Graduate Program in Civil Engineering
School of Civil Engineering
(Revised 2007)

Institute of Engineering
Suranaree University of Technology

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2. Degree Titles

2.1 Master Degree

Full Title	: Master of Engineering in Civil Engineering
(Thai)	: วิศวกรรมศาสตรมหาบัณฑิต (วิศวกรรมโยธา)
Abbreviated Title	: M. Eng. (Civil Engineering)
(Thai)	: วศ.ม. (วิศวกรรมโยธา)

2.2 Doctoral Degree

Full Title	: Doctor of Philosophy in Civil Engineering
(Thai)	: วิศวกรรมศาสตรดุษฎีบัณฑิต (วิศวกรรมโยธา)
Abbreviated Title	: Ph.D. (Civil Engineering)
(Thai)	: วศ.ด. (วิศวกรรมโยธา)

3. Responsible Department (Unit)

School of Civil Engineering, Institute of Engineering, Suranaree University of Technology.

4. Philosophy and Objectives

By nature, civil engineering deals with public service, i.e., civil engineers design structures, plan land use, build roads, buildings and bridges, construct water reservoirs, handle water supply and wastewater treatment; all these functions are to ensure safety and comfort in our daily life. In a final analysis, civil engineers attempt to improve the quality of life for all citizens.

The fundamental objective of the graduate program in civil engineering at Suranaree University of Technology is to train graduate in advanced knowledge of civil engineering which will them to carry out independent and professional work or research. Additional objectives of the programs are (1) to extend the boundaries of knowledge

through research for the betterment of society (2) to preserve, and transmit knowledge to successive generations.

Suranaree University of Technology offers the graduate program in civil engineering to produce master degree and doctoral degree graduates in order to fulfill the country's need. This graduate program is open to all qualified bachelor and master degree graduates in sciences or engineering. Engineering graduates will address the challenges that they will face in their careers, pursue life-long learning and continue to develop their problem-solving skills.

5. Program Inception

Enrollment of the students in this program will begin in the first trimester of academic year 2007.

6. Admission Requirements

The applicant' qualification follows those described in SUT's Regulation for Graduate Studies. The program welcomes all qualified applicants with a Bachelor or a master degree in engineering, or other related fields.

7. Application Process

As stated in the SUT Regulation for Graduate Studies.

8. Academic System

As stated in the SUT Regulation for Graduate Studies.

9. Study Duration

As stated in the SUT Regulation for Graduate Studies.

10. Registration

As stated in the SUT Regulation for Graduate Studies.

11. Degree Requirement

Master degree

- The student must complete the required workload.
- The thesis must be approved by the School of Civil Engineering.
- Before defending the master thesis, the results of the research leading to the thesis must be published (or accepted for publication) in a national research journal or a national symposium.

- Other requirements as stated in the SUT Regulation for Graduate Studies.

Doctoral degree

- The student must complete the required workload.
- The thesis must be approved by the School of Civil Engineering.
- Before defending the doctoral thesis, a full paper which is a part of the thesis must be published (or accepted for publication) in an international journal indexed orlisted in a well recognized database that has been approved by the Institute of Engineering.
- Other requirement as stated in the SUT Regulation for Graduate Studies.

12. Curriculum and Teaching Faculty

12.1 Curiculum Faculty

Assoc. Prof. Dr. Amnat Apichatvullop
Ph.D. (WaterResources Planning),
Colorado State University, U.S.A.

Assist. Prof. Dr. Mongkol Jiravacharadet
Ph.D. (Civil Engineering),
University of Tokyo, Japan

Assist. Prof. Dr. Suksun Horpibulsuk
Ph.D. (Geotechnical Engineering),
Saga University, Japan

Assist. Prof. Dr. Avirut Chinkulkijniwat
D.Eng. (Civil Engineering),
Graz University of Technology, Austria

Dr. Tanongsak Bisarnsin
Ph.D. (Civil Engineering),
University of Texas at Arlington, U.S.A.

12.2 Teaching Faculty

Assoc. Prof. Dr. Sittichai Seangatith
Ph.D. (Civil Engineering),
University of Texas at Arlington, U.S.A.

Assist. Prof. Dr. Chatchai Jothiyangkoon
Ph.D. (Environmental Engineering),

University of Western Australia, Australia

Assist. Prof. Dr. Pornpot Tanseng

Ph.D. (Geotechnical Engineering),

University of Innsbruck, Austria

Dr. Theerawat Sinsiri

Ph.D. (Civil Engineering),

King Mongkut's University of Technology Thonburi, Thailand

Dr. Vacharapoom Benjaoran

Ph.D. (Construction Management and IT), 2005

University of Teesside, UK

13. Enrollments

For the first 5 years, the number of students enrolled in the program in each year is as follows

Academic	Number of admission		Number expected to graduate in the academic year	
Year	Master	Doctoral	Master	Doctoral
2007	5	2	-	-
2008	5	2	5	-
2009	7	2	5	2
2010	7	2	7	2
2011	10	2	7	2

14. Location and Equipment

Location: Classrooms in the Center of Educational Services, Suranaree University of Technology

Equipment: Laboratory equipment from the Center for Scientific and Technology

Equipments; and accessories for lecturing from the Center of Library and Education Media, Suranare University of Technology

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15. Library

The Center of Library Resources and Educational Media offers the following resources and services.

15.1 Resources

15.1.1 Books

Thai	22,424	titles
English	68,616	titles

15.1.2	Journals		
	Thai	142	titles
	International	285	titles
	Received from Donation	995	titles
15.1.3	Audio-visual and electronic	3,279	titles

15.2 Inter-library Loan

Offering loan/photocopying services from other Thai and foreign universities and other public institutions.

15.3 Information Search Service

15.3.1 Search for items at CLREM

15.3.2 Search for items at other libraries

15.4 Database

15.4.1 Database on CD-ROM

- Chemistry Citation Index from 1999
- ComputMath Citation Index from 1999
- Thai theses from B.E.2509

15.4.2 Database On-line

- IEEE/IEL -- Full text database of articles, journals, proceedings and standards in electrical and electronic engineering and other related fields
- DAO -- database of abstracts of master and Ph.D.thesis from U.S., Canada, etc. in all fields.
- Medline -- database in medicine, public health, nursing and medical sciences.
- FirstSearch over 80 databases covering all fields, e.g. sciences, technology, agriculture, medicine, etc.
- E-journal from American Chemical Society over 24 titles covering chemistry, biochemistry and biotechnology from 1996.

CLREM web: http://library.sut.ac.th

16. Fiscal Budget

The School of Civil Engineering receives the annual budget from Suranaree University of Technology.

17. Curriculum

The School of Civil Engineering offers graduate programs leading to advanced degrees in Civil Engineering with specialization in structural, geotechnical and water

resources engineering. Details are as follows.

17.1 Total Credits

Master Degree Program

- **Plan A Scheme A1:** (Research and thesis) (minimum) 45 credits
- **Plan A Scheme A2:** (Instructional courses with thesis) (minimum) 45 credits

Doctoral Degree Program

For Research and thesis

- **Scheme 1.1:** (Master degree holders) (minimum) 60 credits

For Instructional courses with thesis

- **Scheme 2.1:** (Master degree holders) (minimum) 60 credits
- **Scheme 2.2:** (Bachelor degree holders) (minimum) 90 credits

17.2 Program Structure

Master Degree

Plan A Scheme A1: Research and thesis

Students pursuing master degrees under this option are required to undertake master thesis with a minimum workload of 45 credits with no instructional courses. However, at the advice of the supervisors students may audit (attend as visitors) some courses deemed useful for their research. Students must demonstrate their ability to apply the knowledge to solve original research problems. This option is available for those who have work experience and strong academic background in relevant fields and ability to work independently.

Plan A Scheme A2: Instructional courses with thesis

Students pursuing master degrees under this option are required to undertake at least 25 credits of instructional courses and 20 credits of master thesis, distributed as follows:

core courses	5	credits
major courses	12	credits
electives (minimum)	8	credits and
master thesis (minimum)	20	credits

Conditional acceptance may be offered to some applicants under this scheme. These applicants will have to undertake some undergraduate courses deemed appropriate to strengthen their academic background.

Doctoral Degree

Scheme 1.1: Research and thesis

Students pursuing doctoral degrees under this option must be master

degree holders. They are not required to undertake instructional course. However, at the advice of the supervisors students may audit some courses deemed useful for their research. Students must demonstrate their ability to apply the knowledge to solve original research problems. The minimum workload for the thesis is 60 credits.

This option is available for those who have strong academic background in relevant fields and ability to work independently.

Scheme 2: Instructional courses with thesis

Scheme 2.1

Prospective students must be master degree holders of relevant fields. They are required to take at least 15 credits of coursework and 45 credits of thesis. The total load is distributed as follows:

core courses/major courses/electives	15	credits, and
doctoral thesis (minimum)	45	credits

Scheme 2.2

Bachelor degree holders admitted under this plan must have graduated with honors in relevant fields. Candidates are required to take minimum of 30 credits of coursework and 60 credits of thesis, distributed as follows:

core courses	6	credits
major courses	12	credits
electives (minimum)	12	credits and
doctoral thesis (minimum)	60	credits

To strengthen their knowledge and upon consultation with their advisors, students may wish to audit some undergraduate courses. Note that no undergraduate courses can be counted toward the above requirements for graduation.

