1.	School	Engineering
2.	Department	Civil Engineering
3.	Program title (Arabic)	ماجستير الهندسة الجيوتقنية
4.	Program title (English)	Masters of Science in Geotechnical Engineering
5.	Track	Thesis

First: General Rules & Conditions:

	Specialization #	Degree	Dep #	Faculty #	Year	Track
Plan Number	31	8	01	09	2019	Thesis

1. This plan conforms to the valid regulations of the programs of graduate studies.
2. Specialties of Admission:

- The First Priority: Bachelor of Civil Engineering in all its branches

Second: Special Conditions: None

Third: Study Plan: Studying (33) Credit Hours as following:

1. Obligatory Courses (15) Credit Hours:

Course No.	Course Title	Credit Hrs	Theory	Practical.	Pre/Co-requisite
0921701	Advanced Soil Mechanics	3	3	-	
0921702	Soil Dynamics and Geotechnical Earthquake Engineering	3	3	-	
0921703	Continuum Mechanics	3	3	-	
0921704	Research methodology	3	3	-	
0921705	Finite Element Methods	3	3	-	

2. Elective Courses: Studying (9) Credit hours from the following:

Course No.	Course Title	Credit Hrs	Theory	Practical.	Pre/Co-requisite
0921706	Geoenvironmental Engineering	3	3	-	
0921707	Geotechnical Modeling	3	3	-	
0921708	Ground Improvement	3	3	-	
0921709	Advanced Foundation Engineering	3	3	-	
0921710	Advanced Rock Mechanics	3	3	-	
0921711	Advanced Numerical Methods	3	3	-	
0921712	Special Topics in Geotechnical Engineering	3	3	-	
0921713	Advanced Engineering Mathematics	3	3	-	
0921714	Soil Structure Interaction	3	3	-	
0921715	Geosynthetics Engineering	3	3	-	

3. Thesis: (9) Credit hours (0901799).

Course Description

0921701 Advanced Soil Mechanics (3 Credit Hours)

Introduction: models and soil mechanics. Elasticity, Plasticity and yielding, Elastic-Plastic models for soil, Cam-Clay Model, Critical state, Strength of soil, stress-dilatancy, Cambridge Stress path and soil tests, applications of elastic-plastic models

0921702 Soil Dynamics and Geotechnical Earthquake Engineering (3 Credit Hours)

Review of plate tectonics and seismology, Earthquake surface fault rupture, earthquake rebound theory, analysis of earthquake ground motions, travel path and distance effects; influence of soil conditions on seismic site response; seismic site response analysis; evaluation and modeling of dynamic soil properties; seismic performance of foundations and soil structure interaction; evaluation and mitigation of soil liquefaction and its consequences; seismic slope stability and displacement analysis; seismic safety of dams, levees, embankments; seismic design of earth retaining structures.

0921703 Continuum Mechanics (3 Credit Hours)

Strain tensor, deformation rate, coordinate systems, strain-displacement relations, compatibility equations. Stress tensor, balance laws, stress coordinate transformation, deviatoric stresses, stress and motion with large strain. Elastic solids, Navier equations, energy principles, thermodynamics of solids, finite elasticity. Newtonian fluids, constitutive equations, laws of thermodynamics, compressible, ideal and rotational flows, turbulence, boundary layer, heat transfer. Applied topics in continuum mechanics.

0921704 Research methodology (3 Credit Hours)

In this course, the student learns how to conduct a scientific research, starting from developing the research idea up to writing and presenting a technical report. The course starts by attending a number of lectures given by faculty and invited speakers where models of researches and case studies in advanced fields of geotechnical engineering are presented. Meanwhile, students undertake limited researches of their own under the supervision of faculty staff members to learn how to define the problem; how to make literature review, searching through various resources such as the Engineering Index and Internet. Methods of Solution: Analytical, Numerical and Experimental methods.

Report writing: Introduction; Analysis; Description of the experiment; Experimental procedure; Results; Discussion Conclusions; Recommendations; References; Abstract. At least one report/ paper will be prepared and presented by the student in front of colleagues and staff.

0921705 Finite Element Methods (3 Credit Hours)

General concepts, and definitions, introduction to elasticity and plasticity, Theory of finite element, plain stresses, plain strains, Physical systems, (Natural phenomena) methods for solution.

Formulation of differential equations governing the physical system, and the corresponding boundary conditions. Division (discretization) of analysis region into finite elements: Techniques for discretization. Efficient mesh, mesh refinement. FE-Equations (FE Properties) Trial solution, Trial functions: polynomials, Shape functions. Methods for developing FE-equations. Assembly of FE equations, Global equations system, Imposing the BCs, Programming and solutions Verification of the solution, Accuracy and convergence. Implementation of computer programs: High order FE, Isoparametric FE Applications.

