Modules for
Graduate Certificate in Geotechnical Engineering

* SkillsFuture credit (available for Singapore Citizens, subject to approval)

^ SkillsFuture Singapore (SSG) subsidy available for eligible Singapore Citizens and Singapore PR (More information can be found on Application & Programme Fee Page)

1. **CE5104A** ^* Tunneling in Soils
2. **CE5104B** ^* Tunneling in Rocks
3. **CE5106A** ^* Ground Improvement for Soft Soils
4. **CE5106B** ^* Advanced Ground Improvement for Difficult Ground
5. **CE5107A** ^* Principles of Pile Foundation Design
6. **CE5107B** ^* Pile Foundation Problems and EC7 Impact
7. **CE5108A** ^* Lateral Earth Pressures and Retaining Wall Design via Eurocode 7
8. **CE5108B** ^* Deep Excavations Design Using Eurocode 7
9. **CE5113A** ^* Geotechnical Investigation according to EC7
10. **CE5113B** ^* Geophysical Methods & Geotechnical Monitoring
CE5104A Tunneling in Soils

Instructor:
- Prof Leung Chun Fai

Pre-requisite
- Background in Soil Mechanics or equivalent

Module Description
This is an advanced module on analysis and design of tunnels in soils. The topics covered include bored tunneling methods, stability of underground openings, ground movement prediction due to tunnels, effects of ground movements on buildings and structures, instrumentation and monitoring, and stresses on lining. The creation of underground structures to form subways, underpasses, metro stations and other uses is an increasing requirement in major urban areas worldwide. Participants are taught the various methods of construction for creating underground space.

Topics
1. Tunnelling methods in soils
2. Soil pressures and face support
3. Issues on lining design
4. Ground movements due to tunnelling
5. Site investigation for tunnelling works and Instrumentation
CE5104B Tunneling in Rocks

Instructor:

- Prof Leung Chun Fai

Pre-requisite

- Background in geotechnical engineering or equivalent
- Background in rock mechanics is useful but not essential

Module Description

This is an advanced module on analysis and design of tunnels in rocks.

The topics covered include tunneling methods in rocks, construction of caverns, New Austrian Tunneling Method and stability of underground openings in rocks. The creation of underground structures to form subways, underpasses, metro stations and other uses in greater depths would likely encounter excavation in rocks.

Participants are taught the various methods of construction for creating underground space.

Topics

1. Tunneling methods in rocks
2. Rock classification and empirical rock tunnel design charts
3. Excavations in jointed rock and stereographical projection technique
4. Rock support reaction curve
5. Rock tunneling using drill and blast

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CE5106A Ground Improvement for Soft Soils

Instructor:
- Dr Chew Soon Hoe

Pre-requisite
- Background in soil mechanics or equivalent

Module Description

This is a module on the principle of ground improvement techniques for soft soils, as well as its design, construction and monitoring. Topics covered include general ground improvement principles and design considerations, techniques of improving granular soils, techniques of improving cohesive soils. Field operation requirement and construction field controls, monitoring, and performance evaluation, specification and acceptance criteria. Case studies on various techniques will be presented and discussed.

This module will focus on hydraulic method for soft clay (PVD with preloading, PVD with vacuum etc), Vibratory method for Sandy soils, and cement treatment method (Grouting and Deep cement mixing etc).

Participants are taught the basic principles of various ground improvement techniques, and how to select the most appropriate ground improvement techniques to be used in specific circumstances.

Topics

1. General principle of Ground improvement techniques and requirement
2. Hydraulic Methods for soft clay improvement
   - PVD (Prefabricated Vertical Drains) with preloading
   - PVD with vacuum
3. Vibratory method for Sandy soil
   - Vibroflotation method
   - Sand compaction piles and stone columns
4. Admixture method using cement
   - Cementation reaction with soils
   - Grouting methods (compensation grouting and jet grouting)
   - Deep cement mixing method
5. Specification and field monitoring and evaluation
CE5106B Advanced Ground Improvement for Difficult Ground

**Instructor:**
- Dr Chew Soon Hoe

**Pre-requisite**
- Background in soil mechanics or equivalent
- CE5106A Ground Improvement for Soft Soils

**Module Description**

This is an advanced module on ground improvement techniques for difficult ground as well as its design, construction and monitoring. Topics covered include the special requirement for advanced ground improvement techniques, difficult ground (peaty soil, mixed soils in tunnelling, cavity etc), principles and design considerations for various advanced ground improvement techniques (dynamic method, dynamic method combine with PVD, geosynthetics, soil nailing etc), field controls and monitoring, field evaluation - specification, performance evaluation and acceptance criteria, and case study.

