ITA-CET
Committee on Education and Training
Activity Group 3: „University network“

Questionnaire

Training Organisation	São Carlos Engineering School – University of São Paulo
Country	Brazil
First Name	Tarcisio
Last Name	Celestino
E-mail	tbcelest@usp.br
Town	São Carlos - SP

Courses offered

Programme[1]	Course	Semester	Type[2]	Hrs[3]	CP[4]	Syllabus
B-CE	Strength of Materials 1	3	C	4	3	Main objectives and uses of Strength of Materials. Study of structural components subjected to tensile and compressive stresses. Strength and elastic and plastic deformations. Study of the flexural behavior of bar sections with or without symmetry. Bending deformation: elastic line in theories of first and second order. Buckling of bars. Shear center of open thin sections.
B-CE	Strength of Materials 2	4	C	4	3	Overall twist: circular cross sections, closed thin-walled sections, membrane analogy, cellular and open section, thin-walled section. Stress analysis: one-dimensional, two-dimensional, three-dimensional states. Study of deformation, generalized Hooke's law. Strain energy: Energy theorems. Strength criteria. Introduction to the Theory of Elasticity.
B-CE	Engineering Geology 1	4	C	4	3	Structure of the Earth - Key active geological phenomena acting on the Earth's crust; minerals; origin, properties and classification of igneous, sedimentary and metamorphic rocks. Geology of the State of São Paulo, characterization and geological / geotechnical classification of rocks and rock masses; applications of geology to studies of embankments, roads, tunnels, dams and urban and regional

[1] B-CE Bachelor programme in Civil Engineering
M-CE Master programme in Civil Engineering
B-ME Bachelor programme in Mining Engineering
M-ME Master programme in Mining Engineering
MAS Master of advanced studies

[2] C: compulsory
E: elective

[3] Number of teaching hours/week for lectures and exercises

[4] Number of ECTS credit points (1 credit point = 30 hours student workload incl. homework)

						planning.
B-CE	Structural Systems	5	C	3	1,5	Structural elements: description of structural element types, behavior and stability. Structural systems: description of structural system types, load transfer process, instability. Loads: action type, study of nominal values, Brazilian codes. Safety: safety methods, deterministic methods, semi-probabilistic methods, Brazilian code for loads and safety.
B-CE	Structural Analysis 1	5	C	4	3	Hypotheses of the classical method and overview of other methods. Principle of virtual works. Effects of moving loads. Influence lines for statically determinate structures. Diagrams and envelopes of extreme values. Calculation of displacements in statically determinate structures. Solutions for statically indeterminate structures due to loads, settlements, temperature variation, shrinkage and manufacturing defects.
B-CE	Soil Mechanics 1	5	C	4	3	Soils: origin, formation and characterization; subsurface investigation and sounding, index properties and soil classification. Soil compaction. Stresses: principle of effective stress; induced stresses due to external load. Hydraulic conductivity of soils. Theory of seepage in soils (two-dimensional flow). Theory of consolidation: compressibility and settlement.
B-CE	Structural Analysis 2	6	C	4	3	Calculation of displacements in statically indeterminate structures. Process of displacements: resolution of statically indeterminate structures subjected to load, settlements, temperature variation, shrinkage and manufacturing defects. Cross´s process: Application to beams and plane frames with prismatic elements and variable inertia. Introduction to matrix analysis of structures by the Process of Displacements: Applications to beams, trusses and plane frames. Notions of geometric nonlinear analysis.
B-CE	Soil Mechanics 2	6	C	4	3	Shear strength of soils. Slope stability. Earth pressure: Retaining structures. Earth dams. Geosynthetics: general applications. Use of software packages to solve geotechnical engineering problems.

