Subject Description Form

Subject Code	CSE578
Subject Title	Soil and Behaviour and Geotechnical Engineering
Credit Value	3
Level	5
Pre-requisite/ Co-requisite/ Exclusion	Students should have a knowledge and understanding of engineering geology, soil mechanics, and foundation engineering consistent with undergraduate level study in civil engineering.
Objectives	1. To provide students with the knowledge about advanced soil lab tests, stress-strain behaviour of soils, and their constitutive modelling. 2. To provide students with the knowledge on time-dependent stress-strain behavior of soils and Elastic Visco-Plastic modelling. 3. To integrate the knowledge on soil mechanics and different analytical and numerical methods to analyse simple and more complex geotechnical problems. 4. To understand the fundamental theory and simple implementation of commonly used numerical methods, i.e., finite element method and finite different method. 5. To introduce students with commonly used finite element software in geotechnical engineering.
Intended Learning Outcomes	Upon completion of the subject, students will be able: (a) to apply in-depth knowledge about the fundamental soil behavior in geotechnical engineering; (b) understand the basic concept of analytical methods and finite element method as modelling techniques in geotechnical engineering. (c) explain the most common constitutive models and their limitations. (d) apply analytical and numerical methods to analyze and assess simple and more complex soil-structure interaction problems. (e) critically assess the results of analysis and to carry out benchmarking against known solutions. (f) implement simple numerical code and utilize commercial software (e.g. PLAXIS) to develop finite element model and simulate real geotechnical problems and interpret modelling results.

Subject Synopsis/ Indicative Syllabus	i) Introduction and fundamentals of solid mechanics (1 week) Design objectives, theoretical considerations, geotechnical structures. Index Notation and Its Rules, Stress analysis, strain analysis. ii) Laboratory tests and stress-strain behavior of soils (2 weeks) Basic properties, oedometer test, direct shear test, triaxial test, true triaxial test; volume compression behavior, non-linearity; shear strength, shear behavior, shear dilatancy, critical state; visit to soil laboratory. iii) Commonly used constitutive model (3 weeks) Linear isotropic/anisotropic elasticity; hypo-elastic models; Drucker-Prager elastic-plastic model, Mohr-Coulomb elastic-plastic model; critical state models. iv) Elastic viscoplastic model of soft soils (2 weeks) Time-dependent behaviors of soils; Maxwell rheological model; 1D elastic viscoplastic model; 3D elastic viscoplastic model; Non-linear creep of soils; verification and applications. v) Analytical methods (3 weeks) Limit equilibrium method, limit analysis methods, upper and lower bound principles – applications to bearing capacity, lateral earth pressure problems, and slope stability. vi) Numerical methods: finite element method (2 weeks) Fundamental concept and principles of finite element method – applications to advanced analysis of geotechnical structures (footing, pile, retaining structures, slope).
Teaching/Learning Methodology	1. Lectures to deliver teaching materials. 2. Technical seminars delivered by practicing engineers. 3. An individual report on detailed study of a project problem. 4. Teaching and program practice in computer barn; 5. Assignments related to the subject contents. 6. Examination.

Assessment Methods in Alignment with Intended Learning Outcomes

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed (Please tick as appropriate)					
		a.	b.	c.	d.	e.	f.
1. Continuous Assessment	40%	√	√	√	√	√	√
1.1 Homework Assignments-1	10%	√	√	√	√	√	√
1.2 Homework Assignments-2	10%	√	√	√	√	√	√
1.3 Homework Assignments-3	10%	√	√	√	√	√	√
1.4 Software Modeling Project	10%	√	√	√	√	√	√
2. Written Examination	60%	√	√	√	√	√	√
Total	100%						

Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:

Assignment to problems relevant lecture contents will help the students to understand and apply the concepts and methods for real applications. The individual report is good for each student to have critical thinking and apply their knowledge to solve a geotechnical engineering problem. The final examination will check the intended learning outcomes of the whole subject.

Students must pass the final examination and achieve a passing overall score / grade to pass the subject.

Student Study Effort Expected

Class contact:	
▪ Lecture / Talk	39 Hrs.
Other student study effort:	
▪ Self-study and homework	78 Hrs.
Total student study effort	117 Hrs.

Reading List and References	**Books:** Wood DM (1990). Soil Behaviour and Critical State Soil Mechanics, Cambridge University Press. Potts DM and Zdravkovic L (1999). Finite Element Analysis in Geotechnical Engineering: Theory. Thomas Telford Publishing Ltd, U.K. (ISBN: 0 7277 2753 2). Potts DM and Zdravkovic L (2001). Finite Element Analysis in Geotechnical Engineering: Application. Thomas Telford Publishing Ltd, U.K. Yin JH and Zhu GF (2020). Consolidation Analyses of Soils. CRC Press of Taylor & Francis Group (ISBN 9780367555320). For more information see https://www.routledge.com/Consolidation-Analyses-of-Soils/Yin-Zhu/p/book/9780367555320. Bathe, K.J. (1996), Finite Element Procedures in Engineering Analysis. Prentice Hall. Chen, W.F. (1973), Limit Analysis and Soil Plasticity. Elsevier. Cheng Y.M. and Lau C.K. (2008), Soil Slope Stability Analysis and Stabilization – New methods and insights, Francis & Taylors Group. Cook, Malkus and Plesha (1989), Concepts and Applications of Finite Element Analysis. John Wiley. Yin, Z.-Y., Hicher, P.-Y., Jin, Y.F. (2020), Practice of Constitutive Modelling for Saturated Soils. Springer. **Manuals:** Buildings Department (2017). Code of Practice for Foundations 2017. Buildings Department, HKSARG. Guide to Retaining Wall Construction (2020) by GEO (Geotechnical Engineering Office), HKSARG. Guide to Site Investigation (2017). GEO, HKSARG. Geospec 3 Model Specification for Soil Testing (2017). GEO, HKSARG. Review of Design Methods for Excavations (1990). GEO, HKSARG. Foundation Design and Construction (2006). GEO, HKSARG. These manuals from GEO can be found at: https://www.cedd.gov.hk/eng/publications/geo/index.html published by the Geotechnical Control Office (GEO), Civil Engineering Services Department (CEDD), HKSARG of China.

	Papers: Yin JH and Feng WQ (2017). A new simplified method and its verification for calculation of consolidation settlement of a clayey soil with creep. Canadian Geotechnical Journal, 54(3), 333–347. Feng WQ and Yin JH (2017). A new simplified Hypothesis B method for calculating consolidation settlements of double soil layers exhibiting creep. International Journal for Numerical and Analytical Methods in Geomechanics, 41, 899–917. Yin JH, Chen ZJ, and Feng WQ (2022). A general simple method for calculating consolidation settlements of layered clayey soils with vertical drains under staged loadings. Acta Geotechnica, 1- 28.