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<tr><td colspan="5">School of Civil & Environmental Engineering, AAiT, AAU</td></tr>
<tr><td>Course Code</td><td>CEng 3143</td><td>Course Name</td><td colspan="2">Fundamentals of Geotechnical Engineering – III [Mechanical Properties of Soils]</td></tr>
<tr><td>ECTS Credits</td><td>5</td><td>Program</td><td colspan="2">B. Sc. in Civil Engineering</td></tr>
<tr><td>Pre-requisite</td><td colspan="4">CEng2142 Fundamentals of Geotechnical Engineering – II</td></tr>
<tr><td>Module</td><td colspan="2">Fundamentals of Geotechnical Engineering</td><td>Module Coordinator</td><td>Tewodros Gemechu</td></tr>
<tr><td>Course Team</td><td colspan="4">Lecturer: Tewodros Gemechu
Laboratory managers: Alemayehu B., Tenaw W.</td></tr>
<tr><td>Objectives</td><td colspan="4">This course is designed to equip students with the understanding of fundamental mechanical behaviors of soil with competencies applications in areas of soil compressibility and consolidation, changing stress, soil strength parameters, prediction of settlements, and prediction of bearing capacities.
Students will understand common soil mechanics laboratory techniques.</td></tr>
<tr><td>General Competency</td><td colspan="4">Knowledge
✓ Demonstrate fundamental knowledge of soil stress-strain properties, compressibility.
✓ Able to calculate settlements (immediate, primary and secondary consolidation) using both classical methods and Janbu’s concept.
✓ Articulate the peculiar strength features of soil as an engineering material and why shear strength gets all the focus.
✓ Able to determine and have a sense of shear strength values for different types of soils.
✓ Distinguish between the various failure criteria and relate loading conditions to practical aspects.
✓ Articulate the various earth pressure theories and methods of calculation.
✓ Articulate the various bearing capacity theories and methods of calculation.
✓ Exhibit a working knowledge of soil slope stability analysis.
✓ Demonstrate a fundamental knowledge of mechanics of partly saturated soils.

Skill
✓ Perform oedometer tests and interpret the results.
✓ Model practical engineering settlement related problems and solve them in a systematic manner using settlement analysis tools (especially Settle3D).
✓ Perform direct shear and triaxial test and interpret the results.
✓ Model practical slope stability related problems and solve them in a systematic manner using analysis tools (especially SLOPE/W & PLAXIS).

Attitude
✓ Demonstrate individual and team work ethics, professionalism and respectful interaction with both instructors and students during the course work & laboratory experiments.
✓ Reflect upon the geotechnical engineering sub-discipline and its central position in the world of civil engineering.</td></tr>
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Course Content	1. Soil Compressibility & Settlement Analysis 1.1 Introduction 1.1.1 Soil compressibility 1.1.2 Settlement components 1.2 Classical Settlement Analysis 1.2.1 Immediate settlement 1.2.2 Primary consolidation 1.2.3 Secondary consolidation 1.2.4 Rate of consolidation 1.2.5 Oedometer testing & result interpretation 1.3 Janbu's Modulus Concept & Settlement Analysis 1.3.1 Stress-dependent modulus 1.3.2 Settlement calculation 1.3.3 Rate of consolidation 1.3.4 Oedometer testing & result interpretation 1.4 The Enigma of the Leaning Tower Pisa 2. Shear Strength of Soils 2.1 Introduction 2.1.1 Basics of shearing resistance 2.1.2 A recap of principal stresses & principal planes 2.2 Failure Criteria 2.2.1 Tresca 2.2.2 Mohr-Coulomb 2.2.3 Others 2.3 Laboratory tests 2.3.1 Direct shear tests 2.3.2 UC 2.3.3 Triaxial tests 2.3.4 Other tests 2.4 Field tests 2.4.1 Vane shear test 2.4.2 Cone penetration test 2.5 Stress-strain paths 2.5.1 More on triaxial testing 2.5.2 Total stress path 2.5.3 Effective stress path 2.5.4 Modulus from triax 2.6 Dilatancy & Liquefaction 2.7 Sensitivity & Thixotrophy 3. Lateral Earth Pressure 3.1 Introduction 3.1.1 Retaining walls 3.1.2 Earth pressure at rest	4. Bearing Capacity of Soils 4.1 Introduction 4.1.1 Shallow foundations 4.1.2 Plastic failure theory 4.2 Bearing capacity theories 4.2.1 Rankine's 4.2.2 Prandtl's 4.3 Bearing capacity equations 4.3.1 General form 4.3.2 Developments 4.3.2.1 Shape factors 4.3.2.2 Depth factors 4.3.2.3 Inclined loading 4.3.2.4 Ground factors 4.3.2.5 Base factors 4.3.3 Additional considerations 4.3.3.1 Choice of soil parameters 4.3.3.2 Effect of ground water table 4.3.3.3 Eccentric loading 4.3.3.4 Uplift forces 4.4 Bearing capacity based on settlement requirement 4.5 Bearing capacity from in-situ tests 4.5.1 Standard penetration test 4.5.2 Plate loading test 4.6 Bearing capacity from stress fields 4.6.1 Su analysis 4.6.2 a-ϕ analysis 4.7 Introduction to Eurocode bearing capacity provisions 5. Soil Slope Stability 5.1 Introduction 5.1.1 Infinite & finite slopes 5.1.2 Long & short-term stability analyses 5.2 Planar failures 5.2.1 Seepage forces 5.2.2 Planar translational slips 5.3 Rotational failures 5.3.1 Total stress analysis 5.3.2 Effective stress analysis 5.3.3 Effect of tension cracks