B-CE	Reinforced Concrete Structures I	7	C	4	3	Historical evolution of reinforced concrete theories, basic concepts, performance and applications. Mechanical and rheological properties of concrete. Steel for reinforced concrete. Method of Limit States. Design of sections in the Ultimate Limit State. Verification of Service Limit States.
B-CE	Engineering Geology 2	7	C	2	2	Representation of geological maps. Geological and geotechnical investigation and survey of rock mass discontinuities. Analysis and interpretation of geological models. Engineering properties of the main rock groups.
B-CE	Reinforced Concrete Structures II	8	C	4	3	Structural design of buildings. Conception of the structure and pre-sizing of the structural elements. Solid and ribbed slabs. Two-support and continuous beams. Structural pillars.
B-CE	Rock Mechanics	10	C	3	2,5	Introduction. Underground excavations. Geomechanical classifications. Stresses in rock masses. Deformability of rock masses. Strength of rock masses. Rock slope stability. Laboratory practices.
B-CE	Introduction to Geotechnical Engineering	4	E	2	2	Engineering geology in civil engineering works. Soil Mechanics applied to: embankments, earth and rockfill dams, subways, tunnels and foundations. Rock mechanics: applications and case histories.
B-CE	Advanced Strength of Materials	5	E	2	1	Introduction to the theory of elasticity: states of stress and strain, elasticity equations and polynomial Airy functions. Saint-Venant torsion. Method of energy and its application to problems of bending (second order effects and elastic base) and problems of plane elasticity. Finite Difference Method and its application to problems of bending and torsion. Notions of plasticity and plastic analysis of trusses.
B-CE	Introduction to the Finite Element Method	5	E	2	3	Introduction: fundamentals. Processes of displacement. Trusses. Fundamentals on plates. Computer codes: bars. Practical lessons on the use of a commercial codes and application of finite element analysis of bar- and 2-dimensional structures.
B-CE	Fundamentals of Geotechnical Engineering	5	E	2	3	Rocks and soils. Properties. Soil and rock masses. Stereographic projection. Stress. Strain. Three-dimensional behavior. Two-dimensional simplifications. Mohr circle. Pore pressure. Shear strength. Earth pressure. Factor of Safety.

B-CE	Introduction to Trenchless Technology	6	E	2	2	Essential Urban Services. Introduction to trenchless methods. Horizontal Directional Drilling HDD; Path design and dimensioning of the pilot hole; Pipe slection and analysis, Drilling Fluids for HDD. Network replacement by pipe bursting. Pipe Jacking. Drilling by Percussion. Microtunnels. Network rehabilitation by coating. Network rehabilitation by sliplining.
B-CE	Numerical Methods for Stress Analyses in Geotechnical Engineering	6	E	2	3	Importance. Finite element method (FEM). Applications. Types of elements. FEM applied to typical geotechnical engineering problems. Stresses. Open and underground excavations. Constitutive laws.
B-CE	Soil Mechanics Testing 1	6	E	2	3	Sampling. Identification. Index properties. Particle size distribution. Consistency limits. Compaction. Permeability.
B-CE	Special ConcreteTechnology – High Performance Concrete	7	E	2	2	Introduction: general classification of concrete. Conceptualization and classification of special concretes. New materials used in the production of special concrete: Portland cement, additives and admixtures; aggregates. Main types of special concrete: concrete polymers, fiber reinforced concrete, sprayed concrete; colloidal concrete (injected); lightweight concrete, mass concrete, reinforced mortar (microconcrete). High performance concrete: definitions, general characteristics, component materials, strength and production, properties and applications.
B-CE	Soil Mechanics Testing 2	7	E	2	3	Consolidation. Shear strength. Strength envelopes.
B-CE	Concrete Structures C	8	E	2	2	Composite Oblique Bending. Wind load. Global stability. Instability in normal bending: diagrams of bending moment, axial force, curvature; general verification method; equilibrium method. Instability in composite oblique bending: method of equilibrium. Model of strut and tie. Slab punching.

B-CE	Concrete Structures: Pathologies	9	E	2	1	The importance of structural pathologies for the study of constructions. Concept of structural safety. Mechanisms of concrete degradation - carbonation, leaching, shrinkage, action of soot and fungus, salt concentration, the wall effect. Degradation mechanisms of reinforcement corrosion - in aqueous media, the action of aggressive substances. Considerations of materials - cement, aggregates, water, additives, reinforcements. Environmental interference or micro regions - rural atmosphere, urban, marine and industrial environments. Vitiated atmosphere. Design defects. Construction defects. Considerations on climate conditions. Curing.
B-CE	Precast Concrete Structures	9	E	2	2	Introduction: definitions, considerations about industrialization of the construction process, types of elements, materials, advantages and disadvantages; historical evolution. Production: the implementation of precast technology, handling, storage and transportation, assembly of structures. Design: tolerances and clearances, general and specific principles. Links: typology; aspects concerning calculation; sizing of elements used in fittings. Composite structures: structural behavior; shear at the interface. Typology of precast buildings: sheds, buildings with multiple floors and various civil works.
B-CE	Finite Element Method in Geotechnical Engineering	9	E	2	2	Concept of an element. Types of elements. Discretization of continuum. Formulation process. Stiffness matrix of an element. Global stiffness matrix. Boundary conditions. Solution of equation systems. Analyses of the results. Fields of applications. Main features related to Geotechnical Engineering. Constitutive models. Simulation of staged constructions. Advantages and disadvantages. Application examples.
B-CE	Design and Construction of Tunnels	9	E	2	3	Advantages of underground structures. Brazilian projects. Operability and functionality. Ventilation. Empirical methods of design. Rock mass bolting. Sprayed concrete. Face stability. Keyblocks. Settlement. Construction methods. Instrumentation.
B-CE	Rock Mechanics Testing	10	E	4	6	Discontinuities. Sampling and preparation of cores. Physical indices. Seismic velocity. Schmidt hammer. Stress measurement. Deformability. Strength. Concepts of fracture mechanics. Fracture toughness. Permeability. Wet abrassion.

