N A T I O N A L   T E C H N I C A L   U N I V E R S I T Y   O F   A T H E N S

SCHOOL OF CIVIL ENGINEERING

CURRICULUM GUIDE

ATHENS

2013-14

SCHOOL OF CIVIL ENGINEERING

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Publisher: G. Karagiozopoulos - N. Ganis

Publishing Unit

National Technical University of Athens

Iroon Polytechneiou 9, 157 80 Greece

τηλ. 210- 7721561, 210-7721562, fax 210-7721011

Cover: A reproduction of the original artistic design of the Civil Engineering School title by the famous Greek artist N. Hadjikyriakos- Ghikas.

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I. BRIEF HISTORY OF N.T.U.A.

The National Technical University of Athens (N.T.U.A.) is the oldest technical university in Greece.

In its initial form, it was founded as the "School of Arts", in the Spring of 1837, almost simultaneously with the modern Greek State, after the liberation of Greece from the Turkish yoke. At that time, it was a technical school, operating on Sundays and holidays, to offer instruction to those desiring to master in building construction.

The first reformation took place in 1840 and the "School of Arts" switched over to daily operation along with the Sundays counterpart. Studies reached the three years, were enriched with new disciplines and the administration was taken over by the Committee for the Encouragement of National Industry.

A second major change occurred in 1863 with the introduction of theoretical and applied education for managers and technicians in building construction, metals industry, sculpture, painting, ceramics, tanning, soap manufacturing etc. in 1872 the School was transferred from Pireos Street to the Patission Street Complex.

In 1887, the School was promoted to a higher education establishment for Building Construction Engineers, Architects and Mechanical Engineers and its title became "School of Industrial Arts".

In 1914, the establishment was given the official title of "Ethnicon Metsovion Polytechnion". "Ethnicon" means "National" and "Metsovion" was introduced in the title to honour the establishment's great donors and benefactors Nikolaos Stournaris, Eleni Tositsa, Michail Tositsas and Georgios Averof, all from Metsovo, a small town in the region of Epirus. The same title is still in use in Greece but, abroad, the title "National Technical University of Athens" is used instead in order to avoid possible misconceptions regarding the Institution's academic status. The last radical reformation in the organization and administration of N.T.U.A. took place in 1917, when a special bill gave N.T.U.A. a new structure and established the Schools of Civil, Architecture, Surveying, Mechanical & Electrical and Chemical Engineering.

Today, N.T.U.A.'s Schools educate 13,000 students and are located –except the School of Architecture– on the Zografou Campus, a spacious (910,000m2) and open green site, 6 km from the centre of Athens. It includes buildings of

260,000m2 with fully equipped lecture theaters, laboratories, libraries, a Central Library, a Computer Centre and a Medical Centre. Also, on the campus are a Hall of Residence, restaurants, stationery and bookshop, a gymnasium and playing fields.

II. N.T.U.A. STRUCTURE AND ADMINISTRATION

The current legal framework for higher education came into effect in 1982. In accordance with this, N.T.U.A. is divided into nine Schools, as follows:

School of Civil Engineering

School of Mechanical Engineering

School of Electrical and Computer Engineering

School of Architecture

School of Chemical Engineering

School of Rural and Surveying Engineering

School of Mining and Metallurgical Engineering

School of Naval Architecture and Marine Engineering

School of Applied Mathematical and Physical Sciences

As prescribed by law, each School is administrated by a General Assembly consisting of the representatives of Teaching and Research Personnel (TRP: Professors, Associate Professors, Assistant Professors and Lecturers), the representatives of the Scientific and Teaching Personnel (STP: Assistants and Research Associates), the representatives of the Administrative and Technical Personnel (ATP) and representatives of the Students. Certain matters of minor importance are handled by an Executive Board.

A special Electorate elects a professor or an associate professor as President of the School and another member of the same rank as Deputy President.

Each School is subdivided into Departments covering scientific areas. Departments are also administered by General Assemblies, which are similar to the School's Assembly. The Head of a Department, called Director, is elected amongst the members of the General Assembly.

Finally, there may be further subdivisions, in the shape of laboratories, which deal with specific scientific topics. Each laboratory is headed either by a professor or by an associate professor or even by an assistant professor but administratively it belongs to a Department or directly to the School.

N.T.U.A.'s general administration is effected by the Senate, which consists of the Presidents of the Schools, one TRP member from each School, representatives of

STP, representatives of the Special Research Personnel (SRP), representatives of ATP, the administration staff and the representatives of the students. The Senate is headed by the Rector and two Vice-Rectors, who are professors or associate professors elected by a special electorate comprising all N.T.U.A. staff and students.

III. THE SCHOOL OF CIVIL ENGINEERING

1. A SHORT HISTORY OF THE SCHOOL OF CIVIL ENGINEERING

The School of Civil Engineering was established in 1887, as one of the three "Schools of Industrial Arts", within the reorganization of the existing school as an Institution of Higher Education, with a four-year curriculum. The first 13 civil engineers graduated in 1890. In 1914 a new reorganization was performed and the institution was renamed as "Ethnikon Metsovion Polytechneion". In 1977 a major reorganization of the courses took place, while three cycles of studies were developed: Structural Engineering, Hydraulic Engineering and Transportation Engineering. Following the 1982 radical reform, by Law 1268/82, NTUA was divided into nine Faculties (Departments). Recently, the Faculty of Civil Engineering was renamed to School, thus retrieving its historical appellation, whereas a fourth cycle of study was established, Geotechnical Engineering.

1.1. Early period (1887-1890)

The Faculty of Civil Engineering was established by Law AFMA of May 27, 1887, as one of the three "Schools of Industrial Arts". The "School of Arts" already existed since in 1873, located at a building on Patission Street, under the name "Metsovion Polytechneion".

The 1887 Law on "the establishment of the School of Industrial Arts in Athens" was the result of many years of effort by the professors of that time, who assisted in the re-organization of the existing school as an Institution of Higher Education with a four-year curriculum.

The organization and operation of the School were specified in the Bylaw of July 3, 1887. The first article of the Bylaw includes the definition: "The School of Industrial Arts, now consisting of three specialized schools, has as its goal the scientific education of civil and mechanical engineers, similar to those graduating from Higher Schools in Europe, as well as the education of surveyors and foremen".

The first 13 civil engineers graduated in 1890. The School operated under this organization until 1914.

1.2. Reorganization of the School (1890-1917)

In 1912, Angelos Ghinis, Head of the School of Civil Engineering, published a history of the Polytechneion, which included a proposal to the State about the development of the school and the prospects of engineering education in the country, in line with the developments of technology and the expectations for the future.

Two years of effort produced Law 388 of November 1914. According to the first article of this Law the Polytechneion was renamed as "Ethnikon Metsovion Polytechneion". The second article of this Law, declared the already operating School of Civil Engineering as a school of university level education.

The efforts of Angelos Ghinis and his colleagues resulted in the reorganization of the courses, the issuing of Working Rules and the autonomy of the School in certain sectors. All these changes were made official by the Bylaw 388 of November 1915.

After 1915, the School of Civil Engineering functioned as a school with a five year curriculum. Further efforts led to Law 980 in 1917.

1.3. Establishment of the Higher School of Civil Engineering (1917-1977)

From the time of its establishment, the School of Civil Engineering had the largest number of professors and students. For a long period, it was the main student body of the Polytechneion. The growth of other departments closed the gap to some extent but the development of the school was still remarkable.

From 1935 onwards the "Ethnikon Metsovion Polytechneion" was known in English as the National Technical University of Athens (NTUA).

1.4. Integrated development (1977-1982)

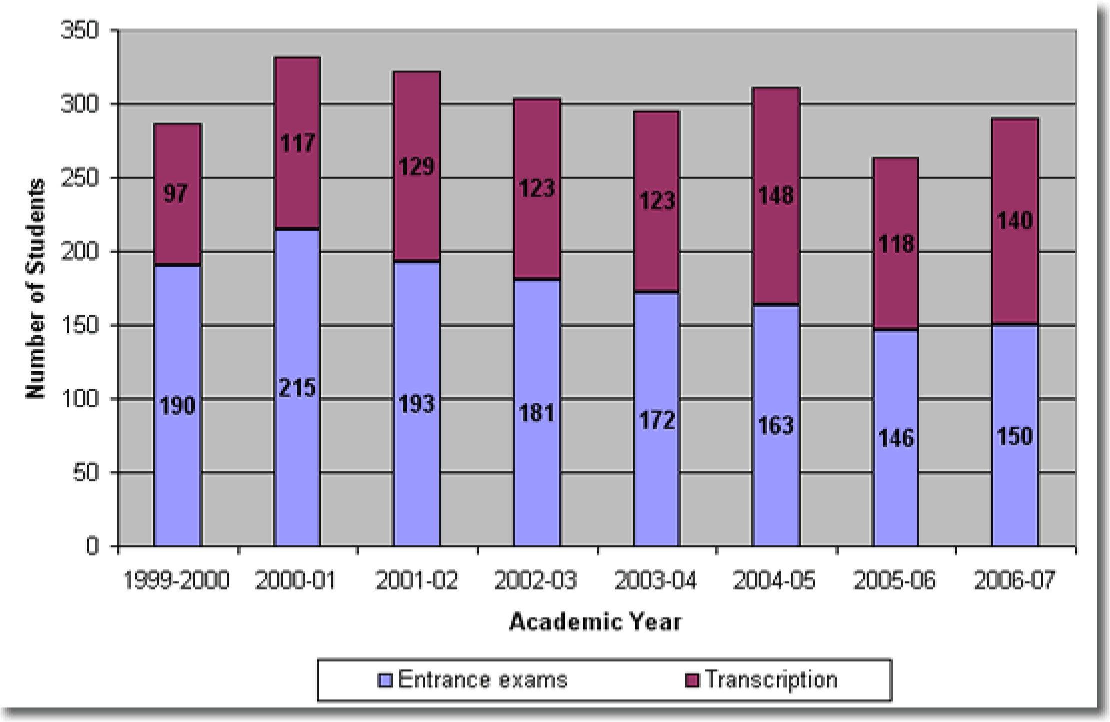
In 1977 a major reorganization of the courses took place. Three cycles of studies were developed: Structural Engineering, Hydraulic Engineering and Transportation Engineering. The courses were also separated into basic courses, mandatory (for students in all three cycles), elective courses, and non-credit (optional) courses.

1.5. Recent period (1982 and after)

Following the last radical reform, by Law 1268/1982, NTUA was divided into nine Faculties (Departments). Eight of these award diplomas as follows:

- Civil Engineering
- Mechanical Engineering
- Electrical and Computer Engineering
- Architecture
- Chemical Engineering
- Rural and Surveying Engineering
- Mining and Metallurgical Engineering
- Naval Architecture and Marine Engineering

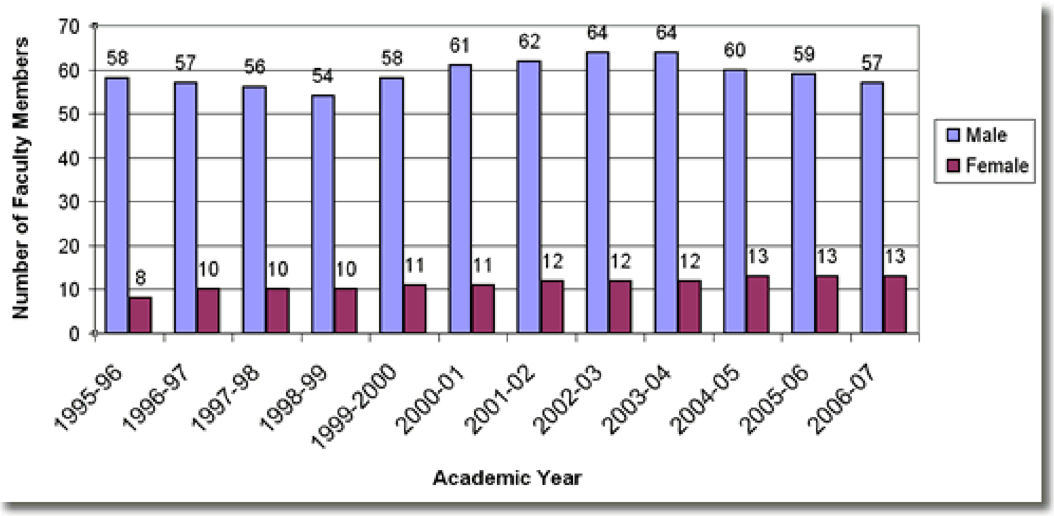
The ninth one, the Department of General Sciences, provided foundation courses to support the curriculum of the other Departments. From 1999-2000, all Departments were renamed to Schools, whereas the General Department was reformed to independent School with five-year curriculum, the School of applied Mathematics and Physical Sciences. The same year, the School of Civil Engineering established two Interdisciplinary Postgraduate Program Studies, in collaboration with other Schools of NTUA. From 2005-06 a fourth cycle of study was added to the undergraduate program course, Geotechnical Engineering.



