University of Isfahan

Course outline
Geotechnical Engineering
Graduate Program

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

September 2024

1. Definition and goal

Geotechnical engineering is one of the graduate programs in civil engineering. This program aims to provide an environment to integrate education and research to elevate the student's skills in geotechnics. With a combination of courses and research activities, the program focuses on the fundamental aspects and practical applications in geotechnical engineering. To achieve these goals, the program primarily focuses on geomechanics, geological engineering, geotechnical earthquake engineering, environmental geotechnics and numerical methods. The research activities cover analytical and numerical methods, laboratory and in-situ tests and field monitoring. The students also trained with a collection of courses related to the design of geotechnical structures including the design of foundations, earth and rockfill dams, tunnels and reinforced soils. Hence, students will gain the strength required to actively get involved in both research and practice.

2. Duration of Program and the structure

The duration of the Master programs in Geotechnical Engineering is two years in accordance with the latest regulations and based on the educational guidelines for the Master 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 as outlined in Table 1.

Table 1: Course and Research Credits

No.	Course Type	credits
1	Core (Based on Table 2)	14
2	Elective (Based on Tables 2 and 3)	10
3	Seminar and Research Methods	2
4	Thesis	6
	Total	*32*

3. Credits

Master's students in Geotechnical Engineering are required to successfully complete the courses in three semesters with 14 credits of Core courses, as listed in Table 2. Their elective courses are selected based on Table 3.

Table 2: Core Courses for the Master's Program in geotechnical Engineering

Course No	Course Title	Credits	Hours per week		
			Theoretical	Practical	Total
CN: 3016219	Advanced Engineering Mathematics	3	48	0	48
CN: 3016215	Advanced Soil Mechanics	3	48	0	48
CN: 3016089	Advanced Foundation Engineering	3	48	0	48
CN: 3016213	Soil Dynamics	3	48	0	48
CN: 3016217 CN: 3016216 CN: 3016093	One of the following courses: Continuum Mechanics Introduction to Finite Element Rock Mechanics	2	32	0	32

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

Course No	Course Title	Credits	Hours per week		
			Theoretical	Practical	Total
CN: 3016217	Continuum Mechanics	2	32	0	32
CN: 3016093	Rock Mechanics	2	32	0	32
CN: 3016256	Soil-Structure Interaction	3	48	0	48
CN: 3016097	Advanced Geological Engineering	2	32	0	32
CN: 3016043	Tunnel Engineering	2	32	0	32
CN: 3016098	Earth and Rockfill Dam	3	48	0	48
CN: 3016216	Introduction to Finite Element	3	48	0	48
CN: 3016226	Geotechnical Earthquake Engineering	3	48	0	48
CN: 3016498	Fundamentals of Coastal Engineering	3	48	0	48
CN: 3016222	Site Investigation	2	32	0	32
CN: 3016385	Groundwater Engineering	3	48	0	48
CN: 3016004	Advanced Soil Mechanics Laboratory	1	0	16	16
CN: 3016005	Rock Mechanics Laboratory	1	0	16	16
CN: 3016006	Soil Dynamics Laboratory	1	0	16	16
CN: 3016106	Marine Geotechnics	3	48	0	48
CN: 3016407	Soil Modeling	3	48	0	48
CN: 3016223	Reinforced Soils	3	48	0	48

ADVANCED SOIL MECHANICS

BASIC INFORMATION
Place in Curriculum and semester: Core, S1
Number of credits: 3

COURSE PREREQUISITES:
-
COURSE CO-REQUISITES:
-
TEACHERS:
The person in charge: Dr. Mahmoud Hashemi
Office location: Faculty of Civil Engineering and 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 hrs	By appointment	-	By appointment

COURSE OBJECTIVES

The course intends to make students familiar with the advanced methods of investigation and identification of soil behavior such as consolidation, swelling, shear resistance, seepage in three-dimensional space and limit states and related theories.
The course may be divided in 2 parts: advanced consolidation concepts & critical state soil mechanics concepts.
The course in 1st part intends to introduce the advanced aspects & concepts of consolidation such as 2- and 3-dimensional consolidation, calculation methods and their application to practical problems of wick drains & PVDs along with field examples, design issues, methods of construction.
The course in 2nd part intends to introduce the advanced aspects & concepts of critical state soil mechanics such as triaxial cell consolidation, normal compression line NCL, critical state line CSL & limit state.
In each chapter, the lectures begin with a brief historical & basic ideas and evolution of the method followed by introducing the framework of the problem & solution. To apply the theoretical methods, practical examples are examined then the various methods are compared and evaluated.
A set of consecutive related (chain) homeworks are given to students finally leading to a separate fully practical project. The ability of analyzing and merge the results with design methodologies are evaluated through an interview for the submitted project. The midterm and final exams are also present to examine the basic written design abilities.

REQUIRED STUDENT RESOURCES

Textbooks and References:

1. B. M. Das, "Advanced Soil Mechanics", 3rd Edition, Taylor & Francis Group, 2008.
2. J. Atkinson, "An Introduction to the Mechanics of Soils and Foundations through Critical State Soil Mechanics", McGraw-Hill Professional; 2nd Edition, 2001.
3. D. Muir Wood, "Soil Behavior and Critical State Soil Mechanics", Cambridge University Press, 2nd Edition, 1991.
4. A. N., Schofield and C. P.,Wroth, "Critical State Soil Mechanics", McGraw-Hill, 1968.

Web links:

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COURSE SCHEDULE/OUTLINE/CALENDAR OF EVENTS

Week	Topic	Reading/Assignment
1	Reminding of soil mechanics - seepage in three-dimensional space: movement of water in the soil	-
2	Terzaghi's one-dimensional consolidation theory and related equations	HW#1
3	The effect of different pore water pressure distributions across layer thickness-time-dependent loading	HW#2
4	Terzaghi's one-dimensional consolidation examples	
5	Analysis of drainage wells (radial two-dimensional consolidation) - the concept of free strain (flexible foundation) and equal strain (rigid foundation)	-
6	Effect of smeared area--time- dependent loading	-
7	Solving examples - the use of prefabricated drains	HW#3
8	Soil behavior in compression and swelling - normal compression line NCL-loading and reloading	-
9	Dry and wet side - one-dimensional and isotropic compression and swelling	-
10	horizontal pressure coefficient in one-dimensional loading - examples	HW#4
11	Critical state strength of soil - behavior of soil in shear - normal and critical states - critical state line CSL	
12	Analyzes of effective and total stress - critical state in triaxial test - critical state parameters	-
13	Critical friction angle and cohesion - examples of critical state	HW#5
14	Limit state line in the three-dimensional space of stress-strain- investigation of soil limit curved surface (Roscoe and Hvorslov curved surfaces)	-
15	Resistance in drained and undrained consolidated conditions - CAMCLAY model - modified CAMCLAY models	HW#6
16	Saturation with inverse compression - failure with constant volume - failure with increasing pore pressure	-