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<tr><td></td><td colspan="2">3.1.3 Active & passive earth pressures
3.1.4 Earth pressure coefficients
3.2 Earth pressure theories
3.2.1 Rankine's theory
3.2.1.1 Granular material
3.2.1.2 Cohesive material
3.2.1.3 Tension cracks & unsupported cuts
3.2.2 Coulomb's theory
3.3 More on calculation of earth pressure
3.3.1 Inclined backfill
3.3.2 Uniform surcharge
3.3.3 Submergence
3.3.4 Soil layering
3.4 Graphical methods for determination of earth pressure
3.4.1 Rebhann's method
3.4.2 Culmann's method
3.5 NTNU method of calculating earth pressure
3.5.1 Stress fields
3.5.2 Su analysis
3.5.3 a-ϕ analysis</td><td>5.3.4 The Swedish method of slices
5.4 Slope stability design charts
5.4.1 Taylor's charts
5.4.2 Bishop & Morgenstern's charts
5.4.3 NTNU charts
5.5 Wedge failure
5.6 Slope stability analysis to Eurocode
6. Fundamentals of Unsaturated Soil Mechanics
6.1 Peculiar Phenomena in the Framework of Unsaturated Conditions
6.2 Stress Variables for Unsaturated Soils
6.3 Conduction Phenomena in Unsaturated Media
6.4 Macroscopic Physical Behavior of Unsaturated Soil Mass
6.5 Earth Pressure for Partially Saturated Soils
6.6 Bearing Capacity of Partially Saturated Soils
6.7 Stability Issues in Unsaturated Slopes</td></tr>
<tr><td>Pre-requisite</td><td colspan="3">CEng2142 Fundamentals of Geotechnical Engineering – II</td></tr>
<tr><td>Semester</td><td colspan="3">Year 3, Semester I (2012EC Academic Year)</td></tr>
<tr><td rowspan="10">Evaluation</td><td>Evaluation technic</td><td>Weight</td><td>Due</td></tr>
<tr><td>Quizzes</td><td>BONUS</td><td>Every other lecture day</td></tr>
<tr><td>Test 1</td><td>10%</td><td>End of Chap.1</td></tr>
<tr><td>Test 2</td><td>15%</td><td>End of Chap.3</td></tr>
<tr><td>Test 3</td><td>15%</td><td>End of Chap.5</td></tr>
<tr><td>Assignments</td><td>MANDATORY</td><td>End of each chapter</td></tr>
<tr><td>Attendance</td><td>MANDATORY</td><td>Minimum of 85%</td></tr>
<tr><td>Laboratory practice</td><td>10%</td><td>Two weeks after practice</td></tr>
<tr><td>Mini project</td><td>10%</td><td>One week after class end</td></tr>
<tr><td>Final exam</td><td>40%</td><td>End of course</td></tr>
<tr><td rowspan="2">Reference literature</td><td colspan="3">Budhu, M. (2000). Soil mechanics and foundations. New York: Wiley.
Ian Smith. (2014). Smith's Elements of Soil Mechanics, 9th Ed. Wiley.
Jean-Louis Briaud. (2013). Geotechnical Engineering: Unsaturated and Saturated Soils. Hoboken, USA, New Jersy: John Wiley & Sons.
Das B.M. (2013). "Soil Mechanics Laboratory Manual" 8th Edition, Oxford University Press.</td></tr>
<tr><td colspan="3">Atkinson, J.H. (2007). The Mechanics of Soils and Foundations. – 2nd ed. New York, USA. Taylor & Francis.
Coduto, D. P., Yeung, M R, and Kitch, W A. (2011) "Geotechnical Engineering, Principles and Practices", Prentice-Hall, Inc., 2nd ed.</td></tr>
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