Student Body of the School of Civil Engineering

2. SCHOOL STRUCTURE

Dean:	**I. Golias, Professor**
Secretary:	**A. Papailiou**
Emeritus Professors:	K. Abakoumkin A.G. Anagnostopoulos A. Armenakas H. Efremidis J.M. Frantzeskakis P. Karydis J.T. Katsikadelis A. Kounadis T.P. Tassios T. Xanthopoulos A. Yiotis



Faculty Members of the School of Civil Engineering

2.1. Department of Structural Engineering

Director:	**E. Vintzilaiou, Professor**
Professors:	I. Vayas
	E. Vintzilaiou
	C. Gantes
	V. Koumousis
	M. Papadrakakis
	E. Sapountzakis

Associate Professors:	I. Psycharis I. Raftoyiannis K. Spiliopoulos I. Tzouvadakis
Assistant Professors:	N. Lagaros C. Mouzakis M. Nerantzaki Viss. Papadopoulos C. Trezos C. Zeris
Lecturers:	T. Avraam E. Badogiannis M. Fragiadakis D. Vamvatsikos E. Vougioukas
Specific Lab & Teaching Staff:	M. Asimakopoulos G. Vlachos X. Lignos G. Mikelis

	A. Stamos
	I. Taflampas
Scient. Associates:	M. Chronopoulos
	S. Glenis
	D. Ilias
	I. Mallis
	I. Sigalas
	E. Toutoudaki

2.2. Department of Water Resources and Environmental Engineering

Director:	**A. Stamou, Professor**
Professors:	A. Andreadakis G. Christodoulou K. Hadjibiros D. Koutsogiannis M. Mimikou K. Moutzouris A. Stamou
Associate Professors:	E. Baltas D.Mamais

Assistant Professors:	D. Dermatas C. Makropoulos N. Mamasis D. Panagoulia P. Papanikolaou V. Tsoukala
Lecturers:	S. Azorakos A. Nanou K. Noutsopoulos I. Stefanakos
Scient. Associates:	T. Katsarelis S. Xatzikomninou
Lab Assistants:	C. Garini P. Margaronis I. Stamataki

2.3. Department of Transportation Planning and Engineering

Director:	**A. Loizos, Professor**
Professors:	J. Golias A. Loizos A. Stathopoulos D. Tsamboulas
Associate Professors:	A. Ballis M. Karlaftis P. Psaraki - Kalouptsidi. G. Yannis
Assistant Professors:	K. Lymperis
Lecturers:	E. Vlahogianni C. Plati A. Kaltsounis
Scient. Associates:	G. Glaros F. Mertzanis
Lab Assistants:	G. Kardamylakis A. Stergiou

2.4. Department of Geotechnical Engineering

Director:	**M. Kavvadas, Associate Professor**
Professors:	G. Gazetas G. Bouckovalas G. Tsiambaos
Associate Professors:	V. Georgiannou M. Kavvadas M.Pantazidou
Lecturers:	N. Gerolimos
Scient. Associates:	A. Kamariotis A. Tzirita
Lab Assistants:	D. Maurokefalou G. Pyrgiotis S. Tsentidis

2.5. Department of Engineering Construction and Management

Director:	**S. Lampropoulos, Associate Professor**
Associate Professors:	S. Lampropoulos J.P. Pantouvakis
Scient. Associates:	D. Kallianis D. Touliatos

3. CURRICULUM PRINCIPLES

a. Organization of courses

The teaching and training of civil engineering students takes place mainly in Zographou Campus, as well as in the Ghini building at 42, Patission Str., Athens.

The Faculty of Civil Engineering operates the following laboratories.

Reinforced Concrete, Steel Structures, Structural Analysis and Aseismic Research, Earthquake Engineering, Earthquake Technology and engineering Seismology, Applied Hydraulics, Harbour Works, Sanitary Engineering, Hydrology and Water Resources, Highway Engineering, Railway Engineering and Transportation, Traffic Engineering, Soil Mechanics, Foundation Engineering, General and Specialized Mechanical Engineering.

Construction of a Civil Engineering Building is under planning on the Zographou Campus. This will provide faculty and students with lecture halls, laboratories and offices. The number of registered students at the Faculty of Civil Engineering for the Academic Year is 1896.

The first and second year courses are taught mainly by staff of the School of Applied Mathematical and Physical Sciences.

Main decisions of the School are taken by board meetings of the School of Civil Engineering. The Secretariat deals with educational and managerial issues.

b. Theoretical and experimental courses

The educational procedures of the Faculty of Civil Engineering require attendance of lectures and tutorials in the lecture halls, and experimental work in the laboratories, as well as student – teacher discussions.

Textbooks and/or lecture notes are distributed to the students at the beginning of the semester. Students, along with traditional study, train themselves by solving computer-based problems, by laboratory experiments and measurements, by surveying, and by data processing and evaluation at home. There are also educational visits to engineering projects under construction or in operation in Greece or abroad, and these visits usually last several days.

The educational process also includes video presentations of engineering projects, as well as lectures by invited speakers on engineering aspects of current works.

The extended knowledge required by the profession of the civil engineer means that the curriculum courses constantly need to be updated. Specialization is feasible due to the large number of elective and non-credit courses offered to the students.

c. Mandatory, elective and non-credit (optional) courses

Mandatory courses: These are basic courses considered necessary for the students to acquire basic knowledge and in order to prepare themselves adequately for the courses of one of the four specialization cycles. Attendance is mandatory for all students of the School of Civil Engineering.

Elective Courses: These are specialized courses which introduce the students to their chosen field or specialization. The student may choose from different groups, thus acquiring the knowledge necessary for more specialized courses.

Non-Credit (optional) courses: These include courses in foreign languages. The students register and attend at least one language course.

The four foreign languages taught are English, French, German and Italian. Students who already have an officially recognized certificate of competence in one of these languages, need not register to a language course.

d. Teaching hours, courses and examinations

The curriculum provides for a five–year period of studies at the School of Civil Engineering. Each year is divided into two semesters, Winter (September to January) and Spring (February to June). Nine of the ten semesters are allocated to attending courses, while the tenth semester is allocated to preparing and defending the degree thesis.

In the first few semesters, the student attends the theoretical courses on which the engineering courses in the later semesters are based. These courses are indispensable university level courses which enable the students to understand, also, the methodologies, procedures and equipment used in civil engineering research.

During the first six semesters, students are taught all the basic courses required for the civil engineering background. From the seventh semester onwards the students register to courses which belong to one of the four cycles.
At the moment, the four cycles of specialization are Structural Engineering, Hydraulic Engineering, Transportation Engineering and Geotechnical Engineering.

The cycles of specialization comprise about 15% of the courses required for the civil engineering diploma. All the students who have taken the basic courses and the specialization courses of one cycle are awarded the diploma of Civil Engineer. The same diploma is awarded to all four cycles. The professional status of the graduate is the status of civil engineer, no matter which specialization cycle he/she attended as a student.

4. DIPLOMA THESIS

a. Diploma Thesis and the Assignment Process.

- The Diploma Thesis has the content and the minimal duration (one complete academic semester, the 10th) of a high level assignment. With the Diploma Thesis the specialization, provided by the courses in the last semesters of the Studies, is completed.

- The Diploma Thesis is prepared by the final semester students in a Department and cognitive object of their choice, under the supervision of a School member of the chosen Department, who teaches the most relevant course, with the potential restriction of Section iv. The choice of the Department and the Diploma Thesis subject is made after the student applies to the Secretariat of the School, according to the academic calendar of the School. The determination of the Diploma Thesis subject and the Sector is done:

i. By selecting from a list of specific Diploma Thesis subjects that each School member announces at the beginning of each academic semester.

ii. With direct agreement between the student and the School member.

iii. After a proposal by the student, provided that a School member accepts it.

iv. By an application of the student to the School.

- Following the definition of the Diploma Thesis subject, the supervisor informs the Head of the Department, who keeps a record of the Diploma theses in the Department, and the Secretariat of the School, so that the applications are forwarded to the Board of Directors for the final approval and distribution of the Diploma Theses.

- Each School member has the right and obligation of supervising Diploma Theses, in the field of the courses they teach or in relevant scientific fields.

- In order to ensure the effective supervision and the balanced distribution of educational work among the School members, each School can define, according to the Sectors advice, a low and upper limit of Diploma Theses supervised simultaneously by a School member.

- Since one of the main objectives is the enhancement of student initiative, the Diploma Thesis development is done by each student individually. If required by the nature of the thesis subject, and after the appropriate justification, a team of students can realize the Diploma Thesis provided that each student's individual contribution to the work development and to the thesis presentation is distinct. The extent of the Diploma Thesis should be the appropriate, so that its completion is feasible in one academic semester of full time work, even though the real completion time depends on the student's ability to fulfill the thesis requirements and his commitment.

b. Diploma Thesis development, submission and examination.

- The Diploma Thesis is developed under the student's responsibility, with the continuous monitoring and help of the supervisor. The Sector is responsible for the unhindered development and presentation of the Diploma Thesis, using the means it allocates and, if it is needed, in collaboration with the Institution's printing facility. Before each examination period, the supervisor fills out the relevant printed form certifying the initial acceptance of the Diploma Thesis that he/she supervises. After the initial acceptance of the Diploma Thesis, the additional expenses of the student until the final presentation are covered by the Departments or the Schools that are eligible for credit with the corresponding sums of functional expenses, supplies, etc. The eligible Departments or Schools are credited from the State's Budget, after their application, at the beginning of the academic year with an upper limit determined by the Senate.
- The final version of the Diploma thesis is submitted according to the academic calendar and in time, i.e. at least ten (10) working days before the defined examination day. The Diploma Thesis is submitted to the Department Administration, initially in three copies that are forwarded immediately to the three members of the examination committee. The finally approved copy remains in the possession of the supervisor, while two more copies are obligatorily submitted to the School library and the Central Library and are available for lending.
- The Diploma thesis presentation text is composed using a text processor and an approved template by the School General Assembly and it should include the following:

v. Synopsis (1.200 to 2.000 words) and Summary (300 to 500 words) in Greek and a foreign language (preferably English).

vi. Table of contents.

vii. References.

- The presentation is given by the student orally and in public, on dates set in the academic calendar of the School and according to the program defined by the School Secretariat. Each presentation should be minimum forty five (45-60) minutes long.

- The examination and marking of the Diploma thesis is performed by a three-member School Committee, proposed by the Department General Assembly and approved by the School's General Assembly or the Board of the School, in case it is authorized. The committee consists of the supervisor, a possible common member and a member with relevant specialization. In case a Diploma thesis is assigned to a student from a different School, the third member of the examining committee should be from the most relevant Sector of that School.

- If a student does not pass the Diploma Thesis oral examinations, he/she can repeat the examination in the next period, after submitting an application. If he fails again, he applies for a new subject in the same or different scientific field, in order to be examined in another period.

c. Evaluation criteria of Diploma Theses.

- The main evaluation criteria are the following:

Updating of the existing knowledge level with the corresponding literature research.

viii. Acquisition of special data (data from lab experiments or field data or theoretical results).

ix. Logical process (e.g. process of assembled data, definition of mathematic models, trials in computers, applications in concrete problems, evaluation of results).

x. Structure and the written presentation of the Diploma thesis, e.g. the continuity of text, the right use of terminology and language, the precise formulation of concepts, the adequate documentation of scientific conclusions, etc.

xi. Originality.

xii. Student's eagerness and initiatives.

xiii. Thesis oral presentation.

- The weighting factors of the above criteria depend on the nature of the thesis subject, and they are in the judgment of the examining committee. For the thesis final degree synthesis it is recommended to use special printed forms. The Thesis final grade is the mean value of the three examiners grades, rounded to the nearest integer or half integer. The lower grade, for successful examination, is 5.5. (Scale is 0-10).