EVALUATION PROCEDURES AND GRADING CRITERIA

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

BASIC INFORMATION

Place in Curriculum and semester: Core, S2
Number of credits: 3

COURSE PREREQUISITES:

-

COURSE CO-REQUISITES:

-

TEACHERS:

The person in charge: Dr. Mahmoud Hashemi
Office location: Faculty of Civil Engineering and 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 hrs	By appointment	-	By appointment

COURSE OBJECTIVES

This course intends to introduce understanding of the functions of pile, the modes of pile reaction, calculation principles & methods and, methods of construction for pile foundations.
The course may be divided in 3 parts: vertical & lateral load-bearing of the piles, and miscellaneous issues such as pile group & pile settlement, & foundation under tension.
In each chapter, the lectures begin with a brief historical & basic ideas and evolution of the method followed by introducing the framework of the problem & solution. To apply the theoretical methods, practical examples are examined then the various methods are compared and evaluated.
A set of consecutive related (chain) homeworks are given to students finally leading to a separate fully practical project. The ability of analyzing and merge the results with design methodologies are evaluated through an interview for the submitted project. The midterm and final exams are also present to examine the basic written design abilities.

REQUIRED STUDENT RESOURCES

Textbooks and References:

1. M.J. Tomlinson, “Pile Design and Construction Practice”, McGraw-Hill Professional; 5th Edition, 2008.
2. J. E. Bowles, “Foundation Analysis and Design”, 3rd Edition, Prentice Hall, 1996.
3. B.M. Das, “Theoretical Foundation Engineering”, 3rd Edition, Prentice Hall, 1996.
4. D.P. Coduto, “Foundation Design, Principles and Practices”, 2nd Edition, Prentice Hall, 2001.

Web links:

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COURSE SCHEDULE/OUTLINE/CALENDAR OF EVENTS

Week	Topic	Reading/Assignment
1	Reminder of the types of foundations - applications of deep foundations (piles) - pile performance (frictional/end bearing) - types of pile construction (cast in situ/driven)	-
2	Soil properties used in pile bearing capacity calculations from field and laboratory tests	
3	Construction methods of piles & its effect on pile reaction	-
4	An introduction to the static bearing capacity of the pile under vertical load and its determination methods - the factors affecting the side and the point reactions of the pile	
5	Relationships of pile point static bearing capacity - Hansen's method - Janbu's method - Vesic's method - Meyerhoff's method	HW#1
6	Relationships of static bearing capacity of pile side - method α - method β - method λ	HW#2
7	Examples of relationships for the static load capacity of the point and the side of the pile	HW#3
8	Vertical tensile static bearing capacity of pile	-
9	Determining the static bearing capacity of the pile from field tests - an introduction to the static bearing capacity of the pile under lateral load and its determination methods	-
10	Lateral static bearing capacity relationships of piles - rigid short pile method - flexible long pile method	HW#4
11	Lateral static bearing capacity relationships of the pile - Brahms method - p-y diagram method - methods for drawing p-y diagram, the effect of installation method, continuous elastic method	-
12	Examples of pile lateral static bearing capacity relations	HW#5
13	Behavior of the pile group under lateral and vertical load	HW#4
14	Examples of pile group under lateral and vertical load	-
15	Settlement of the pile under vertical (side & point) and lateral loads	-
16	Foundations under tensile load (principles-failure surface-bearing capacity)	-

EVALUATION PROCEDURES AND GRADING CRITERIA

Assignment	10% of final grade
Mid-Term Exam	25% of final grade
Final Exam	35% of final grade
Project	30% 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

EARTH AND ROCKFILL DAMS

BASIC INFORMATION

Place in Curriculum and semester: Elective, S3
Number of credits: 3

COURSE PREREQUISITES:

-

COURSE CO-REQUISITES:

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TEACHERS:

The person in charge: Dr. Mahmoud Hashemi
Office location: Faculty of Civil Engineering and 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 hrs	By appointment	-	By appointment

COURSE OBJECTIVES

This course intends to introduce the stages of studies, calculation methods and design principles, methods of construction, maintenance and understanding of the functions of earth and rockfill dams.
The course may be divided in 4 parts: dam parameters selection, slope stability analysis, seepage estimation, construction issues including filter, drainage etc.
In each chapter, the lectures begin with a brief historical & basic ideas and evolution of the method followed by introducing the framework of the problem & solution. To apply the theoretical methods, practical examples are examined then the various methods are compared and evaluated.
A set of consecutive related (chain) homeworks are given to students finally leading to a separate fully practical project. The ability of analyzing and merge the results with design methodologies are evaluated through an interview for the submitted project. The midterm and final exams are also present to examine the basic written design abilities.

REQUIRED STUDENT RESOURCES

Textbooks and References:

1. B. M. Das, K. Sobhan, “Principles of Geotechnical Engineering”, 8th edition, Cengage Learning, 2014
2. B. M. Das, “Advanced Soil Mechanics”, 3rd edition, Taylor & Francis, 2008
3. S. L. Kramer, “Earth and Rockfill Dams”, 3rd Edition, Prentice Hall, 1996.
4. S.K. Sarma, “Stability of Embankments and slopes”, Springer; 1st Edition, 2008.
5. S.K. Sarma, “Embankment Dams”, McGraw-Hill Professional; 1st Edition, 2001.
6. J.L. Sherard, R.J. Woodward and S.F. Gizienski, “Earth and Earth Rock Dams: Engineering Problems of Design and Construction”, 1st Edition , John Wiley & Sons Inc, 1963.

7. A.L. Goldin, “Design of Earth Dams (Geotechnika)”, Taylor & Francis; 1st Edition, 1992.
8. C. Kutzner, “Earth & Rockfill Dams”, Taylor & Francis; 1st Edition, 1997.