17.3 Civil Engineering courses by area of study

Core courses

430601 Introduction to Finite Element Method	4 (4-0-12)
430602 Graduate Seminar in Civil Engineering I	1 (0-3-4)
430603 Graduate Seminar in Civil Engineering II	1 (0-3-4)

Major courses in Structural Engineering

430620 Advanced Theory of Structures	4 (4-0-12)
430621 Dynamics of Structures	4 (4-0-12)
430622 Advanced Mechanics of Materials	4 (4-0-12)

Major courses in Geotechnical Engineering

430640 Theoretical Soil Mechanics	4 (4-0-12)
430641 Advanced Foundation Engineering	4 (4-0-12)
430642 Ground Improvement Techniques	4 (4-0-12)

Major courses in Water Resources Engineering

430660 Advanced Hydrology	4 (4-0-12)
430661 Computational Hydraulics	4 (4-0-12)
430662 Systems Analysis	4 (4-0-12)

Major courses in Construction Management

430680 Contemporary Management for Construction	4 (4-0-12)
430681 Financial Management for Construction	4 (4-0-12)
430682 Advanced Project Planning and Controls	4 (4-0-12)

Electives

430610 Numerical Methods in Engineering	4 (4-0-12)
430611 Statistics for Civil Engineering	4 (4-0-12)
430612 Advanced Engineering Geology	4 (4-0-12)
430613 Continuum Mechanics	4 (4-0-12)
430623 Advanced Matrix Method for Structures	4 (4-0-12)
430624 Theory of Elastic Stability	4 (4-0-12)
430625 Theory of Plates and Shells	4 (4-0-12)
430626 Advanced Finite Element Method	4 (4-0-12)
430627 Advanced Concrete Technology	4 (4-0-12)
430628 Reinforced Concrete Structures	4 (4-0-12)
430629 Advanced Prestressed Concrete	4 (4-0-12)
430630 Masonry Structures	4 (4-0-12)
430631 Steel Structures	4 (4-0-12)
430632 Experimental Method in Civil Engineering	4 (3-3-9)
430633 Wind Effects on Structures	4 (4-0-12)
430634 Earthquake-Resistant Design	4 (4-0-12)
430635 Structural Control	4 (4-0-12)
430636 Mechanics of Composite Materials	4 (4-0-12)
430637 Design of Advanced Composite in Civil Engineering Structures	4 (4-0-12)
430638 Advanced Analytical Tools in Cement Based Materials	4 (4-0-12)
430643 Laboratory, Field Testing, and Instrumentation in Geotechnical Engineering	4 (4-0-12)
430644 Soil Dynamics	4 (4-0-12)

430645 Geomechanics	4 (4-0-12)
430646 Advanced Earth Structures	4 (4-0-12)
430647 Rock Mechanics	4 (4-0-12)
430648 Analytical Method in Geotechnical Engineering	4 (4-0-12)
430649 Numerical Modeling for Geotechnical Engineering	4 (4-0-12)
430650 Deep Excavation and Tunneling	4 (4-0-12)
430651 Unsaturated Soil Mechanics	4 (4-0-12)
430652 Geostatistics	4 (4-0-12)
430663 Modeling of Hydrologic Processes	4 (4-0-12)
430664 Water Resources Systems Analysis	4 (4-0-12)
430665 River and Floodplain Management	4 (4-0-12)
430666 River Engineering	4 (4-0-12)
430667 Statistical Methods in Hydrology	4 (4-0-12)
430668 Subsurface Hydrology	4 (4-0-12)
430683 Legal Concepts and Contract Administration	4 (4-0-12)
430684 Operation Research Method for Construction	4 (4-0-12)
430685 Project Management in Construction	4 (4-0-12)
430686 Economic Decision Analysis in Construction	4 (4-0-12)
430687 Information Technology for Construction Management	4 (4-0-12)
430711 Special Problems in Advanced CE I	4 (4-0-12)
430712 Special Problems in Advanced CE II	4 (4-0-12)
430713 Special Problems in Advanced CE III	4 (4-0-12)
430714 Special Problems in Advanced CE IV	4 (4-0-12)

Thesis

430891 Master Thesis I	(20 credits)
430892 Master Thesis II	(45 credits)
430893 Doctoral Thesis I	(60 credits)
430894 Doctoral Thesis II	(45 credits)
430895 Doctoral Thesis III	(60 credits)

Note: The 6-digit course number has the following meaning:

- The first digit represents the institute code, i.e., Institute of Engineering = 4.
- The second and third digits are the department code, i.e., School of Civil Engineering = 30.
- The fourth digit indicates the study levels, i.e., 5 = advanced undergraduate course, graduate course = 6-8.
- The fifth digits show specific meaning as follows: 0 = core courses, 9 = thesis.

- The sixth digit shows the order of the course.

17.4 Study Plan

Plan A Scheme A1: Research and thesis

Year	1st Trimester	Cr.	2nd Trimester	Cr.	3rd Trimester	Cr.
1	430892 Master Thesis II	3	430892 Master Thesis II	3	430892 Master Thesis II	9
	Total	**3**	**Total**	**3**	**Total**	**9**
2	430892 Master Thesis II	10	430892 Master Thesis II	10	430892 Master Thesis II	10
	Total	**10**	**Total**	**10**	**Total**	**10**

Total 45 credits

Plan A Scheme A2: Instructional courses with thesis

Year	1st Trimester	Cr.	2nd Trimester	Cr.	3rd Trimester	Cr.
1	430601 Introduction to Finite Element Method	4	430602 Graduate Seminar in Civil Engineering I	1	430891 Master Thesis I	3
	Major courses (1)	4	Major courses (3)	4	Electives (2)	4
	Major courses (2)	4	Electives (1)	4		
	Total	12	**Total**	9		
2	430891 Master Thesis I	3	430891 Master Thesis I	7	430891 Master Thesis I	7
	Total	**3**	**Total**	**7**	**Total**	**7**

Total 45 credits

Scheme 1.1: Research and thesis

For master degree holders

Year	1st Trimester	Cr.	2nd Trimester	Cr.	3rd Trimester	Cr.
1	430893 Doctoral Thesis I	3	430893 Doctoral Thesis I	3	430893 Doctoral Thesis I	3
	Total	**3**	**Total**	**3**	**Total**	**3**
2	430893 Doctoral Thesis I	8	430893 Doctoral Thesis I	8	430893 Doctoral Thesis I	8
	Total	**8**	**Total**	**8**	**Total**	**8**
3	430893 Doctoral Thesis I	8	430893 Doctoral Thesis I	8	430893 Doctoral Thesis I	11
	Total	**8**	**Total**	**8**	**Total**	**11**

Total 60 credits

Scheme 2.1: Instructional courses with thesis

For master degree holders

Year	1st Trimester	Cr.	2nd Trimester	Cr.	3rd Trimester	Cr.
1	Core courses/Major courses/Electives (1)	4	Core courses/Major courses/Electives (3)	4	430894 Doctoral Thesis II	3
	Core courses/Major courses/Electives (2)	4	Core courses/Major courses/Electives (4)	3		
	Total	**8**	**Total**	**7**	**Total**	**3**
2	430894 Doctoral Thesis II	3	430894 Doctoral Thesis II	3	430894 Doctoral Thesis II	9
	Total	**3**	**Total**	**3**	**Total**	**9**
3	430894 Doctoral Thesis II	9	430894 Doctoral Thesis II	9	430894 Doctoral Thesis II	9
	Total	**9**	**Total**	**9**	**Total**	**9**

Total 60 credits

Scheme 2.2: Instructional courses with thesis

For bachelor degree holders

Year	1st Trimester	Cr.	2nd Trimester	Cr.	3rd Trimester	Cr.
1	430601 Introduction to Finite Element Method	4	430602 Graduate Seminarin Civil Engineering I	1	430603 Graduate Seminar in Civil Engineering II	1
	Major courses (1)	4	Major courses (3)	4	Electives (2)	4
	Major courses (2)	4	Electives (1)	4	Electives (3)	4
	Total	**12**	**Total**	**9**	**Total**	**9**
2	430895 Doctoral Thesis III	3	430895 Doctoral Thesis III	3	430895 Doctoral Thesis III	3
	Total	**3**	**Total**	**3**	**Total**	**3**
3	430895 Doctoral Thesis III	9	430895 Doctoral Thesis III	9	430895 Doctoral Thesis III	9
	Total	**9**	**Total**	**9**	**Total**	**9**
4	430895 Doctoral Thesis III	9	430895 Doctoral Thesis III	9	430895 Doctoral Thesis III	6
	Total	**9**	**Total**	**9**	**Total**	**6**

Total 90 credits

17.5 Course Description

430601 Introduction to Finite Element Method 4 (4-0-12)

Condition: Consent of the School

Introduction to finite element method (FEM), boundary and initial conditions, discretization of the domain, interpolation models, derivation of element matrices, assembly of element matrices and derivation of system equations; numerical solution of finite element equations; application to solid mechanics problems; modeling considerations and software use.

