterion, strength properties
6	Layered laminate: laminate constitutive equation, laminate notation, equivalent elastic constants
7	Layered laminate: laminate constitutive equation, laminate notation, equivalent elastic constants
8	Laminate stiffness analysis: stiffness formulation procedure, laminate configuration types (isotropic, specially orthotropic, generally orthotropic plies, cross-ply, angle-ply, quasi-orthotropic, antisymmetric plies, estimated membrane elastic constants)
9	Laminate stiffness analysis: stiffness formulation procedure, laminate configuration types (isotropic, specially orthotropic, generally orthotropic plies, cross-ply, angle-ply, quasi-orthotropic, antisymmetric plies, estimated membrane elastic constants)
10	Laminate stiffness analysis: stiffness formulation procedure, laminate configuration types (isotropic, specially orthotropic, generally orthotropic plies, cross-ply, angle-ply, quasi-orthotropic, antisymmetric plies, estimated membrane elastic constants)
11	Laminate stiffness analysis: stiffness formulation procedure, laminate configuration types (isotropic, specially orthotropic, generally orthotropic plies, cross-ply, angle-ply, quasi-orthotropic, antisymmetric plies, estimated membrane elastic constants)

Week	Topic
12	Laminate strength analysis: first-ply-failure in symmetric laminate (membrane load, bending load) first-ply-failure in unsymmetric laminate (membrane load), last-ply-failure procedure, complete ply failure (membrane load, bending load), partial ply failure (membrane load), estimated laminate strength
13	Laminate strength analysis: first-ply-failure in symmetric laminate (membrane load, bending load) first-ply-failure in unsymmetric laminate (membrane load), last-ply-failure procedure, complete ply failure (membrane load, bending load), partial ply failure (membrane load), estimated laminate strength
14	Laminate strength analysis: first-ply-failure in symmetric laminate (membrane load, bending load) first-ply-failure in unsymmetric laminate (membrane load), last-ply-failure procedure, complete ply failure (membrane load, bending load), partial ply failure (membrane load), estimated laminate strength
15	Laminate strength analysis: first-ply-failure in symmetric laminate (membrane load, bending load) first-ply-failure in unsymmetric laminate (membrane load), last-ply-failure procedure, complete ply failure (membrane load, bending load), partial ply failure (membrane load), estimated laminate strength
16	Laminate strength analysis: first-ply-failure in symmetric laminate (membrane load, bending load) first-ply-failure in unsymmetric laminate (membrane load), last-ply-failure procedure, complete ply failure (membrane load, bending load), partial ply failure (membrane load), estimated laminate strength

EVALUATION PROCEDURES AND GRADING CRITERIA

Assignment	10% of final grade
Project	20% of final grade
Mid-Term Exam	30% of final grade
Final Exam	40% of final grade
	100%

ATTENDANCE STATEMENT

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APPROVED ACADEMIC HONESTY STATEMENT

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SYLLABI ON WEB PAGES

Last update: September 2024.

PERFORMANCE-BASED DESIGN OF STRUCTURES

BASIC INFORMATION
Course prefix and semester: Elective, S1 or S2
Number of credits: 3

COURSE PREREQUISITES AND CO-REQUISITES:
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TEACHERS:
Person in charge: Dr Hossein Tajmir Riahi
Office location: Faculty of Civil Engineering and Transportation, University of Isfahan, Hezar-Jerib av., Isfahan, Iran
Phone Number: +98 (31) 37935307
Email Address: tajmir@eng.ui.ac.ir

WEEKLY HOURS

Theory	Problem Solving	Laboratory	Guided learning
3 h	-	-	1 h

COURSE OBJECTIVES
In this course, students will learn the general principles of performance-based seismic design of structures including structural modeling, various methods of analysis, and new systems available to achieve this goal.