M-CE	Engineering Geology	1	C	5	4	THEORY - 1. Introduction (Concepts and development of engineering geology). Earth structure. Tectonic movements. Minerals (genesis, classification and properties). 2. Classification, technological properties and geological-geotechnical applications of rocks: igneous, sedimentary and metamorphic rocks. 3. Geological structures. Representation and statistical treatment of structural data (planes and poles). 4. Weathering processes (physical and chemical). 5. Weathering profiles (classification criteria). 6. Alteration and alterability of rocks: characterization, classification and properties. 7. Characterization and classification of rock masses. 8. Hydrogeotechnics and subsurface water. 9. Methods of surface and subsurface investigation. 10. Natural materials for civil construction (sediments and rocks). Characterization tests. Use and study of aggregates. Dimension stones - classification and main characterization tests. 11. Application of Enginnering geology to the study of the processes of the physical environment; risk analysis and civil engineering design. PRACTICE - 1. Characterization, recognition and classification of minerals and rocks. 2. Exercises on Geological-Geotechnical maps. 3. Exercises on slopes, dams, roads and urban planning. 4. Statistical treatment of discontinuities. 5. Monitoring rock and sediments technologycal characterization tests.
M-CE	Rock Mechanics	1	C	6	5	Index properties of rocks. Rock strength. Strength Criteria. Stress-strain behavior. Fracture mechanics applied to rock mechanics. Scale effect in rock properties. Initial stress state in rock masses and its determination. Deformability of rock and its determination. Planes of weakness of rock masses: orientation, spacing, abundance and persistence; statistical treatment; shear strength and stiffness. Strength and deformability of regularly fractured rock masses. Seepage through fractured rock masses. Rock slope stability. Tests for characterization and measurement of rock strength.
M-CE	Soil Mechanics	1	C	6	5	Introduction. Granulometric analysis. Limits of consistency. Soil Classification. Soil compaction. Geotechnical tests. Geostatic stress state. Permeability and seepage. Consolidation. Soil shear strength.

M-CE	Tunnel Design and Construction	2	E	6	5	Tunnel design. Operation and functionality conditioning factors. Advantages of underground construction for civil purposes - environmental and economic considerations. Support design. Historical evolution - empirical methods. Simplified methods - Convergence-Confinement - Ground-Support interaction. Schwartz-Einstein's Method. Observational methods. Numerical methods - finite elements. Keyblock theory. Materials: sprayed concrete - required properties; implications of its time-dependent behavior. Rock mass bolting. Face stability. Mitigating measures for face instability in mechanized and conventional excavation. Surface settlements. Settlement curves. Gaussian and yield-density settlement troughs. Damage estimation of surface buildings. Construction methods. Instrumentation.
M-CE	Numerical Modelling applied to Geotechnical Engineering	2	E	6	5	1. Concepts of stress and strain. 2. Hooke's law. 3. Elements of Theory of Elasticity. 4. Characteristics of Soil. 5. Constitutive models and yielding criteria. 6. Elements of theory of plasticity. 7. Definitions of the Finite Element Method FEM. 8. Stress Analysis by FEM. 9. Seepage analysis of steady and transient flow. 10. Slope stability analysis. 11. Underground excavation simulation. 12. Solution of coupled stress-seepage problems.

Remarks:

1. The list includes all courses in geotechnical and structural engineering Departments directly related to or pre-rquisites for underground construction courses both at the graduate and post-graduate levels. The list is not exhaustive for the Master’s and Doctor’s degree programs (see 2).
2. For the Master’s and Doctor’s degree programs, there is no clesed list of courses. Depending on specific needs of each program, post-graduate courses from other Departments are always included. Because of their specific charater, not all of them are included in the list provided. The most frequent examples are subjects related to constituive models and reliability from the Strucutural Engineering Department http://www.set.eesc.usp.br/portal/pt/disciplinas. To a lesser extent, courses from other areas like Mechanical Engineering, Geology, Mathematics and Statistics are included in the programs
3. Requirements for the Master’s program are 72 credits from courses plus a dissertation; for the Doctor’s degree program, 48 cridits from courses (for condiated holding a Master’s degree) and 120 credits (for candidates not holding a Master’s degree) plus a thesis.
4. The post-graduate course Tunnel Design and Construction is listed as non-compulsory, according to the Geotechnical Engineering Department requirements. It is compulsory for the program on underground works.
5. The program is in the Depaartment of Geotechnics, São Carlos Engineering School, University of São Paulo http://www5.eesc.usp.br/sgs/eng/graduate.htm.