Participants are taught the basic principles of various advanced ground improvement techniques, and how to select as well as combine a few ground improvement methods to be used in specific circumstances where soil are difficult or/and the project requirements are very stringent.

**Topics**

1. Special requirement for difficult ground (e.g. Peaty soil, mixed soil in tunneling, cavity etc.)
2. Dynamic Improvement Method
   - Dynamic Compaction
   - Dynamic replacement
   - Dynamic replacement and Mixing
   - Dynamic method combined with PVD
   - Dynamic method combined with Vibratory method
3. Ground improvement with Geosynthetics
   - For Separation function
   - For Drainage and filtration function
   - For Reinforcement function
4. Horizontal Inclusions for steep slope
   - Soil Nails
   - Ground Anchors
CE5107A Principles of Pile Foundation Design

Instructor:
  - Dr Ku Taeseo

Pre-requisite
  - Background in soil mechanics and foundation engineering or equivalent

Module Description

This is an advanced module in deep foundation engineering. Topics covered include site investigation for deep foundation, general bearing capacity theorem, overview of pile installation methods, axial pile capacity and deflection, pile load transfer mechanism, and laterally loaded piles as well as group pile issues.

Participants will learn how to deal with design and construction issues pertaining to deep foundations under more general and realistic practical situations. Specific learning objectives include performing design calculations for piles and pile groups.

Topics

1. **Site Investigation for Deep Foundation**
   Various site investigation programs to estimate crucial soil parameters for pile design.

2. **Bearing Capacity Theorem**
   Limit plasticity theory applied to foundation bearing capacity in axial compression

3. **Overview of Deep Foundation System**
   Types of piles, installation methods, effect of pile installation, construction issues.

4. **Axial Pile Capacity**
   Ultimate axial capacity, load transfer, tip and side resistance, structural capacity, geotechnical capacity, negative skin friction.

5. **Axial Pile Deflection**
   Elastic settlement of single pile - chart solution & closed-form solution, settlement of pile groups, case study.

6. **Lateral and Moment Capacity**
   Ultimate lateral capacity of pile, conventional static approach, ultimate soil pressure, capacity of pile groups, design of laterally loaded piles.

7. **Lateral Pile Deflection**
   Elastic continuum analysis for both single and group piles
CE5107B Pile Foundation Problems and EC7 Impact

Instructor:
- Associate Prof Tan Siew Ann

Pre-requisite
- Background in soil mechanics and foundation engineering or equivalent
- CE5107A Principles of Pile Foundation Design

Module Description
This is an advanced module in deep foundation engineering. Topics covered include piles subject to ground movement, piles in difficult ground, foundations for marine structures, construction related problems, pile driving analysis and dynamic testing, and static pile tests, as well as design via Eurocode 7.

Participants will learn how to deal with design and construction issues pertaining to deep foundations under more general and realistic practical situations.

Specific learning objectives include performing design calculations for piles and pile groups under more complex loading modes and ground conditions and pile installation and testing.

Topics
1. Pile subject to ground movement Negative skin friction, piles in soil undergoing lateral movement.
2. Piles in difficult ground Piles in difficult ground: limestone, micro-piles.
3. Foundations for marine structures Design loads, berthing structures and jetties, raked piles.
5. Pile driving analysis and dynamic testing Wave equation analysis, dynamic test, statnamic test, integrity testing.
6. Static pile tests Static pile load tests, Osterberg cell pile load test, pile instrumentation.
7. UniPile design concept Unified design method for capacity, dragload, settlement, and downdrag.
CE5108A Lateral Earth Pressures & Retaining Wall Design via Eurocode 7

**Instructor:**
- Associate Prof Goh Siang Huat

**Pre-requisite**
- Background in Soil Mechanics or equivalent

**Module Description**

Together with CE5108B Deep Excavations Design Using Eurocode 7, this is an advanced module in earth-retaining structures and deep excavations. Topics include earth pressure theories, rigid retaining structures, flexible retaining structures, cellular cofferdams, retaining walls for deep excavations, support systems for deep excavations, and field monitoring. Participants are taught to deal with design and construction issues pertaining to a spectrum of earth-retaining systems from low rigid retaining walls to flexible support systems for deep excavations. They will also learn to apply the methods of limit state, such as BS8002 and Eurocode 7, to the design of rigid and flexible retaining walls. Applications of commercial geotechnical FEM softwares are taught to aid in design of deep excavations to limit ground deformations and satisfy SLS requirements.

At the end of the course, participants are taught the application of advanced earth pressure theories, selection of appropriate retaining structures, and verification of capacity and movement requirements, using limit equilibrium and FEM analysis tools.