REQUIRED STUDENT RESOURCES
Textbooks and references:
1- ASCE, "Seismic Evaluation and Retrofit of Existing Buildings: ASCE/SEI 41-13", American Society of Civil Engineers, 2014.
2- M. N. Fardis, "Advances in Performance-Based Earthquake Engineering", Springer; 2010.
3- S. Chandrasekaran, L. Nunziante and G. Serino, "Seismic Design Aids for Nonlinear Analysis of Reinforced Concrete Structures", CRC Press; 2009.
4- Y. Bozorgnia and V. V. Bertero, "Earthquake Engineering: From Engineering Seismology to Performance-Based Engineering", CRC Press; 2004.

Web links:
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Computer Software:
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COURSE SCHEDULE/OUTLINE/CALENDAR OF EVENTS

Week	Topic
1	Differences between performance-based design and force-based design
2	Structural performance levels and seismic hazard levels
3	Nonlinearity in structures including: geometrical and material nonlinearity and P-Delta effects
4	Large deformations, yielding and energy absorption, brittle and ductile behavior, ductility limit and strength degradation
5	Elastic and plastic energy, cyclic stiffness and strength
6	Strength-based design and deformation-based design, capacity design, failure mechanism, permanent and cyclic loads
7	Nonlinear modeling including: material models, bending, axial and shear plastic hinges
8	Plastic hinges in ASCE41 code, interaction between axial force and bending moment, fiber based hinges
9	Multi-linear elastic and plastic behavior, viscous dampers and seismic isolation systems, types of hysteresis loops (Kinetic, Pivot, Takeda, Isotropic)
10	Nonlinear analysis methods including: time analysis and Ritz vectors, time history analysis, large deformation and P-Delta effects
11	Modal and Rayleigh damping
12	Pushover analysis requirements in ASCE41 and its limitations, force control and displacement control methods, undesirable deformations
13	Finding target displacement based on different methods, performance evaluation and performance levels, capacity to demand ratio and acceptance criteria

Week	Topic
14	Evaluation of structures after analysis
15	Principles and methods of structural analysis (Static and Dynamic, Linear and Nonlinear)
16	Introducing new performance based design methods

EVALUATION PROCEDURES AND GRADING CRITERIA

Assignment	20% of final grade
Project	30% of final grade
Final Exam	50% of final grade
	100%

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SYLLABI ON WEB PAGES

Last update: September 2024.

STRUCTURAL RELIABILITY ANALYSIS

BASIC INFORMATION

Course prefix and semester: Elective, S2
Number of credits: 3

COURSE PREREQUISITES AND CO-REQUISITES:

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TEACHERS:

Person in charge: Dr. Maryam Daei
Office location: Faculty of Civil Engineering and Transportation, University of Isfahan, Hezar-Jerib av., Isfahan, Iran
Phone Number: +98 (31) 37935310
Homepage: http://eng.ui.ac.ir/~m.daei
Email Address: m.daei@eng.ui.ac.ir

WEEKLY HOURS

Theory	Problem Solving	Laboratory	Guided learning
3 h	-	-	1 h

COURSE OBJECTIVES

The aim in structural reliability analysis is calculation of failure probability in which failure is defined as violation of limit state function. Students are expected to become familiar with the following topics:

- ✓ Application of probability and statistics in the analysis and design of civil engineering systems.
- ✓ First order reliability methods and simulation techniques.
- ✓ Probabilistic modeling of loading and resistance parameters.
- ✓ Code calibration and partial safety factors.

REQUIRED STUDENT RESOURCES

Textbooks and References:

1. Nowak, Andrzej S., and Kevin R. Collins. Reliability of structures. CRC Press, 2012.
2. Melchers, Robert E., and André T. Beck. Structural reliability analysis and prediction. John Wiley & Sons, 2018.