Course Outline

1. Overview of finite element method (FEM) (4 hours)
2. Review of matrix algebra and solution of simultaneous linear equations, Review of variational calculus (4 hours)
3. Boundary and initial Conditions - Discretization of the domain (4 hours)
4. Interpolation models (4 hours)
5. Direct stiffness method (4 hours)
6. FEM for structures: Bars and beams (4 hours)
7. FEM for structures: Trusses (4 hours)
8. FEM for structures: Frames and grids (4 hours)
9. Plane stress and plane strain problems (8 hours)
10. Modeling considerations and software use (8 hours)

430602 Graduate Seminar in Civil Engineering I 1 (0-3-4)

Condition: Consent of the School

This course is meant to expose all incoming graduate students to possible areas, topics, and methods of research in Civil Engineering. The students are required to present and discuss academic articles related to their research.

430603 Graduate Seminar in Civil Engineering II 1 (0-3-4)

Condition: Consent of the School

Introduction to research methodology, literature survey, discussion and criticism on academic articles, summary and conclusion, presentation of research results, academic writing, multimedia preparation, oral presentation. The students are required to develop a preliminary thesis proposal, by writing a technical report and presenting their work.

430610 Numerical Methods in Engineering 4 (4-0-12)

Condition: Consent of the School

Introduction to computer software for solving Civil Engineering problems; numerical methods and applications in Civil Engineering problems.

Course Outline

2. Introduction to computer software (4 hours)
3. Approximations and errors (8 hours)
4. Roots of equations (8 hours)
5. Systems of linear algebraic equations (4 hours)
6. Curve fitting (4 hours)
7. Numerical integration (4 hours)
8. Ordinary differential equations (4 hours)
9. Finite difference: elliptic equations (4 hours)
10. Finite-element method (8 hours)

430611 Statistics for Civil Engineering 4 (4-0-12)

Condition: Consent of the School

Introduction to the elements of probability and statistics relevant to the reliability-based design in civil engineering, the concept of system reliability and reliability analysis, and the techniques used to analyze the testing pattern and data.

Course Outline

1. Probability (4 hours)
2. Statistics for reliability analysis (4 hours)
3. Regression and correlation (4 hours)
4. System reliability (4 hours)
5. Combinatorial reliability (4 hours)
6. Reliability of civil engineering system (4 hours)
7. Reliability analysis (4 hours)
8. Point estimate method (4 hours)
9. Generalized point estimate method (4 hours)
10. Gaining information (4 hours)
11. Risk analysis (8 hours)

430612 Advanced Engineering Geology 4 (4-0-12)

Condition: Consent of the School

Rock minerals; geological characteristic; soil formation; geologic map; rock classification; electric log and radioactive log; geologic hazards.

Course Outline

1. Minerals,Identification of rocks, Laterite versus sapolite, Residual soil terminology (4 hours)
2. Alluvial fan deposits, Cross-bedding directions in a barchan dune and a seif

dune in relation to wind direction, Five major classes of dolines, Glaciated terrain (4 hours)

3. Rock and soil symbols, Rock clauses, Soil classification, The activity of soil (4 hours)
4. Topographic maps, Geologic maps, Orientation and study of aerial photographs, Geologic time scale (4 hours)
5. Wulff net, Schmidt's net, and Kalsbeek net (4 hours)
6. Test categories for standardization, Physical properties of rocks (4 hours)
7. Average seismic velocity of some earth materials, Ripper performance estimated by seismic wave velocity, Qualitative interpretation of conventional electric logs, Radioactive logs (4 hours)
8. Quantitative description of rock mass, Engineering classification of intact, Geomechanics classification of jointed rock masses, Geomechanics rock, classification guide for excavation and support in rock tunnels, (4 hours)
9. Geologic hazards (8 hours)

430613 Continuum Mechanics 4 (4-0-12)

Condition: Consent of the School

Study of the underlying physical and mathematical principles relating to the behavior of continuous media, emphasizing in solid mechanics, the foundations of the general nonlinear theories of continuum mechanics, the general treatment of motion and deformation of continua, balance laws, and constitutive theory, particular applications to elastic solids and simple materials.

Course Outline

1. Vectors and tensors (4 hours)
2. Stress (4 hours)
3. Principal stresses and principal axes (4 hours)
4. Analysis of strain and deformation (8 hours)
5. Compatibility conditions (4 hours)
6. Constitutive equations (4 hours)
7. Isotropy (8 hours)
8. Mechanical properties of solids (4 hours)
9. Some simple problems in elasticity (8 hours)

430620 Advanced Theory of Structures 4 (4-0-12)

Condition: Consent of the School

Work done by loads and strain energy; energy theorems; direct approach to formulation of bar; beam of indeterminate structures; large displacement; stability of structure; formulation of geometrically nonlinear problems; formulation of inelastic problems; numerical methods for nonlinear structural analysis.

Course Outline

1. Introduction to structural analysis (4 hours)
2. Energy theorem (4 hours)
3. Application of strain energy (4 hours)
4. Structural fundamental (4 hours)
5. Derivation of structural matrices (4 hours)
6. Structural matrices (4 hours)
7. Generalized structural system (4 hours)
8. Introduction to nonlinear analysis (4 hours)
9. Large displacement analysis (4 hours)
10. Material nonlinearity (4 hours)
11. Numerical methods for nonlinear, structural analysis (8 hours)

430621 Dynamics of Structures 4 (4-0-12)

Condition: Consent of the School

Fundamental of structural dynamics analysis; types of dynamics loadings on structures, methods in formulation of equations of motion which indicates the dynamics behavior of structures; the lump mass model of structures; single-degree-of-freedom systems; multi-degree-of-freedom systems; formulation of the equations of motion of these system as well as their response under various kinds of loading.

Course Outline

1. Overview of structural dynamics (4 hours)
2. Formulation of the equation of motion (4 hours)
3. Single-degree-of-freedom(SDOF) systems (4 hours)
4. Responses of SDOF systems (8 hours)
5. Multi-degree-of-freedom(MDOF) systems (4 hours)
6. Responses of MDOF systems (4 hours)
7. Responses by the transition matrix (4 hours)
8. Stability of the dynamics systems (4 hours)
9. Eigensolution of the dynamic systems (4 hours)
10. Modal analysis of the response (4 hours)
11. Analysis of nonlinear systems (4 hours)

430622 Advanced Mechanics of Materials 4 (4-0-12)

Prerequisite: 430211 Mechanics of Materials or Consent of the School

Analysis of stresses and strains at a point; stress-strain relations for various types of materials; theory of elasticity and energy methods used to analyze structural members; static failure and failure criteria used to predict a failure of structural members; fatigue

analysis; introduction to fracture mechanics; beams on elastic foundation; plate bending; buckling and instability of plate.

Course Outline

1. Theories of stress and strain (4 hours)
2. Stress-strain relations (4 hours)
3. Elements of theory of elasticity (8 hours)
4. Applications of energy methods (8 hours)
5. Static failure and failure criteria (4 hours)
6. Fatigue (4 hours)
7. Introduction to fracture mechanics (4 hours)
8. Beams on elastic foundation (4 hours)
9. Plate bending (4 hours)
10. Buckling and instability (4 hours)

430623 Advanced Matrix Method for Structures 4 (4-0-12)

Condition: Consent of the School

Matrices and computers in the analysis of structures; force and displacement methods; direct stiffness, and energy formulation; applications to plane and space trusses, multi-span gable frames, grid and space frames, multistory building frames; partitioning by use of substructures.

Course Outline

1. Structural theorems (4 hours)
2. Force method (4 hours)
3. Displacement method (4 hours)
4. Derivation of stiffness matrices (4 hours)
5. Stiffness matrices (4 hours)
6. Analysis of structures in 2D (4 hours)
7. Analysis of structures in 3D (4 hours)
8. Irregular boundary conditions (4 hours)
9. Irregular loading conditions (4 hours)
10. Analysis of substructures (8 hours)
11. Structural systems (4 hours)

430624 Theory of Elastic Stability 4 (4-0-12)

Condition: Consent of the School

The analysis of beam-column, elastic buckling, inelastic buckling, experiments and design formula for bars and frames; torsional buckling and lateral buckling of beams, bending and buckling of thin plates.