0921706 Geoenvironmental Engineering (3 Credit Hours)

Introduction to geo-environmental engineering; physiochemical and microstructural behavior of geo-materials, effect of pollutants, design of waste disposal systems; advanced laboratory testing, geotextiles, space geo-mechanics, etc.

Engineering properties of soil-water-contaminants; use of earth and geo-synthetic materials in waste containment applications; evaluation, design and construction of liner and leachate collection systems used in landfills and heap leach mining; remediation of contaminated sites.

Mechanisms of contaminant transport in groundwater. Analysis of groundwater remediation methods and alternatives. Numerical modeling of flow and transport in the subsurface. Software applications.

0921707 Geotechnical Modeling (3 Credit Hours)

Mathematical modeling techniques used in geotechnical engineering. Application of proven computer programs (Mainly PAXIS and ABAQUS) students will be required to complete a more rigorous computer project.

Constitutive laws for geotechnical materials including inelastic hyperbolic and elasto-plastic Cam-clay; soil behavior and critical-state soil mechanics; application of the finite element method to static analysis of earth structures; the Discontinuous Deformation Analysis method.

0921708 Ground Improvement (3 Credit Hours)

Introduction, ground improvement techniques including those without addition of materials, by adding materials and using reinforcing elements. Deep mix elements, compaction, electro remediation, applications, and design procedures for various ground improvement techniques. Use analytical/theoretical/numerical calculations to assess the

effectiveness of a ground improvement technique. Evaluating alternative solutions and the effectiveness before, during and after using ground improvement.

0921709 Advanced Foundation Engineering (3 Credit Hours)

Introduction, Special foundations: trapezoid combined footing, strap footing, beam on elastic foundations, foundations on difficult soils: expansive, dispersive, and collapsible soils, axially loaded pile groups, Laterally Loaded piles and P-Y curves, Wave Equation of Piles, Drivability analysis, GRLWEAP analysis, Residual stresses in Piles, Soil fatigue during pile driving, pile settlement.

0921710 Advanced Rock Mechanics (3 Credit Hours)

Introduction: rock classification, rock structures, and rock testing. Rock strength and failure criteria, Stresses in rock, Rock deformation, Strains and strains rosettes, Stereographic projections of rock structures, bolting and anchorage, block theory, underground openings and geotechnical tunneling, application of rock mechanics to foundation engineering, rock slope stability.

0921711 Advanced Numerical Methods (3 Credit Hours)

Mathematical preliminaries, computer precision, loss of significance, error propagation, linear and nonlinear systems of algebraic equations, interpolating polynomials, numerical differentiation and integration, numerical solution of ordinary differential equations (ODE), initial and boundary values, linear and nonlinear systems, approximation theory, direct methods, iterative techniques, (Eigen values), numerical solution of partial differential equations, (PDE), elliptic, parabolic, hyperbolic, finite differences, characteristics and boundary integral equation methods, curve fitting, least squares, spline, Fourier approximation, discrete and fast Fourier transforms, numerical algorithms for advanced engineering problems.

0921712 Special Topics in Geotechnical Engineering (3 Credit Hours)

The content of this course varies from one term to another. External speakers or professors might be invited to teach this course.Field and laboratory testing of soils to support analysis and design of earth structures. In situ field testing, including SPT, CPT, and vane shear, undisturbed sampling of soil, and laboratory testing of soil, including advanced equipment, instrumentation, data acquisition, and measurement techniques. Consolidation and static and cyclic triaxial and simple shear testing under stress- and strain-control with pore pressure measurements. Preparation of an engineering report. Parameters for estimating structural response, development of fragility curves, and methods for risk calculations.

0921713 Advanced Engineering Mathematics (3 Credit Hours)

ODE's: Linear ODE's Variation of parameters, Power Series Method. PDE's: Separation of Variables, Orthogonal Functions and the general expansion Problem, Bessel Function's and Legender Polynomials, Fourier Series, Integral and Transforms, Laplace Transform. Vector Calculus: differentiation, integration, vector operators, Limits (multivariable), integral theories.

0921714 Soil Structure Interaction (3 Credit Hours)

Response of structural systems with nonlinear materials under large displacements; event-to-event analysis for simple material response; nonlinear solution strategies; linear stability analysis; second order analysis; section analysis for nonlinear material response (moment-curvature, interaction diagrams); truss and beam-column elements with nonlinear materials; nonlinear time history analysis of structures; case studies of nonlinear response.

0921715 Geosynthetics Engineering (3 Credit Hours)

Basic description of geosynthetics. Polymeric materials. Geosynthetics properties and testing, geosynthetic functions and mechanisms, design of geotextiles, geogrids, and geomembranes for applications in separation, pavement, embankment and retaining wall reinforcement, soil stabilization, filtration, erosion control, drainage and liquid barrier, geosynthetic clay liners and geocomposities, durability, construction guidelines and case histories.