Web links:

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Computer Software:

MATLAB

COURSE SCHEDULE/OUTLINE/CALENDAR OF EVENTS

Week	Topic
1	Introduction and Basic Background
2	Brief Review of Probability Theory and Statistics
3	Probability Distributions
4	Concept of Limit State Function and Failure Probability
5	First Order Second Moment Reliability Index
6	Hasofer-Lind Method
7	Sensitivity and Importance Vector
8	Rackwitz-Fisseler Procedure
9	Monte Carlo Simulation Method
10	Latin Hypercube Sampling
11	Rosenblueth`s 2K+1 Point Estimate Method
12	Structural Loads Models
13	Time-Variant Reliability Assessment of Load Combinations
14	Probabilistic Models of Resistance for Steel and Reinforced Concrete Components
15	Calibration of Partial Safety Factor
16	System Reliability

Evaluation Procedures and Grading Criteria

Assignment	5% of final grade
Project	10% of final grade
Mid-Term Exam	35% of final grade
Final Exam	50% of final grade
	100%

Attendance Statement

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Syllabi on Web Pages

Last update: September 2024.

RESEARCH METHOD

BASIC INFORMATION
Course prefix and semester: Core, S1
Number of credits: 1

COURSE PREREQUISITES AND CO-REQUISITES:
-
TEACHERS:
Person in charge: Dr. Hossein Amoushahi
Office location: Department of Civil Engineering, Faculty of Civil Engineering and Transportation, University of Isfahan, Hezar-Jerib av., Isfahan, Iran
Phone Number: +98 (31) 3793 5285
Homepage: http://eng.ui.ac.ir/~h.amoushahi
Email Address: h.amoushahi@eng.ui.ac.ir

WEEKLY HOURS

Theory	Problem Solving	Laboratory	Guided learning
1 h	-	-	20 min

COURSE OBJECTIVES
This course will provide an opportunity for students to establish or advance their understanding of research procedure. The different steps of research procedure, ethical principles and challenges are introduced. And then, students will use these theoretical underpinnings to begin to critically review literature relevant to their field or interests.

REQUIRED STUDENT RESOURCES
Textbooks and References:
1. R. R. Powell and L. S. Connaway, "Basic Research Methods for Librarians", 5th Edition (Library and Information Science Text Series), 2010.
2. R. K. Yin, "Case Study Research, Design, and Methods", 5th Edition, Sage Publications, 2013.
3. W. K. Schuttle and E. Schuttle, "Communications Skills for the Information Age", 3rd Edition, McGraw-Hill Book Co., 2001.

Web links:
-
Computer Software:
Microsoft Word, EndNote
COURSE SCHEDULE/OUTLINE/CALENDAR OF EVENTS

Week	Topic
1	Introduction
2	Research Topic
3	Types of Research
4	Theoretical Approaches
5	Concluding Steps of Research
6	Data Base Searches
7	Literature Reviews Fundamentals
8	Implementing Research
9	Research Ethics
10	Citations and Style Guides
11	Introduction to Endnote Software
12	Different Types of Articles and Scientific Journals
13	Writing Process of Journal Paper
14	Dissertation Proposal
15	Grammar Advice for Writing Dissertation
16	Verbal Presentations Characteristics

Evaluation Procedures and Grading Criteria

Assignment	10% of final grade
Project	40% of final grade
Final Exam	50% of final grade
	100%

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Syllabi on Web Pages

Last update: September 2024.

STABILITY OF STRUCTURES

BASIC INFORMATION

Course prefix and semester: Elective, S1 or S2
Number of credits: 3

COURSE PREREQUISITES AND CO-REQUISITES:

-

TEACHERS:

Person in charge: Dr. Hossein Amoushahi
Office location: Department of Civil Engineering, Faculty of Civil Engineering and Transportation, University of Isfahan, Hezar-Jerib av., Isfahan, Iran
Phone Number: +98 (31) 3793 5285
Homepage: http://eng.ui.ac.ir/~h.amoushahi
Email Address: h.amoushahi@eng.ui.ac.ir

WEEKLY HOURS

Theory	Problem Solving	Laboratory	Guided learning
3 h	-	-	1 h

COURSE OBJECTIVES

In this lesson, students learn the basics of the stability of components and structures, such as the buckling of the columns, torsional buckling, and learn how to use them to design of structures.