From the five years Course Programme of the School and the Diploma Thesis of the fifth year, it can clearly be concluded that the Diploma offered to the students by N.T.U.A. is substantially equivalent to the Master's Degree of acknowledged Anglo –Saxon universities.

5. COURSES AND DIPLOMA THESIS MARKING SCHEMES

Marking in all courses is done by the 0-10 scale, without using fractions of an integer, and using as a basis for passing the mark 5. Diploma Thesis marking is an exception, since it is allowed to use half a mark (0.5) and the basis for passing is the mark 5.5. The overall mark for the diploma is calculated by summing the following:

the arithmetic average of all course marks taken by the student during his studies, with a weighted coefficient of four fifths (4/5), and

the thesis mark, with a weighted average of one fifth (1/5).

Excellent 9 to 10

Very Good 7 to 8,99

Good 5,5 to 6,99

Satisfactory 5 to 5,49

Bad below 5

6. Co-operation with ENPC

The School signed in 2003 an educational agreement with École Nationale des Ponts et Chaussées (ENPC) of Paris, France, whereby students of both establishments can follow a part of the curriculum of the other and attain a "double diploma". Thus students from NTUA fulfilling stringent performance criteria can obtain, after attending ENPC during their two last years of studies, a diploma awarded by both NTUA and ENPC. A few students have already exploited this excellent opportunity.

7. COURSE PROGRAM

7.1. 1st Semester

Courses	Hours
I. Mandatory	
• Mathematical Analysis I	4
• Linear Algebra	3
• Descriptive Geometry	5
• Technical Drawing	4
• Geology for Engineers	4
• Engineering Mechanics I (Statics)	4
Total	24

II. Electives (mandatory the choice of one)	
• English Language	2
• French Language and Technical Terminology	2
• German Language	2
• Italian Language	2
•	

7.2. 2nd Semester

Courses	Hours
I. Mandatory	
• Mathematical Analysis II	4
• Engineering Mechanics II (Mechanics of Deformable Solids)	3
• Computer Programming	4
• Building materials	4
• General Building Technology	3
• Principles Of Ecology And Environmental Chemistry	3
Total	21

II. Electives (mandatory the choice of one)	
• Applied Economics	3
• Elements on Philosophy and Cognition Theory	3
Total	24

III. Electives (mandatory the choice of one)	
• English Language	2
• French Language and Technical Terminology	2
• German Language	2
• Italian Language	2

IV. Elective	
• Computer Aided Design of Civil Engineering Projects	3

7.3. 3rd Semester

Courses	Hours
I. Mandatory	
• Differential Equations	4
• Numerical Analysis	4
• Strength of Materials	2
• Engineering Mechanics III (Dynamics)	3
• Topics on Architecture	3
• Geodesy	3
• Physics	4
Total	23

II. Electives (mandatory the choice of one)	
• Introduction to Energy Technology	3
• Introduction to the Production of Construction Projects	3
• Town and Regional Planning	3
Total	26

III. Electives (mandatory the choice of one)	
• English Language	2
• French Language and Technical Terminology	2
• German Language	2
• Italian Language	2

7.4. 4th Semester

Courses	Hours
I. Mandatory	
• Probability-Statistics	4
• Construction Equipment and Methods	4
• Surveying Applications	3
• Structural Analysis I	5
• Partial Differential Equations and Functions of a Complex Variable	4
• Fluid Mechanics	5
Total	25

II. Electives (mandatory the choice of one)	
• Continuum Mechanics	3
• Experimental Strength of Materials	4
Total	28 or 29

III. Electives (mandatory the choice of one)	
• English Language	2
• French Language and Technical Terminology	2
• German Language	2
• Italian Language	2

7.5. 5th Semester

Courses	Hours
I. Mandatory	
• Soil Mechanics I	4
• Structural Analysis II	5
• Engineering Hydrology	5
• Highway Engineering I	4
• Applied Hydraulics	4
• Environmental Engineering	4
Total	26

II. Electives (mandatory the choice of one)	
• Advanced Numerical Analysis	3
• Computer Applications in Civil Engineering	3
• Introduction in Systems Optimization	3
Total	29

7.6. 6th Semester

Courses	Hours
I. Mandatory	
• Engineering Geology	3
• Soil Mechanics II	4
• Introduction to Reinforced Concrete	4
• Structural Analysis III	4
• Highway Engineering II	4
• Urban Hydraulic Works	4
• Transportation Systems Planning	3
Total	26

7.7. 7th Semester

Courses	Hours
Mandatory	
• Reinforced Concrete	5
• Steel Structures I	5
• Maritime Hydraulics and Harbour Engineering	4
• Foundations	5
• Construction Management	4
Total	23

Structural engineering cycle	
I. Mandatory	
• Structural Analysis IV	4
II. Electives (mandatory the choice of one)	
• Special Topics in Building Technology	3
• Architectural Building Design	3
Total	30

Hydraulic engineering cycle	
I. Mandatory	
• Open Channel and River Hydraulics	4
• Earthquake Resistant Structures	4
Total	31

Transportation engineering cycle	
I. Mandatory	
• Earthquake Resistant Structures	4
• Traffic Flow	4
Total	31

Geotechnical engineering cycle

I. Mandatory	
• Experimental Soil Mechanics	4
II. Electives (mandatory the choice of one)	
• Structural Analysis IV	4
• Open Channel and River Hydraulics	4
• Traffic Flow	4
Total	31

7.8. 8^{th} Semester

7.8.1. Structural engineering cycle

Courses	Hours
Mandatory	
• Reinforced Concrete Structures	5
• Steel Structures II	5
• Elements of Law and Technical Legislation	2
• Structural Analysis V	4
• Earthquake Engineering 1	4
Total	20

Group A	
Electives (mandatory the choice of one)	
• Introduction to Bridge Construction	4
• Steel Structures III	3
• Selected Topics in Foundation Engineering	4
• Computational Hydraulics	4
• Timber Structures	4
• Soil-Structure Interaction	4
• Composite Materials	3
Total	23-24

Group B	
Electives (mandatory the choice of one)	
• Finite Element Analysis of Structures	4
• Advanced Mechanics of Materials	3
Total	26-28

Elective	
• Environment and Development	3

7.8.2. Hydraulic engineering cycle

Courses	Hours
Mandatory	
• Reinforced Concrete Structures	5
• Elements of Law and Technical Legislation	2
• Steel Structures II	5
• Groundwater Flow	4
• Coastal Engineering	3
• Sanitary Engineering	4
Total	23

Group A	
Electives (mandatory the choice of one)	
• Introduction to Bridge Construction	4
• Pavements	4
• Urban Road Networks	4
• Selected Topics in Foundation Engineering	4
• Timber Structures	4
• Finite Elements	4
• Hydroelectric Projects	4
• Computational Hydraulics	4
Total	27

Elective	
• Environment and Development	3

7.8.3. Transportation engineering cycle

Courses	Hours
Mandatory	
• Reinforced Concrete Structures	5
• Steel Structures II	5
• Elements of Law and Technical Legislation	2
• Pavements	4
• Railway Engineering	4
• Urban Road Networks	4
Total	24

Group A	
Electives (mandatory the choice of one)	
• Introduction to Bridge Construction	4
• Steel Structures III	3
• Special Chapters on Urban Planning	4
• Selected Topics in Foundation Engineering	4
• Timber Structures	4
• Finite Elements	4
• Computational Hydraulics	4
Total	27-28

Elective	
• Environment and Development	3

7.8.4. Geotechnical engineering cycle

Courses	Hours
Mandatory	
• Reinforced Concrete Structures	5
• Earthquake Engineering 1	4
• Steel Structures II	5
• Elements of Law and Technical Legislation	2
Total	16

Group A	
Electives (mandatory the choice of two)	
• Structural Analysis V	4
• Selected Topics in Foundation Engineering	4
• Soil-Structure Interaction	4
Total	24
Group B	
Electives (mandatory the choice of one)	
• Introduction to Bridge Construction	4
• Pavements	4
• Finite Element Analysis of Structures	4
• Timber Structures	4
• Groundwater Flow	4
• Coastal Engineering	3
Total	27-28

Elective	
• Environment and Development	3

7.9. 9th Semester

7.9.1. Structural engineering cycle

Courses	Hours
Mandatory	
• Special Topics on Static and Dynamic Structural Analysis	5
• Prestressed Concrete	4
• Earthquake Engineering 2	4
• Steel Bridges	4
Total	17

Group A	
Electives (mandatory the choice of one)	
• Rock Mechanics-Tunnels	4
• Soil Dynamics	4
• Quality Control and Quality Assurance	3
• Construction Management – Special Subjects	3
• Environmental Geotechnics	4
• Environmental Impacts	3
• Experimental Soil Mechanics	3
Total	20-21

Group B	
Electives (mandatory the choice of three)	
• Boundary Elements	4
• Nonlinear Behavior of Steel Structures	4
• Technical Seismology	4
• Special Topics of Finite Element Analysis of Structures	4
• Theory of Disks and Shells	4
• Composite Structures	4

• Modern Design Methods for Reinforced Concrete Structures	4
• Mechanics of Masonry	4
• Theory of Plates	4
• Light Metal Structures	4
• Special Topics in Reinforced Concrete	4
• Practical exercise	4
Total	32-33

7.9.2. Hydraulic engineering cycle

Courses	**Hours**
Mandatory	
• Water Resources Systems Technology	4
Total	4

Group A	
Electives (mandatory the choice of three-five)	
• Irrigation Engineering	4
• Experimental Hydraulics	4
• Hydraulic Structures – Dams	4
• Special Topics in Port Engineering	3
• Off-shore Structures	3
• Environmental Fluid Mechanics	4
• Wastewater Treatment and Disposal	4
• Stochastic Methods in Water Resources	4
• Practical exercise	4
Total	14-24

Group B	
Electives (mandatory the choice of three-one)	
• Traffic Flow	4
• Combined Transport - Specialized Systems	4
• Traffic Management and Road Safety	4
• Experimental Soil Mechanics	4
• Rock Mechanics-Tunnels	4
• Environmental Geotechnics	4
• Soil Dynamics	4
• Structural Analysis IV	4
• Prestressed Concrete	4
• Quality Control and Quality Assurance	3
• Construction Management – Special Subjects	3
• Environmental Impacts	3
Total	23-28

7.9.3. Transportation engineering cycle

Courses	Hours
Mandatory	
• Combined Transport - Specialized Systems	4
• Airport planning	3
• Special Topics in Highway Engineering	4
• Traffic Management and Road Safety	4
• Mass Transport Network Operations	4
• Road and Airfield Pavements	3
Total	22

Group A	
Electives (mandatory the choice of one)	
• Rock Mechanics-Tunnels	4
• Soil Dynamics	4
• Quality Control and Quality Assurance	3

• Construction Management – Special Subjects	3
• Environmental Geotechnics	4
• Experimental Soil Mechanics	4
• Prestressed Concrete	4
• Environmental Impacts	3
Total	25-26

Group B	
Electives (mandatory the choice of one)	
• Advanced Topics on Highway Design	4
• Special Topics in Traffic Engineering	4
• Pavements - Special Topics	4
• Evaluation and Impacts of Transport Infrastructure Projects	4
• Safety and Maintenance of Railway Track	4
• Quantitative Methods in Transportation	4
• Practical exercise	4
Total	29-30

7.9.4. Geotechnical engineering cycle

Courses	**Hours**
Group A	
Electives (mandatory the choice of five)	
• Rock Mechanics-Tunnels	4
• Environmental Geotechnics	4
• Soil Dynamics	4
• Computational Geotechnics	4
• Hydraulic Structures – Dams	4
• Prestressed Concrete	4
• Mass Transport Network Operations	4
• Practical exercise	4
Total	19-20

Group B	
Electives (mandatory the choice of two)	
• Special Topics in Reinforced Concrete	4
• Special Topics in Port Engineering	3
• Earthquake Engineering 2	4
• Composite Structures	4
• Mechanics of Masonry	4
• Pavements - Special Topics	4
• Safety and Maintenance of Railway Track	4
• Modern Design Methods for Reinforced Concrete Structures	4
• Experimental Hydraulics	4
• Construction Management – Special Subjects	3
• Special Topics on Static and Dynamic Structural Analysis	5
Total	25-29

8. COURSES AVAILABLE AT THE SCHOOL OF CIVIL ENGINEERING

8.1. 1st Semester

8.1.1. MATHEMATICAL ANALYSIS I

Real numbers, Supremum and Infimum of a set. Sequences of real numbers, the concept of the limit of a sequence, convergence tests. Series of real numbers, convergence tests. Functions of real numbers, trigonometrical and hyperbolic functions. The concepts of the limit and continuiy of a real function, fundamental results. Derivatives of real functions, fundamental theorems, Taylor's formula. Power series. Taylor and Maclaurin series. The Riemann integral of a real-valued function, tests of integrability, properties of the Riemann integral, fundamental results. Basic integration techniques. Applications. Generalized integrals, convergence tests. Applications.