Web links:

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COURSE SCHEDULE/OUTLINE/CALENDAR OF EVENTS

Week	Topic	Reading/Assignment
1	General comments and history of different types of dams from the past until now and the importance of earth dams - an overview of the importance of the dam as a development project and its objectives	-
2	Types of dams, adaptation of dam type to site conditions, various options for earth and rockfill dams.	
3	Different phases of earth and rockfill dam project studies, how to choose a suitable site, studies planning	-
4	Examining different sections in earth and rockfill dams by providing examples of built dams, determining the criteria for choosing dam sections with their details.	HW#1
5	Classification of slope stability methods	-
6	Limit equilibrium methods including Fellenius (Swedish), Taylor, friction circle, Bishop and Bishop-Morgenstern	-
7	Examples of limit equilibrium methods - stability study of earth and rockfill dams	HW#2
8	Review of seepage flow in soil, Darcy's law, soil permeability coefficient - vertical and horizontal equivalent permeability - laboratory and field permeability	-
9	Mathematical equation of seepage flow in soil - seepage flow network and rules for drawing it - calculation of seepage flow through soil	-
10	Methods of calculating seepage from earth dams - methods of drawing the phreatic line of seepage	-
11	Examples of seepage calculation methods	HW#3
12	Filter and drain design methods	-
13	Examples of filter and drain design	HW#4
14	Insitu and laboratory studies related to damsite and foundations (engineering geology, geophysics, geotechnics, drilling, tracing) - methods of improving alluvial, soil and rock foundations	-
15	Dam construction methods including construction management, required machineries, construction details, probable problems, experimental fills	-
16	Principles and rules governing the compaction of soils - the role of energy consumption in compaction, the theoretical curve of compaction, how to control the soil compaction operations	-

EVALUATION PROCEDURES AND GRADING CRITERIA

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

Project	35% of final grade
	100%

ATTENDANCE STATEMENT

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SYLLABI ON WEB PAGES

Last update: September 2024

SOIL DYNAMICS

BASIC INFORMATION

Place in Curriculum and semester: Core, S1
Number of credits: 3

COURSE PREREQUISITES:

-

COURSE CO-REQUISITES:

-

TEACHERS:

The person in charge: Dr. Mohammad Ali Rahgozar
Office location: Faculty of Civil Engineering and Transportation, University of Isfahan, Hezar-Jerib av., Isfahan, Iran.
Phone Number: +98 (31) 37935286
Homepage: http://cet.ui.ac.ir/~rahgozar
Email Address: rahgozar@eng.ui.ac.ir

WEEKLY HOURS

Theory	Problem Solving	Laboratory	Guided learning
3 hrs	By appointment	-	By appointment

COURSE OBJECTIVES

This course covers subjects related to soil dynamics including the behavior of soils subjected to dynamic and cyclic loadings. In addition to the theoretical aspects of soil dynamics and practical aspects and design of geotechnical design of structures subjected to dynamic loading including machine foundations, dynamic bearing capacity of foundations and seismic design of retaining walls will be covered in this course.

Introductory chapters will address topics on engineering seismology with an emphasis on the nature and consequence of the dynamic loading in the ground, fundamentals of vibrations as well as wave propagation. After reviewing the introductory topics in soil dynamics, the remaining chapters will discuss the properties of dynamically loaded soils, field test measurement, foundation vibration, dynamic bearing capacity of foundations, design of gravity retaining walls and liquefaction of soil. The student's skills will be improved by examples and exercises on the topics covered in this course.

REQUIRED STUDENT RESOURCES

Textbooks and References:

1. Das B. M. and Ramana G.V. “Principles of soil dynamics”, Cengage Learning, 2010.
2. Kramer, S. L. “Geotechnical earthquake engineering”. Prentice Hall, 1996.
3. Ishihara K. “Soil Behaviour in Earthquake Geotechnics”. 1996.

COURSE SCHEDULE/OUTLINE/CALENDAR OF EVENTS

Week	Topic	Reading/Assignment
1	Introductory Topics/ Characteristics of Dynamic Problems/ Nature and	

Week	Topic	Reading/Assignment
	Types of The Dynamic Loading/ Importance of Soil Dynamics.	-
2	Fundamentals Of Vibration/ Systems with Single D.O.F/ Free and Forced Vibration/ Vibration Measurement Instrument/ Systems with Two D.O.F	HW#1
3	Wave Propagation/ Waves in Elastic Medium/ Stress and Strain/ Elastic Stress Waves in Bar/ Stress Waves in An Infinite Elastic Medium/ Stress Waves in Elastic Half-Space	HW#2
4	Properties Of Dynamically Loaded Soils/ Laboratory Tests and Common Soil Behavior Subjected to Dynamic Loading/ Cyclic Tests on Soils Including Travel-Time Test, Resonant Column Test, Cyclic Simple Shear Test, Cyclic Torsional Simple Shear Test, Cyclic Triaxial Test	HW#3
5	Field Test Measurements/ Reflection and Refraction of Elastic Body Waves/ Seismic Refraction Survey (Horizontal Layering).	-
6	Refraction Survey in Soils with Inclined Layering/ Reflection Survey in Soil (Horizontal Layering)/ Reflection Survey in Soil (Inclined Layering)/ Subsoil Exploration by Steady-State Vibration	HW#4
7	Foundation Vibration/ Introduction/ Vertical Vibration Circular Foundations Resting on Elastic Half-Space Historical Development/ Analog Solutions for Vertical Vibration of Foundations/ Calculation Procedure for Foundation Response-Vertical Vibration/Rocking Vibration of Foundations/ Sliding Vibration of Foundations/ Torsional Vibration of Foundations/ Comparison of Footing Vibration Tests with Theory/ Comments on the Mass-Spring-Dashpot Analog Used for Solving Foundation Vibration Problems.	HW#5
8	Coupled Rocking and Sliding Vibration of Rigid Circular Foundations/ Vibration of Foundations for Impact Machines Vibration of Embedded Foundations/ Vertical Vibration of Rigid Cylindrical Foundations/ Sliding Vibration of Rigid Cylindrical Foundations/ Rocking Vibration of Rigid Cylindrical Foundations/ Torsional Vibration of Rigid Cylindrical Foundations/ Vibration Screening/ Active and Passive Isolation.	-
9	Dynamic Bearing Capacity of Shallow Foundations/ Introduction/ Ultimate Dynamic Bearing Capacity/ Bearing Capacity in Sand/ Bearing Capacity in Clay/ Behavior of Foundations under Transient Loads.	HW#6
10	Experimental Observation of Load-Settlement Relationship for Vertical Transient Loading/ Seismic Bearing Capacity and Settlement in Granular Soil.	-
11	Lateral Earth Pressure On Retaining Walls/ Introduction/ Mononobe−Okabe Active Earth Pressure Theory/ Comments on the Active Force Equation/ Procedure for Obtaining PAE Using Standard Charts of K_A.	-
12	Effect of Various Parameters on the Value of the Active Earth Pressure Coefficient/ Graphical Construction for Determination of Active Force, P_{AE} /Laboratory Model Test Results for Active Earth Pressure	HW#7