- ✓ Elastic and inelastic buckling of columns: Euler buckling load, effective length, double and tangential modulus theory, Shanley theory, how to use these principles in the formulation of regulations
- ✓ Columns with imperfection and large deformations
- ✓ Approximate methods and their application in solving stability problems, critical loads using the approximate deformation curve, static potential energy, Rayleigh -Ritz method and Galerkin method
- ✓ Beam-columns, examination of different loads, axial force effect on flexural stiffness, ultimate strength, how to use these principles in the formulation of regulations
- ✓ Torsional buckling, lateral-torsional buckling, lateral buckling of rectangular sections in pure bending, buckling of the Z-shaped beams, how to use these principles in the formulation of regulations
- ✓ Buckling Frames: Checking Different Loading, Axial forces effect on flexural stiffness, how to use these principles in drafting regulations
- ✓ Buckling of plates and shells, precise and approximate methods
- ✓ Numerical methods for buckling analysis of members and plates

REQUIRED STUDENT RESOURCES

Textbooks:

Azhari M., Amoushahi H., Mirghaderi R., Design of Steel Structures, Vol.5, 16th edition, Arkan Danesh Pub., 2016.
Azhari M., Sarrami S., Mirghaderi R., Stability of steel structures, 1st edition, Arkan Danesh Pub., 2017.

References:

1- W. C. Xie, Dynamic Stability of Structures, Cambridge University Press; 2010.
2- N.A. Alfutov, V. Balmont and E. Evseev, Stability of Elastic Structures (Foundations of Engineering Mechanics), Springer; 2000.
3- Z. P. Bazant and L. Cedolin, “Stability of Structures: Elastic, Inelastic, Fracture, and Damage Theories (Oxford Engineering Science Series), Oxford University Press, USA; 2010.
4- G. J. Simitses, Introduction to the Elastic Stability of Structures, Krieger Pub Co; 1986.

COURSE SCHEDULE/OUTLINE/CALENDAR OF EVENTS

Week	Topic
1	Elastic and inelastic buckling of columns: Euler buckling load
2	Effective length, double and tangential modulus theory, Shanley theory
3	Columns with imperfection and large deformations
4	Approximate methods and their application in solving stability problems
5	Critical loads using the approximate deformation curve, static potential energy
6	Rayleigh-Ritz method and Galerkin method

Week	Topic
7	Numerical methods for buckling analysis of members and plates
8	Numerical methods for buckling analysis of members and plates
9	Midterm exam
10	Beam-columns, examination of different loads
11	Axial force effect on flexural stiffness, ultimate strength
12	Torsional buckling, lateral-torsional buckling, lateral buckling of rectangular sections in pure bending,
13	Buckling of the Z-shaped beams, how to use these principles in the formulation of regulations
14	Buckling Frames: Checking Different Loading, Axial forces effect on flexural stiffness, how to use these principles in drafting regulations
15	Buckling of plates and shells, precise and approximate methods
16	Final exam

EVALUATION PROCEDURES AND GRADING CRITERIA

Assignment	20% of final grade
Project	30% of final grade
Mid-Term Exam	25% of final grade
Final Exam	25% of final grade
	100%

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APPROVED ACADEMIC HONESTY STATEMENT

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SYLLABI ON WEB PAGES

Last update: September 2024.

