



Course Syllabus: Sediment Properties and Behavior - ErSE 390B

Division	Physical Science and Engineering Division
Course Number	ErSE 390B
Course Title	Sediment Properties and Behavior
Academic Semester	Spring
Academic Year	2017/2018
Semester Start Date	01/28/2018
Semester End Date	05/24/2018
Class Schedule (Days & Time)	04:00 PM - 05:30 PM Sun Mon Thu

Instructor(s)

Name	Email	Phone	Office Location	Office Hours
Juan Carlos Santamarina	Carlos.Santamarina@kaust.edu.sa	+966128087262	3218, 5, Al-Kindi (bldg. 5)	

Teaching Assistant(s)

Name	Email
------	-------

Course Information

Comprehensive Course Description	Description: (1) Fundamental concepts (Geological history. Governing laws. Biological considerations. Water. Sediment formation and diagenesis). (2) Particulate media (Interparticle forces and effective stress. Fabric. Classification). (3) GeoMechanics (Effective stress. Numerical micromechanics. Strain regimes. Deformation and failure. Biot, Terzaghi, Skempton. Repetitive loading). (4) Coupled Bio-Thermo-Hydro-Chemo-Mechanical Processes (Mixed fluids. Conduction phenomena. Diffusion Phenomena. Thermal properties. Couplings). (5) Localizations, scales and spatial variability. (6) Implications in energy geo-engineering, infrastructure and environmental solutions.
Course Description from Program Guide	
Goals and Objectives	To learn the fundamentals of granular materials, and to anticipate their response to hydro-thermo-chemo-bio-mechanical processes.
Required Knowledge	Fundamentals of physics, mechanics, chemistry and biology
Reference Texts	-Santamarina, J.C., Klein, K. and Fam, M. (2001). <i>Soils and Waves</i> , J. Wiley and Sons, 488 pages (Chapters 1-5 and contents from several other chapters) -Complementary publications (to be provided/assigned) -Class notes -Selected readings
Method of evaluation	40.00% - Tests 20.00% - Homework /Assignments 40.00% - Course Project(s)

Nature of the assignments	Weekly, written analyses due every Sunday. Individual submission (but encouraged to solve with others - Duplication: not acceptable). Project: A 2000 word state-of-the-art review with deep insight into fundamentals of behavior. Final presentation: "youtube" type 8 min lecture (selected ones will be uploaded in our website)
Course Policies	<ul style="list-style-type: none">-This course will be conducted under the guidelines of KAUST's Academic Honor Code.-Cheating of any kind is unethical and unacceptable.-Do not cut and paste any part of your homework or lab reports. Quote and attribute any words that are not your own.-Wireless communication system of all kinds <u>must be turned off</u> while in the classroom, including cell phones.
Additional Information	

Tentative Course Schedule

(Time, topic/emphasis & resources)