Week	Topic	Reading/Assignment
	Coefficient, K_{AE} / Point of Application of the Resultant Active Force, P_{AE}.	
13	Design of Gravity Retaining Walls Based on Limited Displacement/ Hydrodynamic Effects of Pore Water/ Mononobe−Okabe Active Earth Pressure Theory for c − ϕ Backfill/ Dynamic Passive Force on Retaining Wall.	HW#8
14	Liquefaction of Soil/ Introduction/ Fundamental Concept of Liquefaction/ Laboratory Studies to Simulate Field Conditions for Soil Liquefaction.	-
15	Dynamic Triaxial Test/ General Concepts and Test Procedures/Typical Results from Cyclic Triaxial Test.	-
16	Influence of Various Parameters on Soil Liquefaction Potential/ Development of Standard Curves for Initial Liquefaction.	-

EVALUATION PROCEDURES AND GRADING CRITERIA

Assignment	40% of final grade
Final Exam	35% of final grade
Project	25% of final grade
	100%

ATTENDANCE STATEMENT

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SYLLABI ON WEB PAGES

Last update: September 2024

INTRODUCTION TO FINITE ELEMENT METHOD

BASIC INFORMATION

Place in Curriculum, title and semester: Elective, S1
Number of credits: 3

COURSE PREREQUISITES:

-

COURSE CO-REQUISITES:

-

TEACHERS:

The person in charge: Dr. Meysam Mashayekhi
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Homepage: http://cet.ui.ac.ir/~m.mashayekhi
Email Address: m.mashayekhi@cet.ui.ac.ir

WEEKLY HOURS

Theory	Problem Solving	Laboratory	Guided learning
3 hrs	By appointment	-	By appointment

COURSE OBJECTIVES

This course intends to introduce the approximate techniques for the solution of engineering problems with an emphasis on geotechnical applications. Although a variety of methods is reviewed which include the finite difference method, method of weighted residuals and variational method, more lectures and discussions are devoted to the finite element method.
In each chapter, the lectures begin with a brief historical note on the basic idea and evolution of the method followed by introducing the framework of the solution. To demystify the application of these methods for engineering purposes, the example problems have been incorporated into the lecture. Through these examples, the strengths and drawbacks of these numerical methods are highlighted. Finally, the problem sets are intended to either deepen the knowledge and understanding of the topic for the students and also improve their skills in solving the problems with these methodologies. Hence, students would elevate their expertise by applying these methods to the problems associated with engineering specifically for geotechnical applications.

REQUIRED STUDENT RESOURCES

Textbooks and References:

1. Bathe, K. J., “Finite Element Procedures”, Prentice-Hall, Englewood Cliffs,1996.
2. Zienkiewicz O.C., & Taylor, R.L., “The Finite Element Method”, vol. 1, 4th Edition, McGraw Hill, 1989.
3. Reddy, J. N., “An Introduction to the Finite Element Method”, 3rd Edition, McGraw-Hill, New York, 2005.
4. Kaliakin, V.N. “Introduction to Approximate Solution Techniques, Numerical Modeling, and Finite Element Methods” (1st ed.). CRC Press, 2002.

5. Potts, David M. and Zdravković, Lidija, "Finite Element Analysis in Geotechnical Engineering: Volume One - Theory", Thomas Telford Publishing, 1999.
6. Potts, David M. and Zdravković, Lidija, "Finite Element Analysis in Geotechnical Engineering: Volume two - Application", Thomas Telford Publishing, 2001.
7. Lees, A., "Geotechnical Finite Element Analysis: A Practical Guide", ICE Publishing, 2016.
8. Desai, Chandrakant S., ed. "Numerical methods in geotechnical engineering". McGraw-Hill Companies, 1977.

Web links:

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COURSE SCHEDULE/OUTLINE/CALENDAR OF EVENTS

Week	Topic	Reading/Assignment
1	Introduction/objectives/ Requirements for a general solution/ Method of analysis in geotechnical engineering/ Numerical Analysis-Requirement/ Mathematical Modeling/ General form of Governing equations	-
2	Finite Difference Method (FDM)/ Historical Note/ General steps/ Ordinary Differential Equations/ Some Finite Difference Formulas/ Source of Errors	-
3	Partial Differential Equation/ Elliptic PDEs/ Parabolic PDEs/ Hyperbolic PDEs	HW#1
4	Method of Weighted Residuals (MRW)/ Residuals/ General Considerations/ Choice of Trial Functions/ Specific Weighting Functions	-
5	Collocation Method/ Subdomain Method/ Method of Least Squares/ The Bubnove Galerkin Method/ Method of Moments/ Continuity Requirements/ Weak Form	HW#2
6	Variational Method/ Historical Development/ Calculus of Variations/ Functionals/ Existance of Functionals	-
7	Admissible Functions/ Stationary Functional Method/Rayleigh Ritz Method	HW#3
8	Finite Element Method (FEM)/ Notion of the Elements/ Piecewise Defined Approximation/ Fundamental characteristics of FEM	-
9	Development of Finite Element Equations/ Selection of primary dependent variables/ Definition of constitutive relations/ Identification of Element Equations	-
10	Selection of Element Interpolation Function/ Convergence Criteria/ Compatibility Criterion/ Completeness Criterion/ Spatial Isotropy/ Selection of element Nodes/ Specialization of Element Equations	HW#4
11	Steps in Performing Finite Element Analyses/ Discretization of the domain/ Domain discretization error	-
12	Common Element Types/ Element Characteristics/ Placement of Elements/ Mesh Generation/ Assembly of Element Equations/ Nodal Specifications	-
13	Solution of Global Equations/ Mesh Renumbering Schemes/ Local and global Coordinate system/ Natural Coordinate system/ Element Mapping	HW#5
14	Treatment of Derivatives/ Calculation of the secondary dependent variables/ Interpretation of Results/ Validity of Finite Element Analyses	-
15	Element Interpolation Functions/ Systematic derivation of interpolation	HW#6