THEORY OF ELASTICITY

BASIC INFORMATION

Course prefix, title and semester: Core, S1
Number of credits: 3

COURSE PREREQUISITES AND CO-REQUISITES:

-

TEACHERS:

Person in charge: Dr. Hamed Haftbaradaran
Office location: Faculty of Civil Engineering and Transportation, University of Isfahan, Hezar-Jerib av., Isfahan, Iran
Phone Number: +98 (31) 37935616
Homepage: https://eng.ui.ac.ir/~h.haftbaradaran
Email Address: h.haftbaradaran@eng.ui.ac.ir

WEEKLY HOURS

Theory	Problem Solving	Laboratory	Guided learning
3 h	1 h	-	1 h

COURSE OBJECTIVES

Students are expected to:

- ✓ Learn the governing principles of elastic behaviour of deformable bodies

REQUIRED STUDENT RESOURCES

Textbooks and references:

1. A. Bertram, "Elasticity and Plasticity of Large Deformations: An Introduction", 3rd edition, Springer; 2012.
2. M. H. Sadd, "Elasticity: Theory, Applications and Numerics", 2nd edition, Academic Press, New York, 2009.
3. W. F. Chen and A. E. Saleeb, "Constitutive Equations for Engineering Materials, Volume 1: Elasticity and Modeling, and Volume 2: Plasticity and Modeling", Wiley, New York, 1982.
4. S. Timoshenko, and J. Goodier, "Theory of Elasticity", 3rd edition, McGraw-Hill, New York, 1970.

Web links:

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Computer Software:

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COURSE SCHEDULE/OUTLINE/CALENDAR OF EVENTS

Week	Topic
1	Stress: Equations of equilibrium, principle stresses, maximum shear stress
2	Stress: Special cases of stress, equations of equilibrium in cylindrical and spherical coordinates
3	Strain: Strain at a point, strain-stress relationships, principle strains, compatibility conditions
4	Strain: Special cases of strain, strain-stress relationships in cylindrical and spherical coordinates
5	General stress-strain relationships, compatibility conditions based on stress
6 & 7	Solution of three-dimensional elasticity problems using the potential functions, Boussinesq and Kelvin problems
8	Plane strain and plain stress problems
9 & 10	Solution of two-dimensional problems using the stress function
11	Solution of two-dimensional axisymmetrical problems using the stress function
12	Pure bending of beams
13 & 14	Torsion of bars with different cross-sections
15	Energy methods: strain energy, the principle of virtual work, the principle of minimum potential energy
16	Energy methods: Castigliano's theorem, thermal stresses

EVALUATION PROCEDURES AND GRADING CRITERIA

Assignment	5% of final grade
Mid-Term Exam	45% of final grade

Final Exam	50% of final grade
	100%

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SYLLABI ON WEB PAGES

Last update: September 2024.

THEORY OF PLATES

BASIC INFORMATION

Course prefix and semester: Elective, S1

Number of credits: 3

COURSE PREREQUISITES AND CO-REQUISITES:

-

TEACHERS:

Person in charge: Dr. Hossein Amoushahi

Office location: Department of Civil Engineering, Faculty of Civil Engineering and Transportation, University of Isfahan, Hezar-Jerib av., Isfahan, Iran

Phone Number: +98 (31) 3793 5285

Homepage: http://eng.ui.ac.ir/~h.amoushahi

Email Address: h.amoushahi@eng.ui.ac.ir

WEEKLY HOURS

Theory	Problem Solving	Laboratory	Guided learning
3 h	-	-	1 h

COURSE OBJECTIVES

Students are expected to learn the principles governing the behavior of plates and shells and their application in solving some structures.

REQUIRED STUDENT RESOURCES

Textbooks and References:

1- R. Szilard, "Theories and Application of Plates Analysis", Willey, 2014.
2- A. C. Ugural, "Stresses in Beams, Plates, and Shells", 3rd edition, CRC Press, 2009.
3- R. Kienzler, H. Altenbach and I. Ott, "Theories of Plates and Shells", Springer; 2004.
4- E. Ventsel and T. Krauthammer, "Thin Plates & Shells: Theory, Analysis, & Applications", CRC; 2001.
5- S. P. Timoshenko and S. W. Kreiger, "Theory of Plates and Shells", 2nd edition, McGraw Hill Higher Education;1964.