Course Outline

1. Beam-columns (8 hours)
2. Elastic buckling of bars (4 hours)
3. Elastic buckling of frames (4 hours)
4. Inelastic buckling of bars (4 hours)
5. Experiments and design formulas (4 hours)
6. Torsional buckling (4 hours)
7. Lateral buckling of beams (4 hours)
8. Bending of thin plates (8 hours)
9. Buckling of thin plates (8 hours)

430625 Theory of Plates and Shells 4 (4-0-12)

Condition: Consent of the School

Basic equations for the bending of rectangular, circular, and continuous plates; anisotropic rectangular plate with various edge conditions; general theory of deformation of thin shells with small deflections, effect of edge conditions; analysis of shell structures; cylindrical vaults, domes, double curved roofs, and tanks; Numerical and approximate methods for plate and shell analyses.

Course Outline

1. Pure bending of long rectangular plates (4 hours)
2. Small deflections of laterally loaded plates (4 hours)
3. Simply supported rectangular plates (4 hours)
4. Rectangular plates with various edge conditions (4 hours)
5. Circular plates (4 hours)
6. Continuous rectangular plates (4 hours)
7. Anisotropic rectangular plates (8 hours)
8. Deformation of shells without bending (4 hours)
9. General theory of cylindrical shells (4 hours)
10. Numerical methods for plate and shell analysis (8 hours)

430626 Advanced Finite Element Method 4 (4-0-12)

Condition: Consent of the School

Finite element method, numerical method and computer in the analysis of structures; direct and generalized formulation of the approximate analysis with applications to bar, beam, plane strain and plane stress, axi-symmetric and general solid elements, and the modeling of structural systems.

Course Outline

1. Introduction to finite element method (4 hours)
2. Structural theorems (4 hours)
3. Stress and strain in elements (4 hours)
4. Isoparametric formulation (4 hours)
5. Derivation of element matrices (4 hours)
6. Formulation of structural system (4 hours)
7. Large displacement (4 hours)
8. Large strain (4 hours)
9. Material nonlinearity (4 hours)
10. Plasticity (4 hours)
11. Creep (4 hours)
12. Analysis tool and implementation (4 hours)

430627 Advanced Concrete Technology 4 (4-0-12)

Condition: Consent of the School

Review of concrete technology; pozzolanic materials; special concrete; durability of concrete; microstructure of concrete; advanced analytical tools for concrete.

Course Outline

1. Review of concrete technology (8 hours)
2. Pozzolanic materials in concrete (8 hours)
3. Special concrete (8 hours)
4. Durability of concrete (8 hours)
5. Microstructure of concrete (8 hours)
6. Advanced analytical tools for concrete (8 hours)

430628 Reinforced Concrete Structures 4 (4-0-12)

Condition: Consent of the School

Design of structural components such as beams, columns, slabs, footings and walls using the ultimate strength method; building code requirements for reinforced concrete; truss models for shear and torsion, development and anchorage.

Course Outline

1. Overview of concrete structures, Design methods and requirements (4 hours)
2. Strength of structural members in bending (4 hours)
3. Shear strength and shear reinforcement (4 hours)
4. Beams in torsion (4 hours)

5. Serviceability of beams (4 hours)
6. Combined compression and bending: Columns (4 hours)
7. Development of reinforcement (4 hours)
8. Two-way slabs, plates, and continuous reinforced concrete structures (4 hours)
9. Structural stability (4 hours)
10. Length effects on columns (4 hours)
11. Design of footings (4 hours)
12. Design of footings (4 hours)

430629 Advanced Prestressed Concrete 4 (4-0-12)

Condition: Consent of the School

Discussions concerning materials and methods used in prestressing; design of sections for flexure, shear, anchorage, and torsion; camber, deflections and cable layouts, simple spans, continuous beams, and prestressed tanks.

Course Outline

1. Overview of prestressed concrete, Materials and structural behavior (4 hours)
2. Prestressing systems, End anchorages (4 hours)
3. Loss of prestress (4 hours)
4. Analysis of section in flexure (4 hours)
5. Design of section for flexure (4 hours)
6. Shear, Bond and Bearing (4 hours)
7. Post-tensioned slab, Computer applications (4 hours)
8. Torsion design (4 hours)
9. Camber, Deflection (4 hours)
10. Composite construction (4 hours)
11. Continuous beams (4 hours)
12. Tension members, Circular prestressing (4 hours)

430630 Masonry Structures 4 (4-0-12)

Condition: Consent of the School

Masonry unit types and grades, mortar types, reinforcement and connectors, beam, column, arch, bearing wall design; structural behavior and recommended standard construction practices; Plain and reinforced masonry, design parameter establishment, and recommended practice documents.

Course Outline

1. Overview of masonry structures, Modern masonry construction (4 hours)
2. Clay brick and tile-material properties, Material and testing (4 hours)
3. Concrete masonry units, Material properties, Material and testing (4 hours)
4. Mortar, grout, and steel reinforcement, Materials and testing (4 hours)

5. Design parameter establishment (4 hours)
6. Load types and intensities, Loads and load combinations (4 hours)
7. Design philosophy and methodology, Structural analysis and design (4 hours)
8. Structural considerations for masonry walls, Load bearing walls, Shear walls (4 hours)
9. Masonry columns and pilasters (4 hours)
10. Structural considerations for masonry beams, Bending behavior, Design of reinforced concrete beams (4 hours)
11. Structural considerations for masonry beam-columns, behavior and design (4 hours)
12. Connections, joints, and construction details in practice (4 hours)

430631 Steel Structures 4 (4-0-12)

Condition: Consent of the School

Behavior of steel structures under load; topics include beams, columns, building connections, structural stability and bracing requirements; building codes and related documents.

Course Outline

1. Overview of steel structures, design methods and requirements, ASD and LRFD (4 hours)
2. Tension member behavior and design (4 hours)
3. Compression member behavior and design (4 hours)
4. Beam behavior under load and bracing requirements (4 hours)
5. Beam design (4 hours)
6. Torsional design of beam (4 hours)
7. Beam-columns behavior and design (4 hours)
8. Building types and connections (4 hours)
9. Bolted connection (4 hours)
10. Welded connection (4 hours)
11. Bracing requirements for compression members (4 hours)
12. Frame stability and bracing requirements (4 hours)

430632 Experimental Method in Civil Engineering 4 (3-3-9)

Condition: Consent of the School

Principles and techniques of measurements in mechanics; electrical-resistance strain gauges, semiconductor sensors, recording instruments, optical interference methods, photoelasticity, and dynamic measurements.

Course Outline

1. Standards of measurement (4 hours)

2. Treatment of uncertainties (4 hours)
3. Introduction to strain measurements (4 hours)
4. Electric resistance strain gages (4 hours)
5. Semiconductor sensors (4 hours)
6. Recording instruments (4 hours)
7. Analysis of strain-gage data (4 hours)
8. Displacement measurements (4 hours)
9. Measurement of force and torque (4 hours)
10. Measurement of motion (4 hours)
11. Photoelasticity (4 hours)

430633 Wind Effects on Structures 4 (4-0-12)

Condition: Consent of the School

Effects of wind loading on civil engineering structures; atmospheric circulation of wind; fundamental of force induced by bluff-body aerodynamics; applications to design problems.

Course Outline

1. Atmosphere wind (4 hours)
2. Bluff-body aerodynamics (4 hours)
3. Structural dynamics (4 hours)
4. Wind-induced vibration (4 hours)
5. Wind directionality effects (4 hours)
6. Tall buildings: Structural response and cladding design (4 hours)
7. Slender towers and stacks with circular cross section (4 hours)
8. Hyperbolic cooling towers (4 hours)
9. Trussed frameworks and plate girders (4 hours)
10. Suspended-span bridges, tension structures, and power lines (4 hours)
11. Offshore structures (4 hours)
12. Wind-induced discomfort in and around buildings (4 hours)

430634 Earthquake-Resistant Design 4 (4-0-12)

Condition: Consent of the School

Effects of earthquake loading on civil engineering structures; characteristic of earthquake; effect of earthquake loading on structures; applications to design problems.

Course Outline

1. Seismological background (4 hours)
2. Earthquake input mechanisms (4 hours)
3. Earthquake response of single-degree-of-freedom (4 hours)

4. Earthquake analysis of multi-degree-of-freedom (4 hours)
5. Earthquake response of linearly elastic buildings (4 hours)
6. Earthquake response of inelastic buildings (4 hours)
7. Earthquake dynamics of base-isolated buildings (4 hours)
8. Excitation by rigid-base rotation, Multiple-support excitation (4 hours)
9. Soil-structure interaction (4 hours)
10. Nonlinear response to earthquakes (4 hours)
11. Stochastic modeling of strong ground motions (4 hours)
12. Structural dynamics in building codes (4 hours)

430635 Structural Control 4 (4-0-12)

Prerequisite: 430621 Dynamics of Structures or Consent of the School

Introduction of vibration problem in structures; basic concepts of linear system and stability; discussion about how to control structures passively and actively; semi-active control.