Week	Topic	Reading/Assignment
	function/ Lagrangian Elements	
16	Lagrangian interpolating polynomial/ Serendipity Elements/ Triangular Elements	-

EVALUATION PROCEDURES AND GRADING CRITERIA

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

ATTENDANCE STATEMENT

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STUDENTS WITH DISABILITIES ACT FOR STUDENTS WITH SPECIAL NEEDS STATEMENT

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SYLLABI ON WEB PAGES

Last update: September 2024

REINFORCED SOILS

BASIC INFORMATION

Place in Curriculum, title and semester: Elective, S2
Number of credits: 3

COURSE PREREQUISITES:

-

COURSE CO-REQUISITES:

-

TEACHERS:

The person in charge: Dr. Meysam Mashayekhi
Office location: Faculty of Civil Engineering and Transportation, University of Isfahan, Hezar-Jerib av., Isfahan, Iran.
Phone Number: +98 (31) 37935295
Homepage: http://cet.ui.ac.ir/~m.mashayekhi
Email Address: m.mashayekhi@cet.ui.ac.ir

WEEKLY HOURS

Theory	Problem Solving	Laboratory	Guided learning
3 hrs	By appointment	-	By appointment

COURSE OBJECTIVES

Within the last few decades, a variety of methods and materials have been used for improvement of the soil engineering properties. Reinforced soil is a term used for the classification of a series of methods that use mechanical components for the stabilization of soils. This course is intended to introduce some of the popular soil reinforcement methods to graduate students in geotechnical engineering. The course begins with an introductory chapter that includes a historical note on development of the reinforced soils, combined with the classification of reinforced soil. Continuing the chapter with concepts of lateral earth pressure theory and a comparison between ASD and LRFD methods, this chapter concluded with a brief review of geosynthetic materials. The remaining chapters discussed a variety of reinforced wall designs including MSE walls, GRS walls, Nailing systems, and Ground anchors. In each chapter, a historical note on the development of the system is followed by a discussion on the application, components, and materials used for the reinforced wall. The students are expected to learn the mechanism of the load-bearing, modes of failure, and design steps of each reinforced wall. In addition, students' skills will be improved by examples and exercises on the topics covered in this course.

REQUIRED STUDENT RESOURCES

Textbooks and References:

1. Jones, C.J.F.P., “Earth reinforcement and soil structures”, Butterworth, London, UK, 3rd edition, 1996
2. Koerner, R.M., “Designing with Geosynthetics”, Prentice Hall, New Jersey, USA, 6th edition, 2012.
3. Wu, J. T., “Geosynthetic reinforced soil (GRS) walls”, John Wiley & Sons; 2019.
4. FHWA (Federal Highway Administration). “Design and construction of mechanically stabilized earth walls and reinforced soil slopes: Vols. 1 and 2”, 2009.

5. Sabatini, P. J., D. G. Pass, and Robert C. Bachus. Ground anchors and anchored systems. No. FHWA-IF-99-015. United States. Federal Highway Administration. Office of Bridge Technology, 1999.
6. Adams M, Nicks J, Stabile T, Schlatter W, Hartmann J. Geosynthetic reinforced soil integrated bridge system interim implementation guide. Federal Highway Administration (US); 2012.
7. Lazarte, Carlos A., Helen Robinson, Jesús E. Gómez, Andrew Baxter, Allen Cadden, and Ryan Berg. "Soil nail walls reference manual", No. FHWA-NHI-14-007. 2015.
8. Byrne, R. J., D. Cotton, J. Porterfield, C. Wolschlag, and G. Ueblacker. "Manual for design and construction monitoring of soil nail walls." (1996).
9. Ling, H. I., Leshchinsky, D. and Tatsuoka, F. eds. "Reinforced soil engineering: advances in research and practice", 2003.

Web links:

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COURSE SCHEDULE/OUTLINE/CALENDAR OF EVENTS

Week	Topic	Reading/Assignment
1	Introductory Topics/ Concept/ Historical Note/ Importance of Reinforced Soils/ Classification/ Load Support Mechanism/ Construction Methods/ System Rigidity.	-
2	Introductory Topics/ Applications/ Design Overview/ Types of failures/ Design Platform/ Uncertainties/ Overall Process of ASD vs. LRFD.	-
3	Limiting States of Lateral Pressure/ Rankine Earth Pressure Theory/ Coulomb Earth Pressure Theory/ Influence of Wall Movement on Earth Pressures/ Additional Earth Pressure Theory/ Semi-Empirical Earth Pressure Diagrams/ Design Water Pressures/ Pressure Distribution of Surface Surcharge Loads.	-
4	Geosynthetics/ Types/ Functions/ Advantages and Disadvantages/ Physical Properties/ Mechanical Properties/ Load Deformation Properties/ Soil Geosynthetic Composites/ Interface Properties.	HW#1
5	Mechanically Stabilized Earth (MSE) Wall/ Introduction/ Principal Components/ Applications/ Component properties/ Backfill/ Reinforcing Elements/ Soil Compatibility/ Facing Elements/ Basic Construction Steps.	-
6	Soil Reinforcement Interaction/ Pullout Resistance/ Establishment of Structural Design Properties/ Strength Properties and Allowable Strength of Steel and Geosynthetic Reinforcements.	-
7	Limit States for MSE Wall Design/ MSE Wall Design/ Design Steps/ Establish Project Requirements/ Reinforced Wall Fill/ Retained Backfill/ Wall Embedment Depth and Reinforcement Length/ Identify Unfactored Loads/ Summarize Load Combinations, Load Factors, and Resistance Factors/	-
8	Evaluate External Stability/ Settlement Analysis/ Evaluate Internal Stability/ Design of Facing Elements/ Assess Overall Stability/ Assess Compound Stability/ Design Wall Drainage Systems/ Bottom of Wall Elements/ Internal Details/ Design examples.	HW#2
9	Geosynthetic Reinforced Soil (GRS)/ Components and materials/ Reinforced Soil Foundation (RSF)/ GRS Abutment/ GRS Integrated Approach/ Structural Backfill/ Geosynthetic/ Facing Elements/ Corrosion protection/ Performance Test	-
10	Geosynthetic Reinforced Soil (GRS)/ Design Process/ External Stability/	HW#3