I.Tsinias, Professor
G. Smyrlis, Assistant Professor

8.1.2. GEOLOGY FOR ENGINEERS

Introduction. Applications of geology in Civil Engineering. The materials of Earth. Minerals. Igneous, sedimentary and metamorphic rocks. Properties, engineering behaviour of rocks for engineering works. Elements of mechanical behaviour of geological materials. Soils, rocks and rock-masses. Industrial minerals and rocks. Building stones and construction materials. Geodynamics. Earthquakes, global tectonism and lithospheric plates, deformations of Earth crust. Geomorphology, weathering and erosion, soil formation. Subsidence and landslides. Underground water, water flow, water-bearing formations and resources. Pollution of water. Principles of geological mapping and evaluation of geological data for the study and construction of engineering works.

G. Tsiambaos, Professor

8.1.3. LINEAR ALGEBRA

Vector calculus, lines and planes in 3-space. The basic surfaces. Matrices, determinants and linear systems. Linear spaces (introduction, linear subspace, linear independence, basis, dimension, sum of subspaces). Linear mappings (basic definitions, the matrix of a linear mapping, the basic geometric transformations, change of basis). Eigenvalues and eigenvectors of linear transformations and matrices (characteristic polynomial, Cayley-Hamilton theorem, matrix diagonalization). Orthogonal and symmetric matrices. Quadratic forms and applications.

S. Lampropoulou, Professor
A. Fellouris, Associate Professor

8.1.4. DESCRIPTIVE GEOMETRY

Relative positions of lines and planes. Parallel lines and planes. Thales Theorem. Angles between lines, orthogonal lines. Distance of a point from a plane, distance between parallel planes. Dihedral angles, perpendicularity of planes. Perpendicular projection of shapes on a plane. Trihedral angles. Polyhedra: definitions, properties and measurements of prism, pyramid, cylinder, cone and sphere. Exercises.

Projective line, plane, space. Cross ratio. Desargues and Pappos Theorems. Projective transformations. Conic sections, properties, constructions. Applications and exercises.

Introduction to Descriptive Geometry. The system of two planes of projection and the system of horizontal projecting plane with elevations: Point, line and plane depictions, crossing and skew lines. Traces of straight lines and planes, intersection of lines and planes. Problem solving methods. Polyhedra: projections. Pyramid and prism intersection by a straight line and a plane. Development of polyhedra. Intersecting a cone, cylinder and sphere by a straight line and a plane. Development of cylinder and cone. Exercises. Applications.

N. Kadianakis, Associate Professor

8.1.5. ENGINEERING MECHANICS I (STATICS)

Principles of statics (concurrent forces in a plane and in space). Force and moment equilibrium (analytical and graphical methods). Distributed force system. The first and second moment of area. (The centroid and the moments of inertia for an area). Load bearing structures (free body, constraints, plane rigid structures, reaction forces). Principle of virtual displacements (kinematical determination of reaction forces). Plane, statically determined trusses (realization and methods of analysis). Statically determined beams (axial and shear forces, bending moments and diagrams M,Q,N). Compound beams and simple isostatic frames (diagrams M,Q,N). Arches (three-hinged arch, parabolic arch). Flexible cables. Stable and unstable equilibrium. Friction (Colomb's friction law).

D. Eftaxiopoulos, Assistant Professor

8.1.6. TECHNICAL DRAWING

Line drawing and letter and number drawing. Theory and practice on presentation of elementary floor plans, sections and side views. Drafting of floor plans, sections, side views, of small buildings with detailed reference to architectural drawing-symbols. General reference to structural principles and basic materials of simple structures. Elementary theoretical tuition on the presentation of reinforced concrete structures with drawings. Complete structural drawings including foundation drawing. Topographic survey of small building. Theory of topographic map and construction of contour lines. Introduction to computer aided design. System requirements. Drafting instruments, CAD software. Representation of object and structures in two and three dimensions.

I. Tzouvadakis, Associate Professor

8.2. 2nd Semester

8.2.1. MATHEMATICAL ANALYSIS II

The Euclidean space Rn. Functions between Euclidean spaces, limit and continuity of functions. Differentiation of vector-valued functions of a single variable, applications in mechanics and differential geometry, polar, cylindrical and spherical coordinates. Differentiable functions, partial and directional derivative, the concept of differential. Vector fields, gradient-divergence-curl. Fundamental theorems of differentiable functions (mean value theorem, Taylor). Inverse function theorem. Implicit function theorems. Functional dependence. Local and conditional extremes. Double and triple integrals: definitions, integrability criteria, properties. Change of variables, applications. Contour integrals: Contour integral of the first and second kind, contour integrals independent of path, Green's Theorem, simply and multiply connected domains of R2 and R3. Elements of surface theory. Surface integrals of the first and second kind. Fundamental theorems of vector analysis (Stokes and Gauss), applications.

I.Tsinias, Professor
A. Fellouris, Associate Professor

8.2.2. PRINCIPLES OF ECOLOGY AND ENVIRONMENTAL CHEMISTRY

Organization at the organism level: categories, chemical reactions, energy flow. Organization at the population level: temporal changes, interactions, mathematical models. Organization at the ecosystem level: energy flow, bio-geochemical cycles, mathematical models. Introduction to aquatic chemistry, physicochemical properties of water, methods of expressing concentration of chemical compounds in water. Stoichiometry of chemical reactions, acid base reactions, oxidation reduction reactions. Buffering capacity of water, carbonate system, solubility of solids and gases in water. Human population and environment. Natural environment, deforestation, soil pollution, environmental impact assessment. Urban environment, indoor air pollution, noise pollution.

General toxic pollutants, ionizing radiation. Water pollution, oxygen depletion, eutrophication. Atmospheric pollution, acid rain, stratospheric ozone depletion, the greenhouse effect. Introduction to pollution control technology. Economic development and the environment.

K. Hadjibiros, Associate Professor
D. Mamais, Associate Professor
D. Dermatas, Assistant Professor
N. Mamasis, Assistant Professor

8.2.3. GENERAL BUILDING TECHNOLOGY

Selection of building materials. Load-bearing reinforced concrete structure. Internal and external masonry, openings. Floors and ceilings. General insulation against heat, water and sound. Waterproofing of exposed ceilings and underground structures. Roofing. Internal and external door and window frames. Staircases.

I. Tzouvadakis, Associate Professor
A. Sotiropoulou , Assistant Professor
E. Vougioukas, Lecturer

8.2.4. APPLIED ECONOMICS

Introduction to microeconomic theory. Supply and demand. Equilibrium – Price formation. Demand theories: consumer behaviour. Theory of absolute utility. Theory of cardinal utility. Theory of production and production cost. Market types: Perfect competition, monopoly, monopolistic competition, oligopoly.

I. Tsolas , Assistant Professor

8.2.5. COMPUTER PROGRAMMING

Introduction to computers and programming. FORTRAN 77/90/95 computer language. Flowcharts and name list. Constants and variables. Input of statements and data into the computer. Simple input and output statements. Input of a complete program into the computer. Files. Arithmetic statements. Transfer instructions. Subscripted variables – matrices. DO loops. Computed GO TO and implied DO LOOP. Subprograms. Library functions. Arithmetic statement functions and function subprograms. More advanced Fortran statements. Practical exercises in the NTUA computer centres. Writing and running computer programs on simple civil engineering applications.

E. Vintzilaiou, Professor

8.2.6. ELEMENTS ON PHILOSOPHY AND COGNITION THEORY

This course aims to render basic concepts and problems of contemporary analytic philosophy - theory of knowledge, familiar to the student. The origin of these concepts (truth, meaning, reference, proof, justification) is traced back to the relevant platonic dialogues and the concepts are further compared in terms of their contribution in building a defense against skepticism." The syllabus extends to some basic themes of the philosophies of Science and Morality.

A. Koutougkos, Professor

8.2.7. COMPUTER AIDED DESIGN OF CIVIL ENGINEERING PROJECTS

Introduction to Computer Aided Design systems. Necessary electronic equipment. Problems which the software is asked to solve. Design algorithms. Programming languages used in the construction of CAD software. Commercial and open source software. Similarities and differences between traditional and electronic means of organization and presentation of studies of technical projects.

Object drafting in two and three dimensions. Generation and printing of drawings of side plans, floor plans, sections, perspective and axonometric projections. Digital scale-models. Use of virtual materials in object presentations. Photorealism. Sun exposure and shading. Virtual reality walk.
Introduction to programming of drawing-objects and to automation of drawing procedures.

I. Tzouvadakis, Associate Professor

8.2.8. BUILDING MATERIALS

Introduction, structure and properties. Standardization, designation and specifications. Inspection and testing, measurement technique. Natural stones: types, deterioration, protection and maintenance. Aggregates: origin, mining, manufacturing, treatment. Classification and properties. Binders: categories and production. Mechanisms of setting and hardening. Mortars: classes and composition, properties and characteristics. Ceramic materials: production, properties. Cement: production, regulations, types, categories. Mechanisms of setting and hardening. Concrete: ingredients, structure, strength, deformation, durability. Metallic materials: production, structure, designation, physical and mechanical properties, corrosion and thermal behavior. Wood: types and products. Mechanical properties, creep. Durability, fire protection measures. Polymers: types, properties, environmental effect.
Laboratory work
Mechanical testing and determination of physical characteristics of the materials Non-destructive testing.

E. Vintzilaiou, Professor
E. Badogiannis, Lecturer
E. Vougioukas, Lecturer

8.2.9. ENGINEERING MECHANICS II (MECHANICS OF DEFORMABLE SOLIDS)

Simple and compound bars (Hooke's law, Poisson's ratio, thermoelastic behavior). Simple indeterminate structures (methods of forces, of displacements). Shear. Plane stress (tensile and shear stresses, principal stresses and directions, Mohr's circle of stresses, differential equilibrium equations) . Plane strain (strain, rotation, principal stresses, Mohr's circle of strains, compatibility relations). Elastic behaviour (3D state of stress, constitutive equations for isotropic materials, simple statically indeterminate problems of discs). Engineering elastic beam bending theory (area moment of inertia, pure bending, simple bending). Simple bending of composite beams. Elastic curve (statically indeterminate beams).

G. Spathis, Professor
Aim. Sideridis, Lecturer

8.3. 3rd Semester

8.3.1. NUMERICAL ANALYSIS

Computer numerical errors. Linear systems: Gauss' elimination method, vector and matrix norms. Linear systems stability, general iterative method, Jacobi, Gauss-Seidel and relaxation methods. Computation of eigenvalues and eigenvectors. Least squares method. Interpolation (Lagrange, Hermite and splines cubic functions). Numerical integration methods: trapezoidal, Simpson and three-eighths rules. Non-linear algebraic equations and systems: bisection and secant methods, general iterative method, the Newton-Raphson method and higher order methods. Differential equations: Taylor, Runge-Kutta and predictor-corrector methods.

E. Tychopoulos, Assistant Professor

8.3.2. GEODESY

- Introduction, object and purpose of surveying.
- Basic concepts (reference surfaces and coordinate systems, measured quantities, maps and topographic plans).
- Planar Cartesian coordinate reference systems, fundamental problems.
- Observations (mean value, standard deviation, law of error propagation).
- Distance measurements (tapes and EDM, measuring methods, calculations, corrections and reductions).
- Angle measurements (optical and digital theodolites, measuring methods, calculations).
- Levelling, types of heights (measuring methods of height differences , instruments, optical and digital levels, calculations).
- Triangulation (basic concepts, definitions) - Sections (intersection, resection).