Course Outline

1. Introduction (4 hours)
2. Linear Systems (4 hours)
3. Stability analysis (4 hours)
4. Passive control (4 hours)
5. Active control (4 hours)
6. Classical control theory (4 hours)
7. Optimal control theory (4 hours)
8. Output feedback control (4 hours)
9. Nonlinear control (4 hours)
10. Control of buildings (4 hours)
11. Decentralized control of large scale system (4 hours)
12. Semi-active control (4 hours)

430636 Mechanics of Composite Materials 4 (4-0-12)

Prerequisite: 430622 Advanced Mechanics of Materials or Consent of the School

Introduction to fiber-reinforced composite material; linear elastic stress-strain characteristics of fiber-reinforced composite materials; prediction of engineering properties using micromechanics; plane-stress assumptions; plane-stress stress-strain relation in a global coordinate system; classical lamination theory; failure theories for fiber-reinforced composite materials; introduction to fiber-reinforced laminated plates.

Course Outline

1. Introduction to fiber-reinforced composite materials (4 hours)

2. Linear elastic stress-strain characteristics of fiber-reinforced composite materials (4 hours)
3. Prediction of engineering properties using micromechanics (4 hours)
4. Plane-stress assumptions (4 hours)
5. Plane-stress stress-strain relation in a global coordinate system (4 hours)
6. Classical lamination theory: Kirchhoff hypothesis (4 hours)
7. Classical lamination theory: Laminate stiffness matrix (4 hours)
8. Classical lamination theory: Additional examples (4 hours)
9. Failure theories for fiber-reinforced composite materials I (4 hours)
10. Failure theories for fiber-reinforced composite materials II (4 hours)
11. Introduction to fiber-reinforced laminated plates I (4 hours)
12. Introduction to fiber-reinforced laminated plates II (4 hours)

430637 Design of Advanced Composites in Civil Engineering Structures 4 (4-0-12)

Condition: Consent of the School

Design of fiber-reinforced plastic composites (FRP) of civil engineering structures; pertinent fundamental understanding of the constituents; manufacturing processes, and mechanical properties of the fiber reinforced plastic composite materials; the structural behavior and analysis; the design methodology for tension members, compression members, flexural members, and connection.

Course Outline

1. Introduction to fiber-reinforced plastic composite (4 hours)
2. Manufacturing techniques (4 hours)
3. Macro mechanical behavior (4 hours)
4. Standard tests (4 hours)
5. Micromechanical behavior (8 hours)
6. Structural analysis (8 hours)
7. Member selection – manual (4 hours)
8. Design of compression members (4 hours)
9. Design of flexural members (4 hours)
10. Design of connections (4 hours)

430638 Advanced Analytical Tools in Cement Based Materials 4 (4-0-12)

Prerequisite: Consent of the School

Review of advanced xement based materials technology and analytical tools in cement based materials; microstructure of hydration reaction and pozzolanic reaction X-ray diffraction (XRD); thermal analysis (DTA, TGA and DSA) and electron microscope (SEM, BSEM, TEM, EDAX); porosity and pore size distribution of cement based materials; surface area with nitrogen adsorption technique (BET Method) synchrotron

radiation technique.

Course Outline

1. Review of Advanced Concrete Technology and Analytical Tools in Cement Based Materials (8 hours)
2. Solid Phase Analysis by X-Ray Diffraction (XRD) (8 hours)
3. Electron Microscopy with Various Techniques (SEM, BSEM, TEM, X-Ray Chemical Analysis (EDAX)) (8 hours)
4. Thermal Analysis (Differential Thermal analysis (DTA), Thermogravimetric Analysis (TGA) and Differential Scanning Calorimetry (DSC)) (8 hours)
5. Porosity, Pore Size Distribution and Surface Area (Mercury Intrusion Porosimeter (MIP) and Nitrogen Adsorption) (8 hours)
6. Application of Synchrotron Radiation Technique in Cement Based Materials (8 hours)

430640 Theoretical Soil Mechanics 4 (4-0-12)

Condition: Consent of the School

Physical properties; soils classification; ground water; coefficient of permeability; seepage; excess pore water pressure; effective stress; consolidation; strength and deformations.

Course Outline

1. Soil formation and soil constituents (4 hours)
2. Soil mineral and soil-water interaction (4 hours)
3. Index properties and soil classification (4 hours)
4. Soil fabric and its measurement (4 hours)
5. Effective, intergranular and total stress (4 hours)
6. Soil structure (4 hours)
7. Engineering properties of desturctured clays and their assessment (8 hours)
8. Engineering properties of structured clays and their assessment (8 hours)

430641 Advanced Foundation Engineering 4 (4-0-12)

Condition: Consent of the School

Site investigation; evaluation of geotechnical parameters; shallow foundation; instrumentation for pile and evaluation of instrumented pile load test results; improvement of bored pile capacity by toe/shaft grouting, earth pressure theories and retaining structures, instrumentation for deep excavation, observational method for design and construction of retaining structures.

Course Outline

1. Review of some essential soil mechanics and foundation engineering (4 hours)
2. Site investigation, Evaluation of geotechnical parameters,Geotechnical report (4 hours)
3. Shallow foundation-combined footings, Mat foundation, Compensated foundation (8 hours)
4. Instrumentation for pile subjected to axial or lateral loading (4 hours)
5. Evaluation of instrumented pile load test results for advanced pile design: Axial or lateral loading (4 hours)
6. Improvement of bored pile capacity by toe/shaft grouting (4 hours)
7. Earth pressure theories and retaining structures, Sheet pile wall, Diaphragm wall, Conventional/top-down construction (8 hours)
8. Instrumentation planning, Evaluation of monitored results, Evaluation of bracing and wall performance for deep excavation (8 hours)
9. Observational method for design and construction of retaining structures (4 hours)

430642 Ground Improvement Techniques 4 (4-0-12)

Prerequisite: 430640 Theoretical Soil Mechanics or Consent of the School

Compaction; stone columns; vertical drains; preloading; chemical stabilization; reinforced earth.

Course Outline

1. Principle of ground improvement (4 hours)
2. Physical improvement methods : Compaction, Dewatering, Densification (8 hours)
3. Chemical improvement methods (8 hours)
4. Earth reinforcement (8 hours)

430643 Laboratory, Field Testing, and Instrumentation in Geotechnical Engineering 4 (3-3-9)

Condition: Consent of the School

Physical properties; electronic instruments in laboratory; chemical tests; field permeability test; consolidation test; shear strength determination; field tests; instrumentation.

Course Outline

1. Physical properties (4 hours)
2. Scanning electron microscope (4 hours)
3. X-ray diffraction (4 hours)
4. Pore size distribution analysis (4 hours)
5. Field permeability test (4 hours)
6. Consolidation tests (8 hours)
7. Shear strength tests (8 hours)
8. Instrumentation (8 hours)
9. Field trip (4 hours)

430644 Soil Dynamics **4 (4-0-12)**

Prerequisite: 430640 Theoretical Soil Mechanics or Consent of the School

Elasticity; visco-elasticity; soil stiffness; soil damping; soil liquefaction; site characterization; in-situ testing; laboratory testing; seismic response analysis; soil sampling; flow failure.

Course Outline:

1. Characteristics of dynamic problems (4 hours)
2. Characteristic changes in cyclic stress in typical dynamic loading (4 hours)
3. The presentation of stress-strain relations in cyclic loading (4 hours)
4. Apparatus and procedures for laboratory tests (4 hours)
5. In-situ survey by wave propagation (4 hours)
6. Low-amplitude shear moduli (4 hours)
7. Effect of loading speed and stiffness degradation of cohesionless soils (8 hours)
8. Strength of cohesive soils under transient and cyclic loading conditions (4 hours)
9. Resistance of sand to cyclic loading (4 hours)
10. Sand behavior under monotonic loading (4 hours)
11. Analysis of liquefaction (4 hours)

430645 Geomechanics **4 (4-0-12)**

Prerequisite: 430640 Theoretical Soil Mechanics or Consent of the School

Basic concepts; critical state strength of soil; stress-strain modeling based on critical state theory; behavior of soils before failure.

Course Outline

1. Basic concepts (4 hours)
2. Critical state theory (8 hours)
3. Stress-strain modeling (8 hours)
4. Behavior of soils before failure (4 hours)
5. Soil parameters for design (8 hours)
6. Koiter’s equation and slip line fields (8 hours)

430646 Advanced Earth Structures **4 (4-0-12)**

Prerequisite: 430640 Theoretical Soil Mechanics or Consent of the School

State of stress in ground; compacted soil; seepage problems and control methods; slope stability calculations; earth dam design.

Course Outline

1. Natural Soils (8 hours)

2. Properties and applications of compacted soil (8 hours)
3. Seepage (8 hours)
4. Slope stability (8 hours)
5. Earth dam design (4 hours)
6. Field monitoring (8 hours)

430647 Rock Mechanics 4 (4-0-12)

Condition: Consent of the School

Index properties and classification; engineering properties; strength of jointed rock masses; factors influencing strength and modulus; foundation on rocks and rock slope.

