

Numerical Methods in Rock Engineering - Introduction of the course(Week1, 1 Sept)

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Introduction



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- This lecture will be given in English. Why???

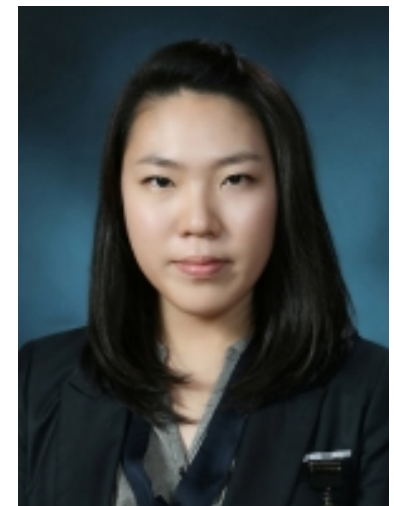
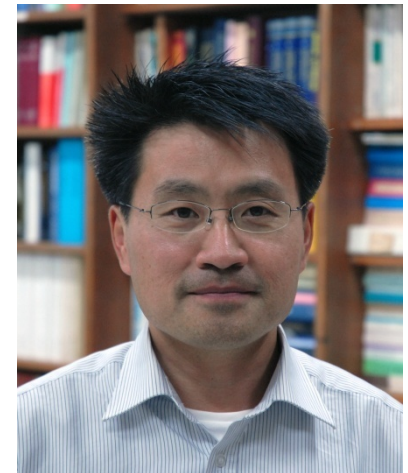
Introduction

Schedules, Room and Instructors



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- Lectures (3 credits)
 - Mon: 09:00 – 11:45
- Lecture Room: 38-323
- Instructor and Teaching Assistant
 - Ki-Bok Min, Room:38-303, kbmin@snu.ac.kr
 - Bona Park, Room:36-324, tautou37@snu.ac.kr



Introduction

Objectives of the course



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- Objective;
 - Be familiar with essential concepts of various numerical methods applied in rock engineering or other related subsurface engineering.
 - Understand the basic principles of FEM, (FDM, BEM) and DEM
 - Be able to apply numerical methods in engineering problems.
 - Emphasis on hands-on experience of applying numerical methods to actual problem of interest

Introduction

Contents of the course



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- W1- 1 Sept Introduction to the course
Numerical Approach in Rock Engineering
- W2 - 8 Sept Public Holidays
- W3 - 15 Sept Finite Element Method
- W4 - 22 Sept Finite Element Method
- W5 - 29 Sept Finite Element Method
- W6 - 6 Oct FEM Exercise (comsol)
- W7 - 13 Oct - (ARMS8 Symposium)
- W8 - 20 Oct Discrete Element Method
- W9 - 27 Oct Discrete Element Method
- W10 - DEM Exercise (Particle system, PFC, 27-29 Oct)

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Contents of the course



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- W11 - 10 Nov DEM exercise (UDEC)
- W12 - 17 Nov Progress presentation (consultation with instructor)
- W13 - 24 Nov Implicit DEM (DDA, NMM) by Prof Tomofumi Koyama (Kansai University)
- W14 - 1 Dec Presentation of Term Paper
- W15 - 8 Dec Final Exam



- References (FEM & DEM)

- Burnett DS, 1987, Finite Element Analysis - from concepts to applications, Addison-Wesley Publishing Company, 844p (or other numerous FEM textbook)
- Jing, L. , Stephansson O, 2007, Fundamentals of Discrete Element Methods for Rock Engineering: Theory and Applications. Elsevier Science
- Jing L, 2003, A review of techniques, advances and outstanding issues in numerical modelling for rock mechanics and rock engineering. Int J Rock Mech Min Sci, **40**(3): p. 283-353.
- Cundall PA, 1979, Discrete Numerical-model for granular assemblies, Geotechnique, 29(1): p.47-65
- Potyondy DO, Cundall PA, 2004, A bonded-particle model for rock, Int J rock Mech Min Sci, 41(8): p.1329-1364
- Cundall PA, 1988, Formulation of a 3-dimensional distinct element model. 1. A Scheme to detect and represent contacts in a system composed of many polyhedral blocks, Int J Rock Mech Min Sci & Geomech Abstr, 25(3):p.107-116
- Hart R, Cundall PA, 1988, Formulation of a 3-dimensional distinct element model. 2. Mechanical calculations for motion and interaction of a system composed of many polyhedral blocks, Int J Rock Mech Min Sci & Geomech Abstr, 25(3):p.117-125