Week	Lectures	Topic
1	Sun 01/28/2018	<u>Introduction.</u> Geological history. History of geotechnical engineering. Failures. Sustainability. Geo-environmental. Energy geotechnology.
1	Mon 01/29/2018	<u>Governing laws.</u> Newtonian mechanics (continuum mechanics and elasticity). Electromagnetism. Thermodynamics. Conservation principles.
1	Thu 02/01/2018	<u>Biological considerations.</u> Introductory concepts. Microorganisms, dimensions, properties. Conditions for life. Bio-mediated geo-processes: bio-gas, bio-cementation, bio-clogging.
2	Sun 02/04/2018	<u>Water.</u> The water molecule. Properties. Water and electrolytes. Diffusion and osmosis. Dry and wet sediments. Counter ion cloud - double later thickness. Phase transformation (evaporation, freezing, hydrates). Molecular dynamics.
2	Mon 02/05/2018	<u>Sediment formation.</u> Minerals, rocks and sediments. Grain formation and size (mechanical, chemical, biological). Transported and residual sediments. Transportation agents and effects. Clay minerals.
2	Thu 02/08/2018	<u>Diagenesis.</u> Dissolution (modes). Re-precipitation (pore habit).
3	Sun 02/11/2018	<u>A single particle.</u> Properties of a single particle (mineralogy, size, shape, specific surface, mechanical, thermal, chemical and electrical properties). Determination.
3	Mon 02/12/2018	<u>Characteristics of particulate media.</u> Sediments as particulate materials. Complementary views: grain mass, grain surface, pores. Macro and microproperties. Phases and phase relations.
3	Thu 02/15/2018	<u>Interparticle forces and effective stress.</u> Electrical and mechanical. Terzaghi's effective stress principle. Summary of pore pressure sources. Modified effective stresses principles (electrical forces, capillary, locked sediments) or multidimensional space?
4	Sun 02/18/2018	<u>Fabric.</u> Fine-grained sediments (pH and c). Coarse-grained sediments (Cu and shape). Mixtures. The effect of mica and platy particles. Fines in coarse grained sediments: Critical fine fraction. Grain size and pore size.
4	Mon 02/19/2018	<u>Sediment Classification.</u> Underlying concepts. Index properties. Schofield chart. Limitations.
4	Thu 02/22/2018	A test will address topics above
5	Sun 02/25/2018	<u>State of stress.</u> Stress history. In situ stress: Coefficient of lateral earth pressure at rest. Hydrostatic conditions. Induced stress (1D, 2D, 3D). Drained loading. Stress paths. Effective stress (defined at boundary).
5	Mon 02/26/2018	<u>Interparticle interaction.</u> Fundamental contact theories. Hertz and Mindlin. Numerical micromechanics: Discrete element methods. DEM.
5	Thu 03/01/2018	<u>Strain regimes.</u> Small-strain and large-strain regimes. Threshold strains.
6	Sun 03/04/2018	<u>Small strain Shear Stiffness.</u> Controlling parameters. Effective stress, capillarity and cementation. Truss model.
6	Mon 03/05/2018	<u>Volume change during loading.</u> Compressibility (isotropic and zero-lateral strain conditions). Contractive and dilative tendencies. Fabric evolution during loading. Micromechanics. Inherent and stress induced anisotropy. Poisson's ratio.
6	Thu 03/08/2018	<u>Saturated sediments.</u> Poroelasticity. Biot, Terzaghi, Skempton. Undrained isotropic loading. Induced pore pressure. Special phenomena (e.g. Mandel-Cryer).
7	Sun 03/11/2018	<u>Strength.</u> Friction and internal shear strength (fine and coarse sediments). Mohr, coulomb and the failure line. Critical state sediment behavior. Load-deformation behavior: drained and undrained deviatoric loading. Normalized behavior.
7	Mon 03/12/2018	<u>Repetitive loading.</u> Ratcheing. Terminal densities.
7	Thu 03/15/2018	A test will address topics above
8	Sun 03/18/2018	<u>Mixed fluids: Immiscible fluids.</u> Surface tension and contact angle. Laplace and Kelvin equations. Sediment-water characteristic curve (van Genuchten). Preliminary implications on small and large strain behavior. Implications: sediment compaction, collapsible sediments, desiccation cracks.
8	Mon 03/19/2018	<u>Conduction phenomena.</u> Different forms of conduction. Seepage (Bernoulli, Pascal, Laplace, Darcy). Hydraulic and electrical conduction at the microscale. Non-linear flow. Numerical solution: network models. Fines migration: clogging and filters.
8	Thu 03/22/2018	<u>Diffusion phenomena.</u> Pressure diffusion: consolidation. Chemical diffusion. Numerical solution.
9	Sun 03/25/2018	<u>Scales and spatial variability.</u> Internal spatial scales in sediments. Pheomena and temporal sclaes. Morphology of heterogeneity. Properties (upper bounds and lower bounds; effective media models). Emerging phenomena.

9	Mon 03/26/2018	<u>Thermal properties.</u> Specific and latent heat. Heat conduction at the particle level. Diffusion. Frozen ground. Lenses. Hydrates.
9	Thu 03/29/2018	<u>Coupled processes.</u> Quasi-static coupled processes (constant fabric and coupled gradients related to fabric changes). Dynamic energy coupling (Stochastic resonance. Friction and noise. AC transport chemical, thermal.)
10	Sun 04/01/2018	above covers contents
10	Mon 04/02/2018	above covers contents
10	Thu 04/05/2018	above covers contents
11	Sun 04/08/2018	above covers contents
11	Mon 04/09/2018	above covers contents
11	Thu 04/12/2018	above covers contents
12	Sun 04/15/2018	above covers contents
12	Mon 04/16/2018	above covers contents
12	Thu 04/19/2018	above covers contents
13	Sun 04/22/2018	above covers contents
13	Mon 04/23/2018	above covers contents
13	Thu 04/26/2018	above covers contents
14	Sun 04/29/2018	above covers contents
14	Mon 04/30/2018	above covers contents
14	Thu 05/03/2018	above covers contents
15	Sun 05/06/2018	above covers contents
15	Mon 05/07/2018	above covers contents
15	Thu 05/10/2018	above covers contents
16	Sun 05/13/2018	above covers contents
16	Mon 05/14/2018	above covers contents
16	Thu 05/17/2018	above covers contents
17	Sun 05/20/2018	above covers contents
17	Mon 05/21/2018	above covers contents
17	Thu 05/24/2018	above covers contents

Note

The instructor reserves the right to make changes to this syllabus as necessary.