Course Outline

1. Index properties and classification (4 hours)
2. Engineering properties of soils and rocks (8 hours)
3. Rock fracture and failure criteria (4 hours)
4. Deformability (4 hours)
5. Creep and moisture sensitive properties (4 hours)
6. Shear strength of rock discontinuities (8 hours)
7. Foundations on rocks (8 hours)
8. Rock slope (8 hours)

430648 Analytical Methods in Geotechnical Engineering 4 (4-0-12)

Prerequisite: 430645 Geomechanics or Consent of the School

Analytical and numerical methods in geotechnical engineering; modeling the stress-strain behavior of soils (elastic models, rigid-perfectly plastic models, elasto-plastic models); analytical methods for ultimate limit state; upper and lower bound theorems; upper and lower bound methods for undrained analysis; upper and lower bound methods for drained analysis; application of upper and lower bound methods; method of characteristics; constructing a characteristic mesh for undrained loading; constructing a characteristic mesh for drained loading; the limit equilibrium method.

Course Outline

1. Analytical and numerical methods in geotechnical engineering (4 hours)
2. Modeling the stress-strain behavior of soils (8 hours)
3. Analytical methods for ultimate limit state (4 hours)
4. Upper and lower bound methods for undrained analysis (8 hours)
5. Upper and lower bound methods for drained analysis (8 hours)

6. Constructing a characteristic mesh (8 hours)
7. Limit equilibrium method (8 hours)

430649 Numerical Modeling for Geotechnical Engineering 4 (4-0-12)

Prerequisite: 430640 Theoretical Soil Mechanics or Consent of the School

Review of continuum mechanics; physical and numerical modeling; constitutive models for soil and structures; selection of suitable constitutive models; numerical modeling with finite Element and finite difference; stability analysis with phi/c reduction method.

Course Outline

1. Review of continuum mechanics (8 hours)
2. Physical and numerical modeling in geotechnical engineering (4 hours)
3. Simple constitutive models and advanced constitutive model for soils and Structures (4 hours)
4. Selection of suitable constitutive models for geotechnical material (8 hours)
5. Numerical modeling with finite element method (8 hours)
6. Numerical modeling with finite difference method (8 hours)
7. Stability analysis by phi/c reduction method (8 hours)

430650 Deep Excavation and Tunneling 4 (4-0-12)

Condition: Consent of the School

Overview of excavation and tunneling method; selection of construction method; instrumentation types and planning; stress and deformation field around tunnel; earth pressure theories; concept of the NATM; mechanized tunneling method; cut and cover tunneling method; concept of lining design; risk assessment for deep excavation and tunneling.

Course Outline

1. Overview of excavation and tunneling method (4 hours)
2. Selection of construction method (4 hours)
3. Instrumentation: Types and planning (4 hours)
4. Stress and deformation field around tunnel and Earth pressure theories (8 hours)
5. Concept of the NATM (New Austrian Tunneling Method) (8 hours)
6. Mechanized tunneling method (8 hours)
7. Cut and cover tunneling method (4 hours)
8. Concept of lining design (4 hours)
9. Risk assessment for deep excavation and tunneling (4 hours)

430651 Unsaturated Soil Mechanics **4 (4-0-12)**

Prerequisite: 430640 Theoretical Soil Mechanics or Consent of the School

Introduction to unsaturated soil problems; phase properties and relations; basic principles; stress state variables; measurement of unsaturated soil properties; flow of water in unsaturated soils; steady state and transient flows; soil water characteristic curve; hydraulic conductivity-suction relations; mechanical behavior of unsaturated soils; pore pressure parameters; volume change constitutive relations under drained and undrained loading; critical-state frameworks and applications; coupling seepage and stress-deformation analyses.

Course Outline:

1. Introduction to unsaturated soil mechanics (4 hours)
2. Phase properties and relations (4 hours)
3. Basic principles (4 hours)
4. Stress state variables (4 hours)
5. Flow of water in unsaturated soils. Steady state and transient flows (4 hours)
6. Soil water characteristic curve, Hydraulic conductivity-suction relations (8 hours)
7. Mechanical behavior of unsaturated soils (8 hours)
8. Application of critical state soil mechanics to unsaturated soils (8 hours)
9. Fluid-mechanical interaction in unsaturated soils (4 hours)

430652 Geostatistics **4 (4-0-12)**

Prerequisite: 430611 Statistics for Civil Engineering or Consent of the School

Introduction to the geostatistic theory; applications in geotechnical engineering.

Course Outline

1. Geostatistics and engineering geological applications (4 hours)
2. The theory of regionalized (16 hours)
3. Structural analysis (Nested structures and the nugget effect, models of variograms,fitting models, hole effect and proportional effect, anisotropies) (8 hours)
4. Kriging and the estimation of engineering geological characteristics (12 hours)
5. Sequential Gaussian and indicator simulation and co-simulation (8 hours)

430660 Advanced Hydrology **4 (4-0-12)**

Condition: Consent of the School

Introduction to hydrology; hydrologic processes; atmospheric water; subsurface water; groundwater; surface water; unit hydrograph; lumped flow routing, distributed flow routing, frequency analysis.

Course Outline

1. Hydrologic processes	(8 hours)
2. Atmospheric water	(4 hours)
3. Subsurface water	(4 hours)
4. Groundwater	(4 hours)
5. Surface water	(4 hours)
6. Unit hydrograph	(8 hours)
7. Lumped flow routing	(4 hours)
8. Distributed flow routing	(4 hours)
9. Frequency analysis	(8 hours)

430661 Computational Hydraulics **4 (4-0-12)**

Condition: Consent of the School

Equations and numerical solution techniques for hydraulic problems, open channels and rivers, sediment in rivers, pipe systems, groundwater flow; diffusion and dispersion in rivers.

Course Outline

1. Equations and numerical solution techniques for hydraulic problems	(4 hours)
2. Gradually varied flow in irregular open channels	(8 hours)
3. Flood waves in rivers and floodplains	(8 hours)
4. Oscillation of shallow water	(4 hours)
5. Scour and deposition of sediment in river channels	(8 hours)
6. Water hammer in pipe systems	(8 hours)
7. Surge protection and air chambers	(4 hours)
8. Seepage and groundwater flows	(8 hours)
9. Diffusion and dispersion of pollutants in rivers	(8 hours)

430662 Systems Analysis **4 (4-0-12)**

Condition: Consent of the School

Introduction to the systems approach for solving problems; problem definition and mathematical formulation; economic theory in decision making; linear programming and dynamic programming.

Course Outline

1. Introduction to systems approach	(4 hours)
2. An overview of mathematical optimization methods	(4 hours)
3. Engineering economics for decision making	(8 hours)
4. Linear programming	(16 hours)
5. Sensitivity analysis and the dual-primal relationships	(4 hours)

6. Dynamic programming (12 hours)

430663 Modeling of Hydrologic Processes 4 (4-0-12)

Condition: Consent of the School

Mathematical modeling and numerical solution of hydrologic processes; rainfall; losses, runoff; empirical and process based models, lumped and distributed parameters models; other modeling considerations, model capability and accuracy, optimization.

Course Outline

1. Mathematical modeling and numerical solution of hydrologic processes Rainfall (4 hours)
2. Infiltration,Unsaturated and saturated flow (4 hours)
3. Surface storage, Evaporation (4 hours)
4. Transpiration,Interception (4 hours)
5. Runoff (4 hours)
6. Numerical representation of terrain (4 hours)
7. Model structure,Empirical and process based models (8 hours)
8. Lumped and distributed parameters (8 hours)
9. Model capability and accuracy (4 hours)
10. Model optimization (4 hours)

430664 Water Resources Systems Analysis 4 (4-0-12)

Prerequisite: 430662 Systems Analysis or Consent of the School

Introduction to water resources systems; simulation techniques and mathematical programming used to analyze and plan common water resources systems.

Course Outline

1. Planning and analysis of water resources systems (4 hours)
2. Identification and evaluation of water management plans (8 hours)
3. Water resources planning objectives (4 hours)
4. Water resources planning under uncertainty (8 hours)
5. Deterministic river basin modeling (8 hours)
6. Stochastic river basin planning models (8 hours)
7. Case studies (8 hours)

430665 River and Floodplain Management 4 (4-0-12)

Condition: Consent of the School

Nature of streamflow, fluvial processes and alluvial channel morphology; Modeling of irregular channels and floodplains; Management issues relating to rivers and floodplains.

Course Outline

1. Introduction to river and floodplain management (4 hours)
2. Nature of streamflow and fluvial processes (4 hours)
3. Hydraulics of flow in irregular channels (8 hours)
4. Floodplain and estuaries (8 hours)
5. Floodplain management systems (8 hours)
6. Alluvial channel morphology (4 hours)
7. Alluvial channel modeling (8 hours)
8. Mixing processes for pollutant (4 hours)

430666 River Engineering 4 (4-0-12)

Condition: Consent of the School

Catchment characteristics; hydrological cycle; catchment areas; sediment sources and sediment yield; river hydraulics; river morphology; sediment transport; planforms; cross sections and longitudinal profiles; river improvement, construction, control of flow regimes; sediment control devices.