Introduction Assessment



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- Assessment
 - Home Assignment : 40 % ~6 home assignments
 - Final Exam : 25 %
 - Term paper : 25 %
 - Participation : 10 %

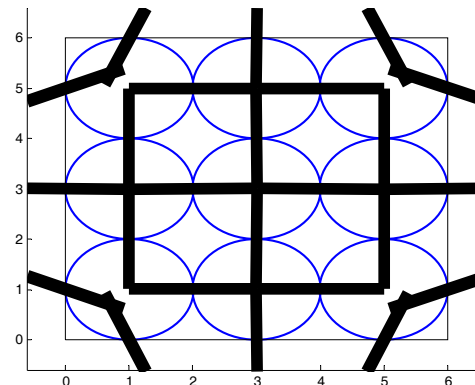
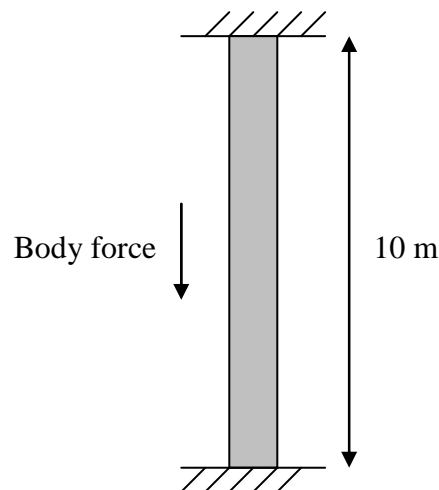
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Home Assignments (40%)



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- #1 1 page summary of selected papers (1988)
- #2 Exercise with FEM code (comsol multiphysics)
- #3 Paper reading (DEM)
- #4 Paper reading (DEM)
- #5 Exercise with UDEC/PFC
- #6 1D(or 2D) coding of FEM/FDM (use excel, matlab, C or fortran)



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Term Project (25%)



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- Select a subsurface engineering problem of your interest and conduct a numerical analysis using any available codes.
- Term paper must include;
 - ↻ Clear objectives
 - ↻ One or two verification cases
 - ↻ Thorough formulation of the chosen numerical method
 - ↻ Concise presentation and discussion on the results
- Timeline
 - ↻ 24 Oct Proposal (1 page)
 - ↻ 17 Nov Progressive Term Paper & Presentation
 - ↻ 1 Dec Presentation of Term Paper
 - ↻ 14 Dec Final Term Paper Submission

Introduction

Term Project



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- A list of example topics
 - Borehole Stability problem in Anisotropic Media (FEM or FDM)
 - Fracture propagation in petroleum/geothermal reservoir (BEM or DEM)
 - Calibration of micromechanical parameters for transversely isotropic rock rock (DEM)
 - Coupled (thermo) hydromechanical analysis in porous medium
 - CO₂ injection in saline formation
 - Thermomechanical analysis for geological repository of nuclear waste
 - Slope Stability in fractured or continuum rock
 - Reinforcement of tunnel
 - Determination of equivalent properties of fractured rock mass (DEM)
 - Reproduction of published landmark papers

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Term Project



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- Presentation
 - Presentation is an extremely important part of your professional life. Therefore, you have a good reason to be serious about this.
 - 15 minutes + 5 min (questions)
 - Be dressed professionally (e.g., tie/suit)
 - Ask questions

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Term Project



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- Your term papers will be published as proceedings.
- Your term papers may be developed into journal papers in the future.

Proceedings of

2011 SNU Student Conference

- Numerical Analysis in Rock Engineering -

Editor : Ki-Bok Min

Department of Energy Resources Engineering

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Final Exam



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- Basic concepts and principles on numerical method, FEM & DEM