**Topics**

1. **Earth pressure theories**
   Earth pressure theories (Rankine, Coulomb and non-planar), relationship between soil movement and earth pressure, selection and acquisition of soil parameters, influence of surcharge loadings and groundwater seepage.

2. **Design Philosophy**
   Different design philosophies for earth retaining structures, with major emphasis on Eurocode 7. The use of the conventional factor of safety approach is also discussed and illustrated for comparison purpose.

3. **Gravity retaining structures**
   Common types of gravity retaining structures and construction methods, the design and analysis of gravity retaining walls based on the EC7 limit states, water and seepage effects.

4. **Flexible retaining structures**
   Cantilever and single-strut flexible retaining walls, pore pressure and seepage analysis, soil arching effects, design and analysis of such flexible walls using simplified limit equilibrium approaches with EC7 concepts.
CE5108B Deep Excavations Design Using Eurocode 7

Instructor:
- Associate Prof Goh Siang Huat

Pre-requisite
- Background in Soil Mechanics or equivalent
- CE5108A Lateral Earth Pressures and Retaining Wall Design Design via Eurocode 7 or equivalent

Module Description

This module builds upon the knowledge and skills acquired in CE5108A Lateral Earth Pressures and Retaining Wall Design Design via Eurocode 7, to cover the topic of deep excavations related to deep shafts and multi-strut supported walls.

Participants are taught to deal with design and construction issues pertaining to deep excavations, such as drained and undrained conditions, as well as field monitoring practices.

Applications of commercial geotechnical FEM software are taught to aid in design and analysis of deep excavations to limit ground deformations and satisfy both serviceability requirements as well as Eurocode 7 ultimate limit states.

Topics

1. Retaining walls for deep excavations Types of braced excavations and construction methods, slurry trenches, diaphragm walls, secant piles, contiguous bored piles, Deep Cement Mixed Soil walls, Soldier Piles and Lagging. Appropriate application of each type of walls.

2. Support systems for deep excavations Struts, rakers and shoring, ground anchors, soil nails, ground improvement with grouted base slab, and influence of construction methods, heave and piping, displacement around and below excavations, groundwater considerations, dewatering and recharge, time dependent effects, structural design of walls and supports, overall stability. Limit equilibrium and FEM analysis of wall performance and ground deformation predictions and control.

3. Field monitoring and case studies Field instrumentation and monitoring, control of ground movement, case studies of earth-retaining structures, including strutted, anchored and soil nail systems.
CE5113A Geotechnical Investigation according to EC7

Instructor:

- Dr Chew Soon Hoe

Pre-requisite

- Background in Soil Mechanics or equivalent

Module Description

This module teaches the essential concepts and methodology for the planning, design and implementation of geotechnical ground investigation for infrastructure, underground construction, and built environment construction.

The module will be broadly divided into two parts. The first part covers various aspects of site investigation such as the planning, design, density of bore holes, sampling technology and sampling disturbance. The second part covers various aspects of in-situ and laboratory testing of soils and rocks. The module will cover ground investigation concepts and practices according to new Eurocode EC7.

This module enables participants to acquire the knowledge and practical skills through the lectures, case studies and projects.

Topics

1. Singapore Geology and Major soil formations: stratigraphy, mineralogy, and Typical problems posed by the major soil formations to construction.
2. Design and planning of site investigation according to EC7.
4. Effects of sampling disturbance on soil behaviour, especially on strength and compressibility characteristic.
5. In-situ testing and interpretation: SPT, CPT, Pressuremeter, Vane shear test, Standpipes & field permeability tests.
7. Geotechnical Interpretation Reports, mini project.
CE5113B Geophysical Methods & Geotechnical Monitoring

Instructor:
- Dr Chew Soon Hoe

Pre-requisite
- Background in Soil Mechanics or equivalent
- CE5113A Basic Geotechnical Investigation according to EC7

Module Description

This module teaches the essential concepts and methodology for the planning, design and implementation of geophysical methods for geotechnical site investigation, and ground instrumentation and monitoring programmes.

The module will be broadly divided into two parts. The first part covers the planning and practices of various type of geophysical methods used in geotechnical site investigation. Basic type of geophysical methods: seismic, resistivity and ground radar and others will be covered. The second part covers various aspects of ground instrumentation and sensors for the measurement and monitoring of ground movement, drawdown, excess pore pressures, strut forces, wall deflection and settlement. Concept and practices of the observational methods in geotechnical works will be covered.

This module enables participants to acquire the knowledge and practical skills through the lectures, case studies and projects.

Topics

1. Concept of geophysical methods for ground investigation.
2. Principles and practices of various Geophysical investigations: seismic, resistivity, geotomography.
4. Interpretation of geophysical survey results.
7. Geotechnical monitoring data presentation and data management system, Geotechnical Information system.