- Modern surveying instruments – measuring methods (Total Stations, GPS).

Exercises and problems are given on all the above topics.

G. Pantazis, Assistant Professor
G. Georgopoulos, Lecturer
O. Arampatzi, Lecturer
E. Teleioni, Lecturer

8.3.3. DIFFERENTIAL EQUATIONS

Introduction to differential equations (definitions). First order differential equations (separable variables, total differential and Euler multiplier, linear, Bernoulli, homogeneous Riccati, Clairaut, Lagrange, orthogonal trajectories). Qualitative theory of differential equations (general). Higher order linear differential equations (general theory). Linear differential equations with constant coefficients (solution of linear equations, variation of parameter method, method of undetermined coefficients, Euler's differential equations, applications). Laplace transforms (inverse Laplace transforms, Heaviside step function, δ-Dirac impulse function, convolution, applications). Power series solution of differential equations (regular and irregular points, Bessel functions, Legendre polynomials). Systems of differential equations (linear systems, homogeneous and non-homogeneous systems, elimination method, variation of parameters and Euler's method, applications). Boundary value problems (Sturm-Liouville).Stability (concept, autonomous systems, phase space, stability solution of linear systems, linearization method, Ljapunov's method).

I. Polyrakis, Professor
D. Gintidis, Assistant Professor

8.3.4. INTRODUCTION TO ENERGY TECHNOLOGY

- Energy and Power (energy transformation, mechanical energy, electrical, chemical, nuclear, thermal, heat, entropy).
- Sources of energy and uses (input and output of energy, stored energy, production and consumption of energy, energy management, environmental impact).
- Electricity (basic relations, electricity production, power plants, electricity consumption, generation, co-generation of power and heat, energy savings).
- Coal (composition, reserves, production and consumption, transport, emissions and pollutants, advanced technologies, liquid fuels from coal, environmental concerns).
- Oil (production, reserves of crude oil, synthetic crude oil, environmental problems).
- Natural gas (reserves, production and consumption, methane, environmental effects).
- Geothermal energy (geologic structure, heat flow, geothermal reservoirs, installations, domestic heating, heat pumps, power production, environmental effects).
- Nuclear energy (nuclear fission, radiation, nuclear power plants, nuclear wastes, electricity production, nuclear fusion, environmental concerns).
- Hydraulic energy (hydro power, plant operation, turbine types, conventional plants and pump storage, tidal plants, wave energy and sea currents' energy, environmental concerns).
- Wind energy (available wind energy, theoretical and technical available wind potential, small and large wind turbines, selection of wind farm site, environmental concerns).
- Solar energy thermal (radiation, seasonal variation, heating domestic and industrial water, passive heating of buildings, environmental concerns).
- Solar energy photovoltaic (solar cells and systems, semiconductors, materials of semiconductors, arrays of collectors, environmental concerns).

- Biological and chemical energy (biomass and bio-fuels, photosynthesis, industrial conversion of biomass, burning, pyrolysis, fuel from wood, energy from solid, liquid and gas wastes, environmental concerns).
- Energy future (problems and strategic plans, long term energy solutions with nuclear fission and fusion, solar energy and geothermal energy).

N. Mamasis, Assistant Professor
I. Stefanakos, Lecturer

8.3.5. INTRODUCTION TO THE PRODUCTION OF CONSTRUCTION PROJECTS

Categories of engineering projects. Technical, operational and entrepreneurial dimension of projects. "Life-cycle" of projects. The construction sector in the European Union. Harmonization of national legislation. Trans-European Networks and infrastructure programs. National planning and financing of construction projects. Client, Designer, Contractor. Organisational structures. Cost-Benefit Analysis. Categories and stages of designs. Design procurement. Design management. Cost Estimating and Tendering. Structure, content and administration of construction contracts. Operation, maintenance and exploitation of engineering projects. Private Financing of Public Investments. Concessions.

S. Lambropoulos, Associate Professor

8.3.6. TOWN AND REGIONAL PLANNING

Theoretical and practical instruction on the development, operation, organization and planning of towns and districts. Theoretical studies on urban and regional planning and related design procedures. Regulations and application examples. Basic concepts on regional and town planning. Elements on urban and rural planning operations. References. Elements of technical intervention, urban/rural plans and regulatory framework. Overview of related urban/rural problems. Exercises on urban/rural analysis and simple methods for land registration.

S. Antonopoulou, Professor
I. Golias, Professor
A. Sotiropoulou*, Assistant Professor*
I. Tzouvadakis, Associate Professor

8.3.7. TOPICS ON ARCHITECTURE

Introduction to architecture. The human scale, analysis of activities and site equipment. Ergonomic design in architecture. Bioclimatic parameters influencing architectural design. Selection of construction materials. Selection and description of the load-bearing structures. Design of utility networks for buildings. Elements for the development of Architectural studies.

I. Tzouvadakis, Associate Professor
E. Vougioukas, Lecturer

8.3.8. ENGINEERING MECHANICS III (DYNAMICS)

- Kinematics of a particle (curvilinear motion, rectangular, normal-tangential, cylindrical components, coordinate systems).
- Kinematics of a rigid body (translation, rotation about a fixed axis, planar kinematics -mechanisms, rotation about a fixed point, general motion, relative motion).
- Kinetics of a particle (mass, momentum, force, Newton’s low of motion, work and energy).
- Kinetics for a system of particles.
- Kinetics of a rigid body (Euler’s equations, planar kinetics).
- Principle of virtual work.
- Lagrange’s equations, Hamilton’s principle.
- Vibrations

V. Kytopoulos, Assistant Professor

8.3.9. STRENGTH OF MATERIALS

Torsion theory. Shear stresses in bending. Skew bending, bending with axial force. Eccentric loading (the section's core region, inactive area). Shear flow in thin-walled members (shear center). The principle of energy conservation. Energy methods (principle of virtual work, Castigliano's theorems, reciprocal theorems of Betti and Maxwell-Mohr). Buckling. Elastoplastic behaviour of solids (yield criteria of Tresca, Mises and Mohr-Coulomb).

G. Spathis, Professor

8.3.10. PHYSICS

- Free vibrations. Simple harmonic oscillator. Harmonic motion with damping: decaying vibrations, decay of energy, quality factor. Non-periodic motion of mass-spring systems.
- Forced vibrations. Transient and steady states, resonance, power absorption.
- Coupled vibrations. Two or more coordinate vibrations: normal modes and mode coordinates, inertial and elastic coupling of mechanical oscillators, determination of normal mode frequencies, energy of normal modes. Coupled vibrations with arbitrary initial conditions, beats. Forced vibrations of coupled oscillators, resonance frequencies. Periodic array of many coupled mechanical oscillators in one dimension: normal modes and non-dispersive waves in an ideal string of discreet oscillators.
- Mechanical waves in continuous elastic media in one dimension. Wave equation in an elastic string. Transverse and longitudinal waves. Traveling waves: energy propagation, characteristic impedance of elastic media, reflection and transmission of traveling waves at a boundary. Standing waves: normal modes in a continuous elastic medium, Fourier analysis. Wave packets, phase and group velocity, dispersion.
- Mechanical waves in two and three dimensions. Two dimensions: waves in elastic membranes, surface waves in liquids. Three dimensions: acoustic waves.

- Electromagnetic waves. Propagation of optic waves in dielectric media: speed of light, refractive index, polarization, reflection, refraction, fundamental laws of optics, geometrical optics. Coherent optical radiation: interference from coherent sources, diffraction, laser radiation.

K. Raptis, Professor
H. Zouboulis, Associate Professor

8.4. 4^{th} Semester

8.4.1. SURVEYING APPLICATIONS

- Traversing – Types of traverses – Field observations – Traverse adjustment – Coordinates of traverse stations
- Topographic surveys – Methods - Stadia and electronic surveying - Topographic plans and maps
- Sections and Cross sections – Volumes – Volume Computations – Setting out (lines, angles, circular curves)
- Use of Topographic plans and maps.

During the semester students gradually carry out a field survey as a whole.

E. Lamprou, Assistant Professor
G. Georgopoulos, Lecturer
O. Arampatzi, Lecturer
E. Teleioni, Lecturer

8.4.2. CONSTRUCTION EQUIPMENT AND METHODS

Elements of Mechanical Engineering. Construction equipment and methods. Operation analysis and cost of construction activities. Earthmoving (excavators, bulldozers, loaders, trucks, scrapers, graders, compactors). Aggregate production (crushers, mills). Concrete production (batch plant, mixers, trucks). Asphalt works. Bridge construction (cranes, travelers, prefabrication). Tunneling (excavation, jumbo, road-header, full-facer, lining).

S. Lambropoulos, Associate Professor

8.4.3. PARTIAL DIFFERENTIAL EQUATIONS AND FUNCTIONS OF A COMPLEX VARIABLE

- Partial Differential Equations: Trigonometric Fourier Series. Boundary Value Problems and Sturm- Liouville Theory. Basic Theory of Partial Differential Equations. Classification of Second Order PDE. Laplace's Equation. The Dirichlet and Neumann Boundary Value Problems. Separation of Variables in Cartesian and Polar Coordinates. The Poisson Equation. The Heat Equation and the Solution of the Initial-Boudary Value Problem in Cartesian Coordinates. The Wave Equation and the Solution of the Initial-Boudary Value Problem in Cartesian Coordinates. The d' Alembert Solution. The Use of the Fourier Integral Transform for the Solution of Problems for Infinite Domains.
- Functions of a complex variable: Complex Numbers and Complex Functions. Differentiability of Complex Functions. Analytic Functions. Cauchy-Riemann Conditions. Elementary Complex Functions. The Integral of a Complex Function. Cauchy Theorem. Cauchy Integral Formulas. Sequences and Series of Functions. Power Series. Taylor Series, Laurent Series. Calculus of Residues-Applications. Conformal Mapping. Möbius Mapping. Applications in Solving Boundary Value Problems for the Laplace Equation.

K. Kyriaki, Professor
D. Gintidis, Assistant Professor

8.4.4. CONTINUUM MECHANICS

Lagrangian and Eulerian description (material time derivative; applications from hydrodynamics; Reynolds transport theorem; conservation of mass; continuity equation). Elementary traffic flow theory (the method of characteristics, shock waves; Rankine-Hugoniot condition). Conservation of linear and angular momentum (the control volume technique). Waves (surface waves in ideal fluids; tidal waves; non-linear waves; capillary waves). Viscous fluids. (the Navier-Stokes equations; creeping flow of Newtonian fluids, flow in porous media, Darcy's law;

the laminar boundary layer. Energy conservation (the heat equation; one - dimensional heat flow).

Ch. Georgiadis, Professor

8.4.5. FLUID MECHANICS

Introduction. Definitions. Basic properties of fluids. Hydrostatics. Pressure at a point. Hydrostatic pressure. Forces on planar and curved surfaces. Buoyancy. Kinematics. Lagrange and Euler methods. Material derivative. Streamlines, Pathlines. Deformation of a fluid element. Vorticity. Dynamics. Types of forces. Principles of conservation: mass, momentum and energy. Equations of continuity, momentum and energy for a finite control volume. Piezometric and energy line. General differential equations for continuity and motion (Navier-Stokes). Streamfunction and velocity potential. Ideal fluids. Euler equations. Bernoulli equation. Cavitation. Flow separation. Flow through orifices, over sharp-crested weirs and under sluice gates. Real fluids, Reynolds number. Laminar and turbulent flow. Drag and Lift. Couette and Poiseuille flow. Reynolds equations. Turbulent stresses. Dynamic similitude. Types of similarity. Basic dimensionless numbers. Introduction to boundary layer theory. Laboratory experiments.

G. Christodoulou, Professor
P. Papanikolaou, Assistant Professor
A. Nanou, Lecturer

8.4.6. EXPERIMENTAL STRENGTH OF MATERIALS

A.

Reminders from the Mechanics of Deformable Bodies. Elements from the Theory of Elasticity: Stress and strain as tensors, strain energy density.

Fracture and Failure of Materials: The theory of strain energy density (Mises), the theory of maximum shear stress (Tresca), the theory of internal friction (Mohr-Coulomb).

Elements from the Theory of Fracture Mechanics: Stress concentration and stress intensity, Stress fields around geometrical discontinuities. Circular holes. Notches. Cracks. Griffith's theory. Energy considerations. Crack Opening Displacement (COD). The plastic zone around cracks.

