جامعة الملك عبدالله
للعلوم والتقنية
King Abdullah University of
Science and Technology

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	2016/2017
Semester Start Date	01/22/2017
Semester End Date	05/18/2017
Class Schedule (Days & Time)	04:00 PM - 06:00 PM | Sun 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	Sediments are multiphase particulate materials. Their unique macroscale properties and behavior reflect intricate grain/pore-scale processes and phenomena. Implications affect all forms of engineering, from infrastructure and energy to the environment.
Course Description from Program Guide	
Goals and Objectives	Particle and pore scale processes in sediments Sediment macroscale properties Engineering
Required Knowledge	Fundamentals of physics, mechanics, chemistry and biology
Reference Texts	Santamarina, J.C., Klein, K. and Fam, M. (2001). *Soils and Waves*, J. Wiley and Sons, 488 pages Large number of scientific papers
Method of evaluation	**40.00**% - Tests **20.00**% - Homework /Assignments **40.00**% - Course Project(s)
Nature of the assignments	Weekly, written analyses
Course Policies	Wireless communication system of all kinds must be turned off while in the classroom, including cell phones.
Additional Information	

Tentative Course Schedule

(Time, topic/emphasis & resources)

Week	Lectures	Topic
1	Sun 01/22/2017 Thu 01/26/2017	Introduction. Geological history. History of geotechnical engineering. Failures. Sustainability. Geo-environmental. Energy geotechnology. Governing laws. Newtonian mechanics (continuum mechanics and elasticity). Electromagnetism. Thermodynamics. Conservation principles. Biological considerations. Introductory concepts. Microorganisms, dimensions, properties. Conditions for life. Bio-mediated geo-processes: bio-gas, bio-cementation, bio-clogging.
2	Sun 01/29/2017 Thu 02/02/2017	Water. The water molecule. Properties. Water and electrolytes. Diffusion and osmosis. Dry and wet sediments. Counter ion cloud - double layer thickness. Phase transformation (evaporation, freezing, hydrates). Molecular dynamics. Sediment formation. Minerals, rocks and sediments. Grain formation and size (mechanical, chemical, biological). Transported and residual sediments. Transportation agents and effects. Clay minerals. Diagenesis. Dissolution (modes). Re-precipitation (pore habit).
3	Sun 02/05/2017 Thu 02/09/2017	A single particle. Properties of a single particle (mineralogy, size, shape, specific surface, mechanical, thermal, chemical and electrical properties). Determination. Characteristics of particulate media. Sediments as particulate materials. Complementary views: grain mass, grain surface, pores. Macro and microproperties. Phases and phase relations. Interparticle forces and effective stress. 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 02/12/2017 Thu 02/16/2017	Fabric. 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. Sediment Classification. Underlying concepts. Index properties. Schofield chart. Limitations.
5	Sun 02/19/2017 Thu 02/23/2017	State of stress. 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) Interparticle interaction. Fundamental contact theories. Hertz and Mindlin. Numerical micromechanics: Discrete element methods.DEM. Strain regimes. Small-strain and large-strain regimes. Threshold strains.
6	Sun 02/26/2017 Thu 03/02/2017	Small Strain Shear Stiffness. Controlling parameters. Effective stress, capillarity and cementation. Truss model. Volume change during loading. Compressibility (isotropic and zero-lateral strain conditions). Contractive and dilative tendencies (*s'-e* or *p'-e* space). Fabric evolution during loading. Micromechanics. Inherent and stress induced anisotropy. Poisson's ratio. Saturated sediments. Poroelasticity. Biot, Terzaghi, Skempton. Undrained isotropic loading. Induced pore pressure. Special Phenomena.(e.g., Mandel-Cryer).
7	Sun 03/05/2017 Thu 03/09/2017	Strength. Friction and internal shear strength (fine and coarse sediments). Mohr, coulomb and the failure line (t-s' or q-p' space). Critical state sediment behavior. Load-deformation behavior: drained and undrained deviatoric loading. Normalized behavior.
8	Sun 03/12/2017 Thu 03/16/2017	Mixed fluids: Immiscible fluids. 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.
9	Sun 03/19/2017 Thu 03/23/2017	Conduction phenomena. 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.
10	Sun 03/26/2017 Thu 03/30/2017	Diffusion Phenomena. Pressure diffusion: consolidation. Chemical diffusion. Numerical solution.
11	Sun 04/02/2017 Thu 04/06/2017	Scales and Spatial Variability. Internal spatial scales in sediments. Phenomena and temporal scales. Morphology of heterogeneity. Properties (Upper bounds and lower bounds; effective media models). Emerging phenomena.
12	Sun 04/09/2017 Thu 04/13/2017	Thermal properties. Specific and latent heat. Heat conduction at the particle level. Diffusion. Frozen ground. Lenses. Hydrates.
13	Sun 04/16/2017 Thu 04/20/2017	Coupled Processes. 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).
14	Sun 04/23/2017 Thu 04/27/2017	Time-related sediment response. Strain rate effects. Natural (aging, thixotropy, dissolution/cementation). Man-made (engineered, surface modified sediments, ground modification).
15	Sun 04/30/2017 Thu 05/04/2017	Localization. Shear bands and progressive failure. Compression bands. Hydraulic fracture in sediments. Freezing and lensing. Piping (hydromechanical, chemical)

16	Sun 05/07/2017 Thu 05/11/2017	Repetitive loading. Ratcheting. Terminal densities.
17	Sun 05/14/2017 Thu 05/18/2017	Engineering Implications
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Note

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