Web links:

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Computer Software:

MATLAB

COURSE SCHEDULE/OUTLINE/CALENDAR OF EVENTS

Week	Topic	Reading /Assignment
1	Plate theories of static, linear-elastic plate problems	-
2	Exact solutions of governing differential equations	-
3	Solutions by double trigonometric series (Navier's approach)	-
4	Solutions by double trigonometric series (Navier's approach)	Ass 1
5	Solutions by single trigonometric series (Levy's method)	-
6	Solutions by single trigonometric series (Levy's method)	Ass 2
7	Energy and variational methods for solution of lateral deflections	-
8	Energy and variational methods for solution of lateral deflections	Ass 3
9	Buckling of plates	-
10	Buckling of plates	-
11	Finite element method	-
12	Finite element method	-
13	Classical finite strip method	Ass 4
14	Theories of shear deformation in relatively thick and thick plates	-
15	Dynamic and free vibration analysis of elastic plates	-
16	Composites Plates	-

Evaluation Procedures and Grading Criteria

Assignment	15% of final grade
Project	25% of final grade
Mid-Term Exam	30% of final grade
Final Exam	30% of final grade
	100%

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Syllabi on Web Pages

Last update: September 2024.

THEORY OF SHELLS

Basic Information

Course prefix and semester: Elective, S1 or S2
Number of credits: 3

Course prerequisites and co-requisites:

-

Teachers:

Person in charge: Dr. Mehrdad Hejazi
Office location: Department of Civil Engineering, Faculty of Civil Engineering and Transportation, University of Isfahan, Hezar-Jerib av., Isfahan, Iran
Phone Number: +98 (31) 37935308
Homepage: http://eng.ui.ac.ir/~m.hejazi
Email Address: m.hezaji@eng.ui.ac.ir

Weekly hours

Theory	Problem Solving	Laboratory	Guided learning
3 h	1 h	-	1 h

Course Objectives

Students are expected to:

- ✓ Learn the governing principles of shells behaviour

Required Student Resources

Textbooks and references:

1. S. S. Behavikatti, "Theory of Plates and Shellss", New Age International Pvt., 2010.
2. C. R. Calladine, "Theory of Shell Structures", Cambridge University Press, 1989.
3. W. Flugge, "Stresses in Shells" Springer, Berlin, 1973.
4. V. S. Kelkar, and R. T. Sewell, "Fundamentals of the Analysis and Design of Shell Structures", Prentice Hall, 1987.
5. E. Venstse, and T. Krauthammer, "Thin Plates snd Shells: Theory, Analysis and Applications", CRC Press, 2001.

Web links:

-

Computer Software:

-

Course Schedule/Outline/Calendar of Events

Week	Topic
1	Membrane theory of shells: General differential equations of shells of revolution
2	Shells of revolution: axisymmetrical load, axially symmetric deformation, asymmetrical load
3	Cylindrical shells of general shape
4	Shells of general form
5	Applications of membrane theory
6	Bending theory of shells: fundamental equations
7	Axisymmetrically loaded circular cylindrical shells
8	Shells of revolution under axisymmetrical loads
9	Axisymmetrical deformation
10	Buckling of cylindrical shells: fundamental equations
11	Buckling of cylindrical shells: lateral and axial pressure
12	Buckling of cylindrical shells: design equations, inelastic buckling
13	Buckling of shells of revolution: unstiffened, stiffened, design equations, inelastic buckling
14	Free vibration of cylindrical shells
15	Free vibration of shells of revolution
16	Analysis of shells by the finite element method

EVALUATION PROCEDURES AND GRADING CRITERIA

Assignment	5% of final grade
Project	25% of final grade
Mid-Term Exam	30% of final grade
Final Exam	40% of final grade
	100%

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SYLLABI ON WEB PAGES

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