Static Loading: Tension, Torsion, Shear, Compression, Buckling, Bending,

Hardness.

The Influence of Time:

Elements from the Theory of Rheology (Creep, Relaxation).

Fatigue.

Impact loading.

B.

The role of the experiment in Strength of Materials: Design and realization of an experiment. Experimental data acquisition, storage and processing. Report writing.

Experimental study on the mechanical behaviour and failure of materials:

1. Tension of metallic materials.
2. Compression and buckling of metals and concrete.
3. Tri-axial loading of concrete.
4. Three and four poing bending of concrete beams.
5. Metal hardness measurements.
6. Torsion of metallic bars.
7. Creep and relaxation.
8. Non-destructive testing using ultrasounds.
9. Impact, fatigue.

10. Fracture due to geometric discontinuities (hole, crack).

V. Kytopoulos, Assistant Professor
V. Kefalas, Assistant Professor
V. Vadalouka, Assistant Professor
G. Bourkas, Lecturer
Aim. Sideridis, Lecturer

8.4.7. PROBABILITY-STATISTICS

The meaning of probability. Axioms of probability. Conditional probability. Independent events. Random variables. Density and cumulative distribution functions. Parameters of distributions. Generating and characteristic functions. Special discrete and continuous distributions. Functions of random variables. Central limit theorem. Random sample and sampling distributions. Estimation of parameters. Point estimation. Interval estimation. Hypothesis testing. Goodness of fit tests. Contingency tables. Simple and multiple linear regressions.

V. Papanikolaou, Professor
D. Fouskakis, Assistant Professor
M. Loulakis, Assistant Professor

8.4.8. STRUCTURAL ANALYSIS I

Introduction to the static analysis of structures. Concepts of a rigid configuration and of a structure. Supports of a structure. Loads. Equations of equilibrium. Statically determinate and indeterminate structures. Evaluation of the degree of statical indeterminacy. Geometrically unstable structures. Resolution of complex statically determinate structures. Small deformation theory. Cross-sectional stresses. Stress resultants' diagrams of simply supported, cantilever and Gerber-type beams. Three-hinged arches. Cable members. Trusses. System-supported beams. Influence lines of simply supported beams, Gerber-type beams, three-hinged arches, trusses. Maximum and minimum stress resultants under different types of live loads. Statically and kinematically admissible systems. The principle of virtual work for bar-type structures. Betti-Maxwell theorem. Unit load theorem. Deformation calculations for statically determinate structures.

V. Koumousis, Professor
K. Spiliopoulos, Associate Professor
Viss. Papadopoulos, Assistant Professor
N. Lagaros, Assistant Professor

8.5. 5th Semester

8.5.1. SOIL MECHANICS I

Introduction, applications of soil mechanics in civil engineering. The nature of soil, types of soil, density, water content,Atterberg limits, subsurface soil investigation. Stresses and strains in soil elements, description of the stress state at a point with the Mohr's circle, total and effective stresses, the "effective stress principle", geostatic stresses and stress changes due to externally applied loads (under plane strain and axisymmetric conditions). Phenomenological and microscopic description of soil deformation mechanisms. The triple role of the fluid phase. Stress-strain relationships under different loading conditions: one-dimensional compression, cylindrical (tri-axial) compression, simple shear, torsion. Shear strength of a soil element, Mohr-Coulomb failure criterion. Undrained loading: excess pore pressure, stress-strain relations under various loading conditions, undrained shear strength of soils.

Laboratory: Demonstration of common soil mechanics tests used to detrermine physical and mechanical properties.

G. Bouckovalas, Professor
M. Kavvadas, Associate Professor
V. Georgiannou, Associate *Professor*

8.5.2. INTRODUCTION IN SYSTEMS OPTIMIZATION

Basic elements of operation research. Selected optimisation procedures for decision making and design of civil engineering projects.

M. Karlaftis, Associate Professor
N. Lagaros, Assistant Professor

8.5.3. COMPUTER APPLICATIONS IN CIVIL ENGINEERING

The use of electronic computers for the solution of problems related to Civil Engineering. Programming languages with particular emphasis on FORTRAN 90. Geometric and algebraic test problems. Integration, least-squares, Fourier series. Solution of linear algebraic systems and eigenvalue problems. Applications to different Civil Engineering disciplines. The Matlab program and its uses, Matlab toolboxes and mathematical libraries, the Matlab programming language, graphics in Matlab and interaction with other programming languages. Various Matlab commands, such as commands for: Simple calculations, complex numbers, matrices, solution of linear systems, polynomials, polynomial roots, graphics in 2D or 3D, histograms, symbolic mathematics, derivatives, integrals, interpolation polynomials, differential equations, functions, solution of non-linear equations, solution of non-linear systems, Taylor polynomials.

E. Papadrakakis, Professor
N. Lagaros, Assistant Professor

8.5.4. APPLIED HYDRAULICS

1. Introduction. Characteristics, types, basic equations and analysis techniques of flows. **2. Distribution of flow velocity near walls.** Equations for turbulent flow. Turbulent stresses. Flow velocity distributions. **3. Theoretical analysis of flow in circular pipes.** Entrance region and uniform flow. Friction losses, friction factor and the Darcy-Weisbach equation. Distribution of flow velocities and shear stresses in laminar and turbulent flow. Effect of rough walls. The Moody chart. **4. Practical problems of flow in pipes.** Types of simple problems. Problems with pumps and turbines. Multiple pipe-systems . Pipes in series and parallel pipes. Complex problems. **5. Flow in non-circular ducts.** Hydraulic radius and diameter. Friction losses. Flow between parallel plates. **6. Introduction to open channel flow.** Characteristics and basic equations for steady flow. **7. Uniform flow. Equations for uniform flow.** The Manning formula. Calculation of normal depth. **8. Critical flow.** Equations of specific energy and force. Calculation of critical depth. Critical flow applications in prismatic rectangular channels. Hydraulic jump. **9. Practical problems of open channel flow.** Simple design problems for unlined and lined channels. Simple problems of gradually varied flow. Classification and analysis of flow profiles.

A. Stamou, Professor
G. Papanikolaou, Assistant Professor
A. Nanou, Lecturer

8.5.5. HIGHWAY ENGINEERING I

Introduction. Planning and design of highways. Basic elements of geometric design. Design speed, operating speed V85, maximum allowable speed. Horizontal alignment, tangents, spiral curve transitions, circular curves. Types of clothoids. Vertical alignment, profile diagram, grades, sag and crest vertical curves. Fitting alignment to topography. Cross sectional elements and cross slope. Methods of attaining superelevation. Superelevation run-off lengths. Illustrative cross sections. Pavement widening on curves. Stopping sight distance. Passing sight distance. Role of sight distances in planning and design of highways. Sight distance on horizontal and vertical curves. Visibility diagrams.

A. Loizos, Professor
A. Kaltsounis, Lecturer

8.5.6. ENVIRONMENTAL ENGINEERING

Transport phenomena in the aquatic environment: advection, molecular and turbulent diffusion, dispersion, related mathematical formulation. Physical, chemical and biochemical processes in the aquatic environment and reactors. Flow and mixing regimes in reactors (batch, continuous flow completely mixed and plug flow). Disposal of liquid wastes in recipients, study of self purification capacity and quantitative assessment of impacts (oxygen depletion in rivers, eutrophication in lakes, toxicity, microbial pollutionof bathing waters). Principles of water and wastewater treatment in compliance with legal requirements and description of related treatment plants. Reuse and utilisation of sewage and sludge with emphasis on agricultural practices. Solid waste management according to the prevention ladder principle: characteristics, valorisation, collection and transportation, recycle, reuse, recovery of materials and energy, landfilling, composting, thermal treatment. Materials and design of landfill liners. Introduction to air and noise pollution due to traffic. Training in experimental methods.

A. Andreadakis, Professor
A. Stathopoulos, Professor
D. Mamais, Associate Professor
M. Pantazidou, Associate Professor
K. Noutsopoulos, Lecturer

8.5.7. ADVANCED NUMERICAL ANALYSIS

- Part A: Hermite and Gauss numerical integration. Hermite interpolation. Orthogonal polynomials. Error estimates. Two-dimensional numerical integration. Complex numerical integration (trapezoidal, Simpson). Various types of numerical integration on triangles.
- Part B: Numerical solution of integral equations using trapezoidal and Simpson's formulae. Solutions of partial differential equations by numerical methods. Finite difference method. Finite elements method. Error estimation and stability. Applications: problems on elasticity, liquid flow, heat propagation, infiltration, wave theory problems.

E. Tychopoulos, Assistant Professor

8.5.8. STRUCTURAL ANALYSIS II

Statically determinate and indeterminate structures - degree of indeterminacy. Compatibility of deformations. Formulation of the force method. Calculation of flexibility coefficients. Temperature variation effects. Settlement of supports. Elastic supports. Applications. Calculation of deformations of statically indeterminate structures. Checking of solutions. Simple space structures. Symmetric structures. Symmetric and anti-symmetric loading. Degree of kinematic indeterminacy of structures, nodal displacements, examining the kinematic indeterminacy. Formulation of the nodal displacement method. Comparison with the force method. Fundamental solutions for fixed-fixed and fixed-simply supported beams. Stiffness coefficients. Applications. Symmetric structures. Structures having skew members. Applications. Cross method with non-translated and translated nodes. Influence lines of statically indeterminate structures. Muller-Breslau principle. Applications on continuous beams and frames.

V. Koumousis, Professor
K. Spiliopoulos, Associate Professor
Viss. Papadopoulos, Assistant Professor
N. Lagaros. Assistant Professor

8.5.9. ENGINEERING HYDROLOGY

Introductory concepts (definitions, historical overview, hydrological cycle, hydrological data, drainage basin). Description, analysis and measurement of hydrological processes (precipitation, water losses, surface and groundwater flows). Probabilistic and statistical methods in technical hydrology (probabilistic description of hydrological processes, risk analysis, standard statistical analysis and forecasting of hydrological variables, statistical investigation of the correlation between hydrological variables, improvement of hydrological datasets). Calculation methods (flood hydrograph, linear basins, unit hydrograph, flood routing, introduction to catchment scale simulation models).

M. Mimikou, Professor
E. Baltas, Associate Professor
N. Mamasis, Assistant Professor
C. Makropoulos, Assistant Professor

8.6. 6th Semester

8.6.1. URBAN HYDRAULIC WORKS

Introduction to water supply. Quality of drinking water. Water demand. Water collection and intake. Case study: the water supply system of major Athens. Aqueducts: general layout, design flows, water transfer by open channels and conduits, special constructions, pumping stations, water tanks. Water distribution networks: design flows, general layout, pressure zones, pressure reducing valves, minimum pressure control. Mathematical modelling of water supply networks: schematisation, computational procedures. Sewer systems: storm, sanitary and combined sewers, general layout, design flows, hydraulic modelling, technology of sewers, wastewater quality issues.

D. Koutsoyiannis, Professor

8.6.2. SOIL MECHANICS II

Application of elastic continuum theory: stresses and strains in soil masses under external loading. Plane-strain and axis-symmetric loading. The St. Venant principle. Horizontal earth pressures under different loading conditions. Rankine and Coulomb methods. Gravity retaining walls. The role of elastic deformations. Retaining structures of the Athens metro stations. Limit equilibrium methods in soil mechanics. Slope stability under drained and undrained conditions. Ultimate load of foundation (bearing capacity). Ground water flow in one dimension. Evolution in time of excess pore water pressures and consolidation of a clay layer due to vertical external loading . Seismic Liquefaction.

G. Gazetas, Professor
V. Georgiannou, Associate Professor
N. Gerolimos, Lecturer

8.6.3. INTRODUCTION TO REINFORCED CONCRETE

- Concrete (Introduction, mix design, production, quality control and application. Concrete technology. Hardened concrete behaviour: cracking, uni-, bi- and tri-axial behaviour; Stress-strain relationships; statistical variability; creep, shrinkage, etc.). Reinforcing steel (mechanical characteristics and technical information). Concrete-steel interaction (bond) and anchorage. Durability of concrete.
- Laboratory work: concreting, consistence tests, compression and direct and indirect tension tests; tensile testing of steel bars. Bond and reinforcement anchorage tests.
- Reinforced concrete (RC). Line structural elements: linear elastic beam; RC beam; serviceability and ultimate limit states; behaviour in bending and shear; effect of axial load. Columns.
- Laboratory work: testing of RC beams with and without stirrups under transverse load with and without the combined action of axial load.
- Introduction to prestressed concrete.