Course Outline

1. Catchment characteristics (8 hours)
   - -Hydrological cycle
   - -Catchment areas
   - -Sediment sources and sediment yield
2. River hydraulics (8 hours)
   - -Water levels
   - -Discharge
   - -Relation curves
   - -Backwater curve computation and flood routing
3. River morphology (16 hours)
   - -Sediment transport
   - -Planforms of river
   - -Longitudinal profiles
   - -River bends
   - -Confluences and bifurcations
4. River engineering works (12 hours)
   - -Temporary river improvement
   - -Permanent river improvement
   - -Constructions
   - -Control of flow regime

5. Sediment control devices (4 hours)
   -Bottom intake structures for mountainous streams
   -Sediment control devices and their characteristics

430667 Statistical Methods in Hydrology 4 (4-0-12)

Condition: Consent of the School

Probability and probability distribution; properties of random variables; discrete probability distributions; normal distribution; continuous probability distributions; probability plotting and frequency analysis; confidence intervals and hypothesis testing; linear regression; correlation; multivariate analysis; analysis of hydrologic time series; stochastic hydrologic models.

Course Outline

1. Probability and probability distribution (4 hours)
2. Properties of random variables (4 hours)
3. Discrete probability distributions (4 hours)
4. Normal distribution (4 hours)
5. Continuous probability distributions (4 hours)
6. Probability plotting and frequency analysis (4 hours)
7. Confidence intervals and hypothesis testing (4 hours)
8. Linear regression (4 hours)
9. Correlation (4 hours)
10. Multivariate analysis (4 hours)
11. Analysis of hydrologic time series (4 hours)
12. Stochastic hydrologic models (4 hours)

430668 Subsurface Hydrology 4 (4-0-12)

Condition: Consent of the School

Water and the subsurface environment; fluid flow and mass transport; the geologic setting; water movement in geological formations; analytical solutions to flow problems; well hydraulics; numerical solutions of the groundwater flow equation, contamination of subsurface water; groundwater-surface water interaction; remediation; multi-fluid flow and transport.

Course Outline

1. Water and subsurface environment (4 hours)
2. Fluid flow and mass transport (4 hours)
3. The geologic setting (4 hours)
4. Water movement in geological formations (4 hours)
5. Analytical solutions to flow problems (4 hours)

6. Well hydraulics (4 hours)
7. Numerical solutions of the groundwater flow equation (4 hours)
8. Contamination of subsurface water (4 hours)
9. Groundwater-surface water interaction (4 hours)
10. Remediation (4 hours)
11. Multi-fluid flow and transport (8 hours)

430680 Contemporary Management for Construction 4 (4-0-12)

Condition: Consent of the School

This course provides characteristics of construction projects and fundamental principles of modern construction management. The course will serve as an introduction to other courses in construction management. It includes project definition, project scope, project tools and implementation, project management theory and role of project manager, professional development, organization design and project structure, communication, managing change and performance measurement.

Course Outline

1. The Dynamic New Workplace (4 hours)
2. Information and Decision Making (4 hours)
3. Historical Foundations of Management (4 hours)
4. Environment and Competitive Advantage (4 hours)
5. Strategic Management and Entrepreneurship (4 hours)
6. Controlling to Ensure Results (4 hours)
7. Organizational Design and Work Processes (4 hours)
8. Leading to Inspire Effort (4 hours)
9. Motivation and Rewards (4 hours)
10. Individual Performance and Job Design (4 hours)
11. Communication and Interpersonal Skills (4 hours)
12. Change Management and Innovation (4 hours)

430681 Financial Management for Construction 4 (4-0-12)

Condition: Consent of the School

This course introduces the basic financial skills needed to manage construction projects and organizations for profit. The course provides principles and techniques to manage vital resources of construction projects including cost, budget, and accounting system. This course also provides a thorough grounding in all aspects of financial management, cost control including explanations of financial documents and cost reports, an overview of bookkeeping fundamentals, types of estimates, organization of cost estimates, and quantity takeoffs.

Course Outline

1. Conventions in Accounting (4 hours)
2. Bookkeeping Fundamentals (4 hours)
3. Financial Statement Preparation (4 hours)
4. Analyzing Company Financial Data (4 hours)

5. Cost Control Concepts (4 hours)
6. Cost Account Structures (4 hours)
7. Bid Preparation and Cost Recovery (4 hours)
8. The Estimating Process (4 hours)
9. Time and Cost Integration (8 hours)
10. Accounting for Equipment Costs (4 hours)
11. Job and Fixed Overhead Costs (4 hours)

430682 Advanced Project Planning and Controls 4 (4-0-12)

Condition: Consent of the School

This course provides applications in the planning and scheduling to construction projects with advanced planning tools. The course includes project planning and scheduling, resource allocation, cost planning, monitoring and control, methodology, critical path method, capacity and efficiency of resources, tracking the project progress, strategic in resource leveling and rescheduling, implementation problems and computer applications.

Course Outline

1. Reviewing A Project Case Study (4 hours)
2. Concepts of Construction Planning (4 hours)
3. Fundamental Scheduling Procedures (4 hours)
4. Advanced Scheduling Techniques (4 hours)
5. Introducing Microsoft Project and Understanding Project Management (4 hours)
6. Starting a New Project (4 hours)
7. Project Resources Management (4 hours)
8. Planning Resource and Task Costs (4 hours)
9. Checking and Adjusting the Project Plan (4 hours)
10. Tracking Progress and Responding to Changes (8 hours)
11. Reporting and Analyzing Project Information (4 hours)

430683 Legal Concepts and Contract Administration 4 (4-0-12)

Condition: Consent of the School

This course provides a general foundation in construction law and contracts that construction practitioners need to protect themselves, their employers and the works. To facilitate smooth running of construction projects, construction professionals need to be aware of their rights, obligations and liabilities when they enter into contractual relations either as individuals or on behalf of their employers. The course includes general principles of law, contracts: general principles, construction contracts, tortuous liabilities, law relating to land, construction statutes, construction claims prevention and management, disputes and their resolution, construction insurances.

Course Outline

1. Construction and the Legal System (8 hours)
2. Litigation Procedure (4 hours)
3. General Principles of Contracts (4 hours)
4. Construction Contracts (8 hours)
5. Tortuous Liabilities (8 hours)
6. Law Relating to Land (4 hours)

7. Construction Statutes (4 hours)
8. Construction Claims and Disputes (4 hours)
9. Construction Risks and Insurances (4 hours)

430684 Operation Research Method for Construction 4 (4-0-12)

Condition: Consent of the School

This course provides an understanding of operation research methods and their applications in construction management. Particular emphasis is laid on using examples from the construction industry. Applications of mathematics techniques for business decision-making such as linear programming, transportation problem, assignment problem, inventory model, Markov model, simulation and game theory.

Course Outline

1. Introduction to Management Science (4 hours)
2. Linear Programming (8 hours)
3. What-If Analysis (8 hours)
4. Transportation Models (4 hours)
5. Project Management with PERT/CPM (4 hours)
6. Inventory Management (4 hours)
7. Queuing Models (8 hours)
8. Forecasting (4 hours)

430685 Project Management in Construction 4 (4-0-12)

Condition: Consent of the School

This course provides an introductory overview on construction management, focusing on organizational and contractual approaches to project management, and the procurement and bidding procedures. This course provides civil engineers the basic knowledge on project procurement such as prequalification, bidding, and contracting systems. International comparison of these systems will also be discussed.

Course Outline

1. Management in the Engineering and Construction Industry (4 hours)
2. Development and Organization of Projects (4 hours)
3. Applications and Requirements for Management Organizations (4 hours)
4. Preconstruction Stage (4 hours)
5. Bidding and Awards (4 hours)
6. Construction Stage (8 hours)
7. Estimating Project Costs (4 hours)
8. Value Engineering (4 hours)
9. Quality Management and Safety during Construction (4 hours)
10. Construction Supply Chain Management (4 hours)
11. Theory of Lean Construction (4 hours)

430686 Economic Decision Analysis in Construction 4 (4-0-12)

Condition: Consent of the School

This course introduces the basic economic concepts and decision making models

used in the construction industry such as interest calculations, comparison of alternatives, replacement and depreciation of machinery, tax considerations, evaluation of projects, decision making under risk and under uncertainty, and economic decision models.

Course Outline

1. Basic Concepts of Engineering Economy (8 hours)
2. Engineering Economics (8 hours)
3. Comparison of Economic Alternatives (8 hours)
4. Market Consideration in Economic Decisions (8 hours)
5. Economic Analysis under Special Conditions (8 hours)
6. Economic Decision Making under Risk and Uncertainty (8 hours)

430687 Information Technology for Construction Management 4 (4-0-12)

Condition: Consent of the School

This course provides various applications of modern information technology that are now playing an important role in effectively and efficiently managing construction projects. The course includes data structure and relational database management system, expert system and decision support system, interoperability system, integrated corporation tools: MRP i, MRP ii, ERP, IFC, knowledge management, artificial intelligence (AI), evolutionary optimization, stochastic simulation, Internet Intranet and data security, CAD nD, Object-Oriented Programming: VBA.