Week	Topic	Reading/Assignment
	Internal Stability/ Basic steps in the design of GRS-IBS/ Instrumentation and Monitoring/ Maintenance/ Design examples.	
11	Soil Nailing/ Introduction/ Materials and components/ Tendons/ Grout/ Corrosion Protection/ Facing/ Shotcrete/ Final Facing/ Connection Components/ Drainage System/ Construction sequence/ Applications.	-
12	Soil Nailing/ Advantages and Limitations/ Resisting Mechanisms and Limit States/ Load Transfer/ Soil Nail Interaction and Tensile Force Distribution/ Limit states/ Design Considerations.	-
13	Soil Nailing/ Design Steps/ Preliminary Design/ Internal Stability/ Sliding Stability/ Basal Heave/ Nail Pullout/ Nail Tensile Resistance/ Facing stability; Bending, Punching Shear, Headed Stud in Tension/ Service Limit State.	HW#4
14	Ground Anchors; Introduction/ Soils Unsuitable for Anchors/ Materials and components; Bar Tendon, Strand Tendon/ Construction Sequence / Ground Anchor Types/ Load Testing of Ground Anchors/ Preproduction, Performance, Proof and Lift-Off Tests/	-
15	Ground Anchors; Design Steps/ Select Corrosion Protection of Ground Anchors/ Select Earth Pressure Diagram/ Evaluate Factored Loads/ Evaluate Individual Anchor Loads and Subgrade Reaction Force/ Evaluate Anchor Inclination/	-
16	Ground Anchors; Design Steps/ Select Tendon Type and Check Tensile Resistance/ Select Tendon Size and Trumpet Opening Size/ Evaluate Anchor Bond Length/ Evaluate Factored Bending Moment and Flexural Resistance of Wall/ Evaluate Bearing Resistance of Vertical Wall Element/ Estimate Maximum Lateral Wall Movements and Settlements at the Service Limit/ Design Examples	HW#05

EVALUATION PROCEDURES AND GRADING CRITERIA

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

ATTENDANCE STATEMENT

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SYLLABI ON WEB PAGES

Last update: September 2024

SOIL MODELING

BASIC INFORMATION

Place in Curriculum and semester: Elective, S3
Number of credits: 3

COURSE PREREQUISITES:

-

COURSE CO-REQUISITES:

-

TEACHERS:

The person in charge: Dr. Meysam Mashayekhi
Office location: Faculty of Civil Engineering and Transportation, University of Isfahan, Hezar-Jerib av., Isfahan, Iran.
Phone Number: +98 (31) 37935295
Homepage: http://cet.ui.ac.ir/~m.mashayekhi
Email Address: m.mashayekhi@cet.ui.ac.ir

WEEKLY HOURS

Theory	Problem Solving	Laboratory	Guided learning
3 hrs	By appointment	-	By appointment

COURSE OBJECTIVES

As one of the courses related to modeling and computational geomechanics, this course is intended to broaden the modeling and computational knowledge and skills of graduate students in geotechnical engineering. To provide a framework for modeling soil behavior, materials from soil mechanics, continuum mechanics and tensor analysis would be required in the development of the course. In addition, knowledge of numerical modeling and programming languages is highly desirable.
Introductory chapters will address topics on mathematical analysis, continuum mechanics, and a review of the laboratory soil tests to draw a framework for the modeling. After reviewing the preliminary materials, the remaining chapters will discuss a variety of soil constitutive models. The extended list of the discussed models in the course is provided in outline but to name a few, elastic models such as hyperelastic and hypoelastic models, elastoplastic models such as Mohr-Coulomb, Drucker-Prager, and critical state-based models such as MCC will be covered. In addition to classic soil models, more advanced models will be addressed (time permitting) such as Single Hardening, Bounding Surface, etc. In the lectures, the student will review the components of each class of soil models and learn the application, advantages and shortcomings of each model. Also, the student is expected to improve their knowledge and skills through exercises that include modeling software or programming languages as well as reading related papers and supplemented materials.

REQUIRED STUDENT RESOURCES

Textbooks and References:

1. Wood, D. M. “Soil behaviour and critical state soil mechanics”, Cambridge university press, 1990.
2. Wood, D. M. “Geotechnical modelling”. CRC press, 2017.
3. Puzrin, A. “Constitutive modelling in geomechanics: introduction”. Springer Science & Business Media, 2012.
4. Klausner, Y. “Fundamentals of continuum mechanics of soils”. Springer Science & Business Media, 2012.
5. Desai, C. S., and Siriwardane, H. J., “Constitutive Laws for Engineering Materials: With Emphasis on Geologic Materials”, Prentice Hall, Inc., Englewood Cliffs, New Jersey, 1984.
6. Yu, H. “Plasticity and geotechnics”. Vol. 13. Springer Science & Business Media, 2007.
7. 7. Liu Y, and Zheng Y. “Plastic Mechanics of Geomaterial”. Springer Singapore; 2019.
8. Borja R.I., “Plasticity Modeling and Computation”, Springer-Verlag, 2013.

COURSE SCHEDULE/OUTLINE/CALENDAR OF EVENTS

Week	Topic	Reading/Assignment
1	Introductory Topics/ Types of Modeling in Geotechnical Engineering/ Empirical (Semi-Empirical) Methods/ Theoretical Methods/ Numerical Methods/ Constitutive Modeling/ Physical Modeling.	-
2	Boundary Value Problems in Geotechnics/ Continuum Duality/ Elementary Tensor Analysis/ Indicial Notation/ Scalars and Vectors/ Second Order Tensors .	-
3	Review of Important Aspects of Continuum Mechanics/ Kinematics/ Stresses/ Stress tensor/ Equations of Motion/ Principal Stresses/ Stress Tensor Invariants.	HW#1
4	Review of Important Aspects of Continuum Mechanics/ Strains/ Strain Tensors/ Properties of the Strain Tensor/ Invariants and Their Relations.	-
5	Laboratory Testing with Relation to Constitutive Modeling/ Triaxial Stress-Strain space/ Conventional Drained/Undrained Triaxial Compression Test.	HW#2
6	Material Characteristics of sand and clays/ Complexities of the Mechanical Behavior of Soils/ Anisotropy, time/rate and temperature dependence.	-
7	Elastic Material Idealization/ Hyper- and hypoelastic models/ Special Case of Linear Models.	HW#3
8	Elastic Material Idealization/ Special Case of Nonlinear Models/ Quasilinear Models/ Model Based on Hyperbolic Relations.	-
9	Fundamental Aspects of Rate Independent Elastoplasticity/ Uniaxial Plasticity/ Loading/Unloading/ Consistency Condition/ Yield Surface/ Associated and non-Associated Flow Rule / Hardening/Softening Laws.	-
10	Simple Examples of Formulations Suitable for Metal Plasticity (von Mises and Tresca failure criteria)/ Failure Criteria for Geomaterials/ Development of General Elastoplastic Constitutive Matrix.	HW#4
11	Rate Independent Elastoplasticity Models for Geomaterials/ Examples of Formulations Suitable for Geo-Materials (Mohr-Coulomb Failure Criterion, Drucker-Prager Model, Cap models).	-
12	General Aspects of Two- and Three-Stress Invariant Models/ Discussion of Failure Criteria Suitable for Geomaterials/ General Notes on Numerical Implementation.	HW#5
13	Rate Independent Elastoplastic Models Suitable for Clays/ Critical State Concept and Associated two- and three-Invariant models.	-