C. Zeris, Assistant Professor
E. Badogiannis, Lecturer
E. Vougioukas, Lecturer

8.6.4. HIGHWAY ENGINEERING II

Highway earthworks. Area of cross sections. Determination of volume of earthworks by appropriate methods. The mass diagram. Calculation of average haul distance and corresponding cost. Freehaul, overhaul and economic haul. Balancing lines. Principles of pavement design and pavement types. Soil classification for highway construction purposes. Elements of flexible pavements. Elements and types of intersections and interchanges. Basic elements of three dimensional highway design. Combinations of horizontal and vertical alignment.

A. Loizos, Professor
A. Kaltsounis, Lecturer

8.6.5. STRUCTURAL ANALYSIS III

The Direct Stiffness Method and its application in the analysis of framed structures. Vectors of nodal forces and nodal displacements of an element. Transformation matrices. Stiffness matrix of a truss element (in two and three-dimensions), of a frame element (in two and three-dimensions), of a grid element, in local and global system of axes. Equivalent nodal forces. Formulation of nodal load, nodal displacement and global stiffness matrices of the structure. Structure support. Inclined supports. Internal releases. Calculation of structure's nodal displacements and elements' nodal forces. Elements of variable cross-section. Rigid offsets. Static condensation. The method of substructures. Computer implementation of the Direct Stiffness Method.

E. Papadrakakis, Professor
E. Sapountzakis, Professor
M. Nerantzaki, Assistant Professor

8.6.6. TRANSPORTATION SYSTEMS PLANNING

Introduction to transportation- activity systems. Land use. Accessibility. Systems characteristics, the 4-step planning process. Transportation demand analysis: aggregate and disaggregate demand, economic aspects. Transporation infrastructure supply analysis: cost models and economic planning. Demand-supply equilibration and network equilibria. Transporation models and simulation methods: regression, choice models and traffic assignment. Travel data collection and analysis methods.

A. Stathopoulos, professor
P. Psaraki – Kalouptsidi, Associate Professor
D. Tsamboulas, Professor
M. Karlaftis, Associate Professor

8.6.7. ENGINEERING GEOLOGY

Introduction. Engineering Geology and Geotechnics. Properties of geological materials. Rocks as discontinuous media: Rock mass. Geotechnical classification of rocks and rockmasses. Site investigation. Geology and foundation of buildings and engineering works. Geology and underground openings and tunnels. Geology and dams-reservoirs. Rock slope stability. Geology and construction materials. Geology of Greece and geological conditions in relation to the study and construction of engineering works. Geology and waste disposal.

G. Tsiambaos, Professor

8.7. 7th Semester

8.7.1. EARTHQUAKE RESISTANT STRUCTURES

- Fundamental concepts of engineering seismology: Cause of earthquakes – Recording of earthquakes – Seismometry – Seismic waves – Accelerograms – Principles of seismic hazard analysis.
- Elastic seismic response of single degree-of-freedom systems: Equation of motion – Response spectrum – Effects of foundation conditions on the seismic response – Torsional response of elastic single-storey systems.
- Inelastic response of single-degree-of-freedom systems: Ductility – Behaviour factor – Design spectrum – Seismic design (force method).
- Seismic response of multi degree-of-freedom systems: Modal spectrum analysis – Simplified lateral force method of analysis – Seismic response of continuous systems.
- Basic issues of Eurocode 8: Seismic loads – Capacity design – Principles for a rational seismic design.
- Demonstration of the dynamic response of model structures.

K. Spyrakos, Professor
I. Psycharis , Associate Professor

8.7.2. CONSTRUCTION MANAGEMENT

Introduction to Construction Management and to the relevant legislative & regulative framework. Books of Knowledge (BOKs) and Project Management Standards. Project Organisation. Planning, Scheduling and Controlling methods. Gantt Charts, S-curves, Matrix Schedules, Horse Blankets, Lines of Balance. Critical Path Analysis (GERT, CPM, MPM, PERT). Project Cost and Financial Planning (Actual vs Contractual Cost, cost estimating, unit rates and operational estimating, cost reporting, invoicing and cost protocols according to the Greek Law), Cost / Time Trade Offs. The use of Floats, Scheduling of Resources with resource / time constraints. Project Control - Schedule control / Financial Control. Product Breakdown Structures (PBS), Work Breakdown Structure (WBS) and Organisational Breakdown Structures (OBS). Construction management software & IT applications, Quality in Construction, Application of ISO 9000 in construction, Health and Safety of Construction Works.

J.P. Pantouvakis, Associate Professor

8.7.3. SPECIAL TOPICS IN BUILDING CONSTRUCTION

- Construction methods of building insulation (Thermal - Moisture - Noise - Insulation)
- Construction of building finishes
- Building construction of doors, windows etc.,
- Construction of building Stairs
- Writing a Technical Report
- Timber and Metal structures, construction methods -Restoration, maintenance and support of traditional structures.
- Advanced construction methods (prefabrication, Space stuctures)

I. Tzouvadakis, Associate Professor
A. Sotiropoulou, Assistant Professor
E. Vougioukas, Lecturer

8.7.4. MARITIME HYDRAULICS AND HARBOUR ENGINEERING

Introduction to sea hydraulics. Waves: generation of wind-waves, wave measurements, real waves and their mathematical representation. Theories of small and finite amplitude waves. Analysis of wave records: description parameters, distribution of wave heights. Seabed influence: shoaling, breaking, refraction. Wall influence: reflection, diffraction. Pressures of standing and breaking wave on vertical wall. Types and roles of ports. Design criteria for harbour works. Vessel characteristics. General layout of harbours. Navigation channels, port entrance, manoeuvring area. Wharves and piers. Design of rubble-mound breakwaters. Walls with vertical face: calculations under standing and breaking wave conditions. Design of quaywalls.

Berth outfits. Planning of back – up area of general cargo area. Sheds and other facilities.

K. Moutzouris, Professor
V. Tsoukala, Assistant Professor
S. Azorakos, Lecturer

8.7.5. FOUNDATIONS

General principles of foundation design. **Shallow foundations:** Bearing capacity of foundations under central, eccentric and inclined loading. Principles of calculation of foundation settlement. Models of the soil reaction, contact pressures, settlements of foundations in cohesive and cohesionless soils, allowable deformations. Design of shallow foundations: spread and combined footings, strip foundations, mat foundations. **Deep foundations:** Construction considerations. Methods of deriving pile capacity for driven and bored piles in cohesive and cohesionless soils.. Settlement of single piles. Axial capacity and settlement of piles in groups. Negative shaft friction, lateral loading of piles. Principles of the foundation design based on Eurocode EC-7.

M. Kavvadas, Associate Professor
V. Georgiannou, Associate Professor

8.7.6. ARCHITECTURAL BUILDING DESIGN

Design of special purpose buildings and environments (office buildings, transport terminals for mass transport carriers, research installations, industrial buildings, warehouses, etc). Analysis of operations, determination of equipment and installations, analysis and development of space design criteria (anthropometric, structural, environmental, financial, etc). Structures and construction respecting the existing environment. Computer assisted analysis of the criteria, in order to achieve optimum design.

I. Tzouvadakis, , Associate Professor
A. Sotiropoulou, Assistant Professor
E. Vougioukas, Lecturer

8.7.7. TRAFFIC FLOW

- Traffic flow theory. Basic traffic flow parameters. Use of statistical distributions for the description of traffic flow parameters. Relations between traffic flow, speed and traffic density.
- Traffic capacity and level of service: Principles, Variables affecting traffic capacity, Calculations for the estimation of traffic capacity and level of service on interurban roads of two and three lanes per direction and of two lanes in total.
- Principles of traffic investigations and counts. Principles of sampling. Counts of traffic flows, delays and speeds. The moving observer method.

J. Golias, Professor
G. Yannis, Associate Professor
E. Vlahogianni, Lecturer

8.7.8. EXPERIMENTAL SOIL MECHANICS

The course covers laboratory methods commonly used to determine the soil parameters that govern its engineering behaviour. As part of the course the students have the opportunity of performing standard laboratory tests. Tests include: soil classification tests based on the measurement of the grading of a soil sample, its water content, unit weight and Atterberg limits (e, w%, γ_s, γ_d, LL, PL). Measurement of hydraulic conductivity using constant head and falling head permeameters. Measurement of the parameters needed for consolidation settlement calculations (E_s, c_c, c_s, c_v) using the consolidation test. Determination of shear strength parameters of non-cohesive soils using the direct shear strength apparatus. Drained and undrained triaxial tests. Comparison between laboratory and field measurements. Use of a single unifying framework based on critical state theories to describe and interpret the observed soil behaviour.

V. Georgiannou, Associate Professor

8.7.9. STEEL STRUCTURES I

Steel as a structural material, applications of steel structures, advantages and disadvantages, steel production, mechanical properties of steel, ultimate and serviceability limit states, factors of safety, evaluation of loads (permanent and live loads, snow, wind, earthquake, temperature loads), load combinations, cross section classification, member verification at the ultimate limit state under tension, compression (flexural buckling), shear, bending (of laterally protected members), torsion (uniform and non-uniform) and their combinations. Elastic and plastic analysis and design. Bearing-type bolts in shear. Single storey industrial buildings: conceptual planning, basic members and their function (main frames or trusses, purlins, auxiliary columns, vertical and horizontal bracing, sheeting, foundation).

Laboratory exercises:

1. Demonstration and explanation of the role and function of each member in the structural system of typical single story steel buildings (using the example of the building housing the Steel Structures Laboratory).
2. Bolting: types of bolts, tightening and prestressing, treatment of contact surfaces and friction coefficient, assembly of beam-to-column joints.

C. Gantes, Professor

8.7.10. REINFORCED CONCRETE

Introduction. Design limit states. Ultimate and serviceability limit states. Design against axial actions: Assumptions, properties of materials. Rectangular sections. Axial tension. Prevalent bending, diagrams and CEB design tables. Prevalent compression. Columns, interaction diagrams. T-beams, analytical design and design tables. Anchorage of steel bars, bond, anchorage types, basic development length. Lap splices. Design for shear. Cyclic shear. Capacity design of beams in shear. Ductility. Capacity design of columns for bending and for shear. Torsion. Cracking. Modelling of RC structures. Construction detailing, minimum covers, distance of bars, allowed curvatures. Minimum requirements per structural element (sectional dimensions, minimum reinforcement). Laboratory tests (production-reinforcing-casting of concrete, anchorages).

C. Trezos, Assistant Professor
E. Vintzilaiou, Professor
P. Giannopoulos, Associate Professor

8.7.11. STRUCTURAL ANALYSIS IV

Dynamic loads. Formulation of equations of motion of single-degree-of-freedom systems with the method of Direct Equilibrium and the Principle of Virtual Work. Damping. Free and forced undamped and damped vibrations of single-degree-of-freedom systems. Resonance. Generalised single-degree-of-freedom systems. The finite element method for the dynamic analysis of framed structures. Free and forced vibrations of multi-degree-of-freedom systems. Eigenmode analysis. Numerical integration of the equations of motion and computer implementation. Numerical methods for the computation of natural frequencies and modes of vibration. Damping of multi-degree-of-freedom systems. Response of multi-degree-of-freedom systems with moving supports. Applications on Civil Engineering structures. Dynamic analysis of singe- and multi-story buildings. Participation of eigenmodes in the method of mode superposition. Modal contribution. Method of response spectrum.

E. Sapountzakis, Professor
M. Nerantzaki, Assistant Professor

8.7.12. OPEN CHANNEL AND RIVER HYDRAULICS

Introduction. The equations of continuity, momentum and energy. Critical flow theory. Applications. Examples. Uniform flow. Design of lined and unlined channels for uniform flow. Best hydraulic section.

Non-uniform, gradually varying flow. Classification of flow profiles. Qualitative analysis, control sections. Quantitative analysis. Profile calculation for free surface flow in natural and artificial conduits. Complex problems.

The hydraulic jump. Types and characteristics of jump. Locating and controlling the jump. Energy dissipation. Stilling basins.