Course Outline

1. Data Structure & Relational Database Management System (4 hours)
2. Expert System and Decision Support System (4 hours)
3. Integrated Corporation Tools: MRP i, MRP ii, ERP, IFC (4 hours)
4. Knowledge Management & Artificial Intelligence (AI) (4 hours)
5. Stochastic Simulation (8 hours)
6. Advanced Optimization Problems and Techniques (8 hours)
7. Object-Oriented Programming: VBA (4 hours)
8. CAD nD (4 hours)
9. Intranet, Internet and Data Security (4 hours)
10. Contemporary System or Software Package for Civil Engineering (4 hours)

430711 Special Problems in Advanced Civil Engineering I 4 (4-0-12)

Condition: Consent of the School

Study of special problems in advanced civil engineering case studies by using advanced approaches to solve the problems or experiments.

430712 Special Problems in Advanced Civil Engineering II 4 (4-0-12)

Condition: Consent of the School

Study of special problems in advanced civil engineering case studies by using advanced approaches to solve the problems or experiments.

430713 Special Problems in Advanced Civil Engineering III 4 (4-0-12)

Condition: Consent of the School

Study of special problems in advanced civil engineering case studies by using advanced approaches to solve the problems or experiments.

430714 Special Problems in Advanced Civil Engineering IV 4 (4-0-12)

Condition: Consent of the School

Study of special problems in advanced civil engineering case studies by using advanced approaches to solve the problems or experiments.

430891 Master Thesis I (20 credits)

Condition: Consent of the School

Original research work leading to the preparation of a master thesis in the fulfillment of the requirement for the master degree. Enrollees are bachelor degree holders.

430892 Master Thesis II (45 credits)

Condition: Consent of the School

Original research work leading to the preparation of a master thesis in the partial fulfillment of the requirement for the master degree.

430893 Doctoral Thesis I (60 credits)

Condition: Consent of the School

Original research work leading to the preparation of a doctoral thesis in the fulfillment of the requirement for the doctoral degree.

430894 Doctoral Thesis II (45 credits)

Condition: Consent of the School

Original research work leading to the preparation of a doctoral thesis in the partial fulfillment of the requirement for the doctoral degree.

430895 Doctoral Thesis III (60 credits)

Prerequisite: Consent of the School

Original research work leading to the preparation of a doctoral thesis in the partial fulfillment of the requirement for the doctoral degree.

18. Curriculum Quality Assurance

1) Program Management

The programs are administered by the Schools with the approval of the Institute. The aim is to create programs which are up-to-date, flexible and relevant to the needs of students, in order that they can apply what they learn to develop themselves and be successful personally and professionally.

2) Teaching and Learning Resources

A wide variety of instructional media, an outstanding teaching staff, the ampus buildings, the financial resources available, the library, the e-learning and the e-training facilities all enhance the learning experience

3) Counseling

Academic advisors, teaching assistants, and special tutorial classes are provided for students .

4) High consumer satisfaction

Graduates' performance is given high evaluation by subsequent employers.

19. Curriculum Revision

The preceding curriculum has been started in the academic year 1999. The revised curriculum is done so as to include new knowledge and advancement. It consists of three fields; namely, structural, geotechnical, and water resources engineering. New courses are added and outdated courses were taken out. The study program consists of core and major courses, electives and thesis. The core courses are common to every field and the major courses are for each field. In this revision, the six-digit course number has been changed from 410XXX to 430XXX according to the new Institute and School codes. The comparison of the revised and preceding curriculums is tabulated as follows.

NO.	Preceding Curriculum	Cr.	Revised Curriculum	Cr.	Note
1	410601 Numerical Method in Engineering	4	430610 Numerical Methods in Engineering	4	Revise the course content
2	410602 Systems Analysis	4	430662 Systems Analysis	4	Revise the course content
3	410603 Statistics for Civil Engineering	4	430611 Statistics for Civil Engineering	4	Revise the course content
4	410604 Advanced Engineering Geology	4	430612 Advanced Engineering Geology	4	Revise the course content
5	410610 Continuum Mechanics	4	430613 Continuum Mechanics	4	Revise the course content
6	410611 Advanced Mechanics of Materials	4	430622 Advanced Mechanics of Materials	4	Modify the course content
7	410612 Theory of Elastic Stability	4	430624 Theory of Elastic Stability	4	Revise the course content
8	410613 Experimental Method in Civil Engineering	4	430632 Experimental Method in Civil Engineering	4	Revise the course content
9	410620 Advanced Theory of Structures	4	430620 Advanced Theory of Structures	4	Modify the course content

10	410621 Advanced Matrix Method for Structures	4	430623 Advanced Matrix Method for Structures	4	Revise the course content
11	410622 Finite Element Method	4	430626 Advanced Finite Element Method	4	Modify the course title and content
12	410623 Reinforced Concrete Structures	4	430628 Reinforced Concrete Structures	4	Revise the course content
13	410624 Steel Structures	4	430631 Steel Structures	4	Revise the course content
14	410625 Advanced Prestressed Concrete	4	430629 Advanced Prestressed Concrete	4	Revise the course content
15	410626 Theory of Plate and Shell	4	430625 Theory of Plates and Shells	4	Modify the course title and content
16	410627 Advanced Concrete Technology	4	430627 Advanced Concrete Technology	4	Modify the course content
17	410628 Timber Structures	4	-		Canceled
18	410629 Masonry Structures	4	430630 Masonry Structures	4	Revise the course content
19	410630 Design of advanced Composite in Civil Engineering Structures	4	430637 Design of Advanced Composite in Civil Engineering Structures	4	Modify the course content
20	410631 Dynamics of Structures	4	430621 Dynamics of Structures	4	Revise the course content
21	410632 Wind Effects on Structures	4	430633 Wind Effects on Structures	4	Revise the course content
22	410633 Earthquake-Resistant Design	4	430634 Earthquake-Resistant Design	4	Revise the course content
23	410634 Structural Control	4	430635 Structural Control	4	Revise the course content
24	410641 Construction Method and Equipment	4	-		Canceled
25	410642 Analytical Construction Management	4	-		Canceled
26	410643 Problem Analysis in Construction Industry	4	-		Canceled
27	410644 Construction Project Administration	4	-		Canceled
28	410650 Theoretical Soil Mechanics	4	430640 Theoretical Soil Mechanics	4	Modify the course content

29	410651 Laboratories, Field Testing , and Instrumentation	4	430643 Laboratory, Field Testing, and Instrumentation in Geotechnical Engineering	4	Modify the course title and content
30	410652 Advanced Foundation Engineering	4	430641 Advanced Foundation Engineering	4	Modify the course content
31	410653 Ground Improvement Techniques	4	430642 Ground Improvement Techniques	4	Modify the course content
32	410654 Soil Dynamics	4	430644 Soil Dynamics	4	Modify the course content
33	410655 Geomechanics	4	430645 Geomechanics	4	Revise the course content
34	410656 Earth Dam Design	4	430646 Advanced Earth Structures	4	Modify the course title and content
35	410657 Rock Mechanics	4	430647 Rock Mechanics	4	Revise the course content
36	410658 Analytical Method in Geotechnical Engineering	4	430648 Analytical Method in Geotechnical Engineering	4	Modify the course content
37	410660 Water Resource Systems Analysis	4	430664 Water Resources Systems Analysis	4	Revise the course content
38	410661 Modeling of Hydrologic Processes	4	430663 Modeling of Hydrologic Processes	4	Revise the course content
39	410662 Advanced Hydrology	4	430660 Advanced Hydrology	4	Revise the course content
40	410663 Computational Hydraulics	4	430661 Computational Hydraulics	4	Revise the course content
41	410664 River and Floodplain Management	4	430665 River and Floodplain Management	4	Revise the course content
42			430601 Introduction to Finite Element Method	4	New course added
43			430602 Graduate Seminar in Civil Engineering I	1	New course added
44			430603 Graduate Seminar in Civil Engineering II	1	New course added
45			430636 Mechanics of Composite Materials	4	New course added
46			430638 Advanced Analytical Tools in Cement Based Materials	4	New course added
47			430649 Numerical Modeling for Geotechnical Engineering	4	New course added

48			430650 Deep Excavation and Tunneling	4	New course added
49			430651 Unsaturated Soil Mechanics	4	New course added
50			430652 Geostatistics	4	New course added
51			430666 River Engineering	4	New course added
52			430667 Statistical Methods in Hydrology	4	New course added
53			430668 Subsurface Hydrology	4	New course added
54			430680 Contemporary Management for Construction	4	New course added
55			430681 Financial Management for Construction	4	New course added
56			430682 Advanced Project Planning and Controls	4	New course added
57			430683 Legal Concepts and Contract Administration	4	New course added
58			430684 Operation Research Method for Construction	4	New course added
59			430685 Project Management in Construction	4	New course added
60			430686 Economic Decision Analysis in Construction	4	New course added
61			430687 Information Technology for Construction Management	4	New course added