Week	Topic	Reading/Assignment
14	Rate Independent Elastoplastic Models Suitable for Clays / Original and Modified Cam-Clay model/ Bounding Surface Model.	HW#6
15	Rate Independent Elastoplastic Models Suitable for Sands and Silty Sands/ Lade-Kim (SHM)/ Dafalias-Manzari-Li model.	-
16	General Aspects of Viscoplasticity for Geomaterials/ Simple Models/ time, rate and temperature dependent models.	-

EVALUATION PROCEDURES AND GRADING CRITERIA

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

ATTENDANCE STATEMENT

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SYLLABI ON WEB PAGES

Last update: September 2024

GROUNDWATER ENGINEERING

BASIC INFORMATION

Place in Curriculum and semester: Elective, S2
Number of credits: 3

COURSE PREREQUISITES:

-

COURSE CO-REQUISITES:

-

TEACHERS:

Person in charge: Dr. Mahmoud Hashemi
Office location: Faculty of Civil Engineering and 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	-	1 h

COURSE OBJECTIVES

The course is aimed to make student familiar with the types of aquifers, basic concepts of groundwater flow, groundwater hydraulics in steady and unsteady conditions near the wells, analysis, modelling, attenuation and remediation of groundwater pollution.

Students are expected to learn:

- ✓ General and basic concepts: history, types of porous media (unconsolidated, jointed, karst), types of aquifers (unconfined, confined, leaky, perched) and their characteristics, history of exploiting groundwater with emphasis on Iranian qanat system
- ✓ Introduction on the modelling: continuum approach in porous media, hydrologic cycle, groundwater budget equation, groundwater data and how to measure, record and report it
- ✓ Concepts of groundwater flow: concepts of porosity, hydraulic conductivity, storage, permeability, heterogeneity and anisotropy in aquifers
- ✓ General groundwater flow: Darcy law and its application in one-dimensional groundwater flow problems, Dupuit-Forchheimer assumptions and their application in unconfined aquifer flow
- ✓ Analysis of groundwater flow: General groundwater equation in unconfined and confined aquifers, application of groundwater flow equation in steady one-dimensional groundwater flow problems, application of groundwater flow equation in unsteady one-dimensional groundwater flow problems, potential theory and flow nets, two-dimensional steady groundwater flow
- ✓ Hydraulics of groundwater flow in unconfined aquifer well: hydraulics of groundwater steady flow in aquifer well, hydraulics of groundwater unsteady flow in aquifer well, pumping-out test, flow near boundaries, image well method
- ✓ Hydraulics of groundwater flow in confined aquifer well: hydraulics of groundwater steady flow in aquifer well, hydraulics of groundwater unsteady flow in aquifer well, Theis equation, Cooper-Jacob method, recovery method, hydraulics of groundwater unsteady flow in leaky aquifer well, multiple well systems, partially penetrating wells

- ✓ Groundwater pollution: natural quality of groundwater, salinity of groundwater and its sources, physical, chemical and biological characteristics of groundwater, municipal, industrial and agricultural irrigation sources of groundwater pollution, solved and dissolved pollutants of groundwater, light non-aqueous phase liquids LNAPLs and non-aqueous phase liquids DNAPLs, methods for attenuation and remediation of groundwater pollution
- ✓ Analysis of groundwater pollution: advection-dispersion equation, groundwater pollutants, analytical solution for advection-dispersion equation
- ✓ Remediation of groundwater pollution: monitoring quality and quantity of groundwater, methods for remediation of aquifers with emphasis on conventional pump and treatment method
- ✓ Saline water intrusion: types of water salinity problems in aquifers, island and coastal aquifers, Ghyben-Herzberg relation for estimation of fresh-saline waters interface, effect of well in form of fresh-saline waters interface (Strack relation), upconing of fresh-saline waters interface due to well pompage, equation of fresh-saline waters interface in oceanic island aquifers, control of saline water intrusion
- ✓ Numerical modelling of groundwater flow: various numerical models for solution of flow and solute transport equations, finite-difference method for solution of flow in steady and unsteady conditions, finite-difference method for solution of solute transport equation, introduction on MODFLOW and MT3DMS softwares, their related packages and applications

REQUIRED STUDENT RESOURCES

Textbooks and References:

1. Todd, D.K., Mays, L.W., Groundwater Hydrology, John Wiley & Sons, Inc. 2005. London, 273 p.

References:

1. Charbeneau, R.J., Groundwater Hydraulics and Pollutant Transport, Prentice-Hall, 2006.
2. Fetter, C.W., Applied Hydrogeology, Prentice-Hall, 2001.
3. Bedient, P.B., Rifai, H.S., Newell, C.J., Ground water contamination: transport and remediation, Prentice Hall 1994/1999.
4. Bear, J., Hydraulics of Groundwater, McGraw-Hill, New York, 1979.

Web links for Required Computer Softwares:

MODFLOW 6 v.6.2.2: USGS Modular Hydrologic Model

https://www.usgs.gov/software/modflow-6-usgs-modular-hydrologic-model

MT3D-USGS: Groundwater Solute Transport Simulator for MODFLOW

https://www.usgs.gov/software/mt3d-usgs-groundwater-solute-transport-simulator-modflow

The Groundwater Toolbox: A Graphical and Mapping Interface for Analysis of Hydrologic Data

https://www.usgs.gov/software/groundwater-toolbox-graphical-and-mapping-interface-analysis-hydrologic-data

PEST++, a Software Suite for Parameter Estimation, Uncertainty Analysis, Management Optimization and Sensitivity Analysis

https://pesthomepage.org/

COURSE SCHEDULE/OUTLINE/CALENDAR OF EVENTS

Week	Topic
1	General and basic concepts: history, types of porous media (unconsolidated, jointed, karst), types of aquifers (unconfined, confined, leaky, perched) and their characteristics, history of exploiting groundwater with emphasis on Iranian qanat system

Week	Topic
2	Introduction on the modelling: continuum approach in porous media, hydrologic cycle, groundwater budget equation, groundwater data and how to measure, record and report it
3	Concepts of groundwater flow: concepts of porosity, hydraulic conductivity, storage, permeability, heterogeneity and anisotropy in aquifers
4	General groundwater flow: Darcy law and its application in one-dimensional groundwater flow problems, Dupuit-Forchheimer assumptions and their application in unconfined aquifer flow
5	Analysis of groundwater flow: General groundwater equation in unconfined and confined aquifers, application of groundwater flow equation in steady one-dimensional groundwater flow problems, application of groundwater flow equation in unsteady one-dimensional groundwater flow problems, potential theory and flow nets, two-dimensional steady groundwater flow
6	Hydraulics of groundwater flow in unconfined aquifer well: hydraulics of groundwater steady flow in aquifer well, hydraulics of groundwater unsteady flow in aquifer well, pumping-out test, flow near boundaries, image well method
7	Hydraulics of groundwater flow in confined aquifer well: hydraulics of groundwater steady flow in aquifer well, hydraulics of groundwater unsteady flow in aquifer well,
8	Hydraulics of groundwater flow in confined aquifer well: Theis equation, Cooper-Jacob method, recovery method, hydraulics of groundwater unsteady flow in leaky aquifer well, multiple well systems, partially penetrating wells
9	Groundwater pollution: natural quality of groundwater, salinity of groundwater and its sources, physical, chemical and biological characteristics of groundwater, municipal, industrial and agricultural irrigation sources of groundwater pollution,
10	Groundwater pollution: solved and dissolved pollutants of groundwater, light non-aqueous phase liquids LNAPLs and non-aqueous phase liquids DNAPLs, methods for attenuation and remediation of groundwater pollution
11	Analysis of groundwater pollution: advection-dispersion equation, groundwater pollutants, analytical solution for advection-dispersion equation
12	Remediation of groundwater pollution: monitoring quality and quantity of groundwater, methods for remediation of aquifers with emphasis on conventional pump and treatment method
13	Saline water intrusion: types of water salinity problems in aquifers, island and coastal aquifers, Ghyben-Herzberg relation for estimation of fresh-saline waters interface, effect of well in form of fresh-saline waters interface (Strack relation)
14	Saline water intrusion: upconing of fresh-saline waters interface due to well pompage, equation of fresh-saline waters interface in oceanic island aquifers, control of saline water intrusion
15	Numerical modelling of groundwater flow: various numerical models for solution of flow and solute transport equations, finite-difference method for solution of flow in steady and unsteady conditions
16	Numerical modelling of groundwater flow: finite-difference method for solution of solute transport equation, introduction on MODFLOW and MT3DMS softwares, their related packages and applications

EVALUATION PROCEDURES AND GRADING CRITERIA

Assignment	50% of final grade
Mid-Term Exam	20% of final grade
Final Exam	30% of final grade
	100%

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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:

-

TEACHERS:

Person in charge: Dr. Mahmoud Hashemi
Office location: Faculty of Civil Engineering and 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.

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

Week	Topic
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
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.

SEMINAR AND RESEARCH METHODS

BASIC INFORMATION

Course prefix and semester: Core, S1
Number of credits: 2

COURSE PREREQUISITES:

-

COURSE CO-REQUISITES:

-

TEACHERS:

Person in charge: Dr. Mohammadali Alijanian
Office location: Faculty of Civil Engineering and Transportation, University of Isfahan, Hezar-Jerib av., Isfahan, Iran.
Phone Number: +98 (31) 3793 5317
Email Address: m.alijanian@eng.ui.ac.ir

WEEKLY HOURS

Theory	Problem Solving	Laboratory	Guided learning
2 h	-	-	-

COURSE OBJECTIVES

Students are expected to:

- ✓ become familiar with the scientific searching and indexing.
- ✓ become familiar with the methods of presentation and scientific speech.
- ✓ become familiar with the principles of writing research proposals and thesis.

REQUIRED STUDENT RESOURCES

Textbooks and References:

www.clarivate.com
www.scimagojr.com

Web links:

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Computer Software:

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COURSE SCHEDULE/OUTLINE/CALENDAR OF EVENTS

Week	Topic	Reading /Assignment
1	Definitions	-
2	Introducing research steps	HW1
3	Types of publications and research outcomes	-
4	Types of references and indexing	-
5	Indices for evaluation of research	-
6	Keys to searching and literature review	-
7	Keys to develop an introduction	HW2
8	Types of material and methods (in Engineering)	HW3
9	Keys to prepare scientific results	HW4
10	Keys to develop discussion, abstract or conclusions	HW5
11	Keys to prepare a presentation	HW6

Week	Topic	Reading /Assignment
12	Reviewing process and keys to prepare responses	-
13	Seminar by students	-
14	Seminar by students	-
15	Seminar by students	-
16	Presenting proposals	-

EVALUATION PROCEDURES AND GRADING CRITERIA

Assignment	30 of final grade
Seminar	40% of final grade
Research proposal	30% of final grade
	100%

ATTENDANCE STATEMENT

The course instructor clearly informs students on the first day of class and in writing in the syllabus of their (1) policy regarding class absence and (2) policy, if any, for making up missed assignments. If class attendance is a component of the course grade, the course instructor must clearly communicate this to the class in writing in the syllabus.

STUDENTS WITH DISABILITIES ACT FOR STUDENTS WITH SPECIAL NEEDS STATEMENT

Any students with disabilities or other special needs, who need special accommodations in this course, are invited to share these concerns or requests with the instructor and contact the Disability Services Office as soon as possible.

APPROVED ACADEMIC HONESTY STATEMENT

The academic community is operated on the basis of honesty, integrity, and fair play. It applies to cases in which cheating, plagiarism, or other academic misconduct have occurred in an instructional context. Students found guilty of academic misconduct are subject to penalties, up to and possibly including suspension and/or expulsion. Student academic misconduct records are maintained by the Office of Registration and Records.

SYLLABI ON WEB PAGES

Last update: September 2024