Rapidly varying flow. Broad and sharp crested weirs. Lateral spillways. Dam spillways. Sluice gates. Free overfall. Design of transitions for sub-critical flow. Curves and transitions in super-critical flow. Oblique hydraulic jumps. Bridge abutments. Culverts. Junctions. Spatially variable flow.
Unsteady flow. Gradually varying flow, St. Venant equations. Stage – discharge relationship in unsteady flow. Introduction to flood routing methods (e.g. Muskingum and others). Elements of sediment transport.

G. Xristodoulou, Professor

8.8. 8th Semester

8.8.1. COASTAL ENGINEERING

Introduction. Field of application. Coastal wave mechanisms. Wave breaking. Theory of radiation stress. Wave - generated currents. Coastal sediments, sample collection, statistical parameters. Sediment motion. Sea bed shear stress. Sea bed roughness. Wave friction coefficient. Initiation of sediment movement. Sediment suspension. Sediment transport. Neutral line. Sediment motion. Monitoring techniques. Sediment transportation along - and cross – shore. Sediment transport rate. CERC method. Sediment accumulations Influence of coastal obstacles and works. Mathematical study of coastal line evolution. Introduction to coastal protection works. Structures parallel to the coastline. Structures perpendicular to the coastline. Beach nourishment.

K. Moutzouris, Professor
V. Tsoukala, Assistant Professor

8.8.2. SOIL-STRUCTURE INTERACTION

The concept of soil–foundation–structure interaction. Examples of applications to foundations, retaining systems, underground sturctures. The rigid foundation on elastic continuum. Seismic soil–structure interaction. Beams and plates on soil under external loading. Foundations subjected to concentrated soil deformation. Piles under lateral and axial loading. Tunnel–soil interaction.

G. Gazetas, Professor
M. Kavvadas, Associate Professor
N. Gerolimos, Assistant Professor

8.8.3. FINITE ELEMENT ANALYSIS OF STRUCTURES

Energy theorems. Principle of virtual work. Stationary principle of total potential energy. Ralyleigh-Ritz and Galerkin methods. General stiffness matrix derivation of a finite element in two and three dimensions. Shape functions and stiffness matrix derivation of one-dimensional elements. Stiffness matrix derivation of a finite element in plane stress and plane strain elasticity problems. Triangular and orthogonal elements. Isoparametric formulation. Isoparametric shape functions, coordinate transformation, numerical integration. Quadrilateral elements in plane stress, plane strain and axisymmetric conditions. Three dimensional solid elements of tetrahedral and hexahedral type. Selection rules for the shape functions, equilibrium and compatibility conditions, convergence requirements and the patch test. Numerical errors and convergence. Modelling, discretization and error estimation. Simulation of structures with different types of elements and comparison of the numerical results. Analysis of buildings according to the seismic design codes. Numerical implementation and computer programming of the method.

E. Papadrakakis, Professor
V. Koumousis, Professor

8.8.4. EARTHQUAKE ENGINEERING 1

- Elastic seismic response of single degree-of-freedom systems: Equation of motion – Free vibrations – Damping – Earthquake response – Response spectrum – Alternative representations of response spectra – Effects of foundation conditions on the seismic response.
- Inelastic response of single-degree-of-freedom systems: Ductility – Behaviour factor – Overstrength – Relations qy-μ – Inelastic response spectrum – Design spectrum – Seismic design (force method).
- Seismic response of multi degree-of-freedom systems: Modal spectrum analysis – Simplified lateral force method of analysis – Seismic response of continuous systems.
- Basic issues of Eurocode 8.
- Demonstration of the dynamic response of model structures.

K. Spyrakos, Professor
I. Psycharis , Associate Professor
C. Mouzakis, Assistant Professor

8.8.5. URBAN ROAD NETWORKS

Introduction to urban transportation systems. Hierarchy, standards, configuration and spacing of urban road networks. Traffic capacity of intersections: U.S.A. and U.K. methods. Traffic signalization: Signalization warrants, Optimization of signalization of an isolated intersection, Delays, Queues, Coordinated signalization of an artery. Parking: Characteristics, Estimation of parking needs, Design/ construction and operation of parking places , Parking surveys and studies, Financial evaluation of parking garages construction . Road signs (Vertical, horizontal): Characteristics, Warrants, Horizontal and vertical road signs.

J. Golias, Professor
D. Tsamboulas, Professor
E. Vlahogianni, Lecturer

8.8.6. SELECTED TOPICS IN FOUNDATION ENGINEERING

- **Flexible retaining walls and anchors:** General overview. Computation of earth pressures for cohesive and non-cohesive soils, under various drainage and flow conditions. Design of self supported flexible walls (without anchors). Design of flexible walls with single or multiple anchors. Construction and design methods for anchors. Evaluation of the overall stability of the wall-anchor-soil system. Computer aided application in design practice.

- **Soil improvement and reinforcement:** General review of available methods. Soil improvement by pre-loading. Strength and compressibility of the improved ground for different cases of applied preloading. Use of drains to accelerate excess pore pressure dissipation and reduce pre-loading time-design methodology. Soil reinforcement using gravel piles. Construction methods. Bearing capacity and settlements of single gravel piles. Equivalent shear strength and settlement of a group of gravel piles.

- **Field exercises:** Visits of relevant construction sites within the Greater Athens area and a (2-3 day) trip to major construction sites all over Greece.

G. Boukovalas, Professor

8.8.7. SPECIAL CHAPTERS ON URBAN PLANNING

Contemporary urban areas: Socio-economic and spatial restructuring. Social cohesion. European dynamics. City and region: New relationships, new geography. Analytical methods and tools for spatial planning analysis. Planning and sustainable urban development. Impact on gentrification of state-led renewal and infrastructure projects as well as of cultural industry. City transportation planning, environmental aspects. The challenges for cities in Greece. Case studies on relevant topics

M. Markou, Lecturer
I. Tzouvadakis, Associate Professor
A. Sotiropoulou, Assistant Professor

8.8.8. INTRODUCTION TO BRIDGE CONSTRUCTION

Introduction. Background knowledge. Preparatory actions, acquisition of input information and data. General characteristics of bridges. Terminology of bridges. Superstructure details. Structural systems of bridges. General arrangement. Forms of bridge supports and wingwalls. Bridge hydraulics. Standards of bridge design loading. Design guidelines. Types of deck structures. General features and methods of analysis. Slab–T beam and box girder bridges. Design of piers and abutments. Bridge foundations. Seismic design of bridges.

Durability of bridges. Modern construction methods. Design topics pertaining to particular construction methods.

E. Vintzilaiou, Professor
G. Gazetas, Professor

8.8.9. REINFORCED CONCRETE STRUCTURES

Slabs. Two way slabs. Flat slabs. Non rectangular slabs. Frames. Footings. Corbels. Deep beams. Walls. Buckling, Seismic design. Repair and strengthening of reinforced concrete structures. Surveilance and certification of production control.

C. Trezos, Assistant Professor
E. Vintzilaiou, Professor

8.8.10. TIMBER STRUCTURES

Introduction, areas of applications, comparison of structures made of different materials. Composition, properties, dampness of timber. Basic mechanical characteristics. Structural timber. Calculation principles, strength, forces, combination of forces. Calculation of timber structures. Joints (riveting, bolting, bonding), fabrication and design. Roofs. Frames. Panels. Scaffoldings, formwork. Bridges. Foundations. Durability. Earthquake resistant design of timber structures. The effects of fire on timber. Damage assessment and restoration.

E. Vougioukas, Lecturer

8.8.11. PAVEMENTS

Principles. Definitions. Pavement types. Axle loads and road traffic. Pavement loading. Effect of environmental and climatic conditions. Geotechnical characteristics. Failure criteria and response analysis. Pavement distress and damage. In situ applications. Flexible, semi-rigid and rigid pavement design. Analytical - Empirical methods. Computational applications in pavement analysis and design. Geotechnical substructure and soil support. Pavement layer materials. Classification of soils. Unbound and hydraulically bound pavement materials. Concrete. Asphalt / bituminous mixes. Laboratory testing of materials. Mechanical properties of mixes. Strength and deformation characteristics of pavements. Pavement bearing capacity. Basic requirements for pavement construction tender documents. Exercises and applications.

A. Loizos, Professor
C. Plati, Lecturer

8.8.12. FINITE ELEMENTS

Introduction in the Finite Element Method (FEM). General description of the FEM. Displacements method. Plane finite elements. Three dimensional and axisymmetric finite elements. General families of elements and isoparametric elements. Generalization of the Finite Element Method. Weighed Residual Method (Variational Methods, Rayleigh-Ritz Method). Fluid and Heat conduction field problems. Elasto-Dynamic field problems (static and dynamic behaviour). Incompressible and non-Newtonian materials (application in the simulation of structural problems). Methods for the solution of large systems in the FEM. Pre-processing and post-processing of data and other techniques in the FEM. The errors in the FEM.

E. E. Theotokoglou, Professor

8.8.13. ENVIRONMENT AND DEVELOPMENT

Part 1: Theoretical backround and tools: environment and development, sustainable development and other approaches, policies for environment and development, different tools.

Part 2: Case-studies: global warming, Waste management-saving-recycling-valorisation. Air conditioning friendly to the environment. Lignite, natural gas and alternative energy resources, technological and environmental approach. Water resources and environment. Environment as an economic activity: a second life for former industrial zones (Lavrio). The role of law in the conflict between environment and development.

Part 3: the role of engineer in the conflict between environment and development.

K. Hadjibiros, Professor
V. Tsoukala, Assistant Professor

8.8.14. ADVANCED MECHANICS OF MATERIALS

Elements of Tensor Analysis. Elements of Variational Calculus. Traction. Stress Tensor. Balance Laws. Equations of Motion and Equations of Equilibrium. Symmetry of Stress Tensor. Strains and Rotations. Equations of Compatibility. Constitutive Elasticity Equations. Strain Energy. Generalized Hooke's Law. Anisotropy – Isotropy. Navier-Cauchy Equations and Beltrami-Michell Equations. Boundary Conditions. Boundary Value Problems. Energy Theorems and Methods. Rayleigh-Ritz Method. Two-Dimensional Problems. Plane Strain and Plane Stress. Airy's Stress Function. Self-Similar Problems. Flamant-Boussinesq and Kelvin Problems. Exact Theory of Torsion. Prandtl's Stress Function. Bending Problems.

Ch. Georgiadis, Professor

8.8.15. STEEL STRUCTURES II

Verification at the ultimate limit state of laterally unprotected members under axial force and bending (flexural and lateral torsional buckling). Mechanical fasteners under tension, shear and their combinations, bearing-type bolts, slip-resistant bolts, eye-bars, bolted connections. Welded connections and welding technology. Beam-to-column joints, beam-to- beam joints, column bases. Seismic design of single and multi story steel buildings, types of bracing systems, capacity design.

Laboratory exercises:

1. Lateral buckling of beams.
2. Quality control of welds with non-destructive methods.

C. Gantes, Professor

8.8.16. STEEL STRUCTURES III

Uniform built-up compression members with lacing bars or batten plates. Fire design of steel structures. Behavior and supplementary rules for stainless steels. Resistance and stability of shells. Chimneys, silos and wind generator towers.

Trusses fabricated using hollow sections. Fatigue design, strength and verifications. Crane supporting beams.

Uniform built-up compression members with lacing bars or batten plates. Fire design of steel structures. Behavior and supplementary rules for stainless steels. Resistance and stability of shells. Chimneys, silos and wind generator towers. Trusses fabricated using hollow sections. Fatigue design, strength and verifications. Crane supporting beams.

C. Gantes, Professor
I. Raftoyiannis, Associate, Professor
T. Avraam, Lecturer

8.8.17. RAILWAY ENGINEERING

Introduction: The role of railways. Permissible axle loads. Load specifications. Permanent way, track materials, rails, sleeper, fastenings, ballast. Static and dynamic calculations of the permanent way. Turnouts and crossings. Substructure: embankments, cuttings, draining. Track geometry, vehicles. Clearances, traction, train formation. Railway stations – freight rail transport, freight terminals.

A. Ballis, Associate, Professor
K. Lymperis, Assistant Professor

8.8.18. STRUCTURAL ANALYSIS V: PLASTIC ANALYSIS OF FRAMED STRUCTURES

Engineering theory of elastoplastic bending. Fully plastic bending moment, elastoplastic boundaries, influence of shear and axial forces. Loading-unloading, remaining stresses. Classical methods of plastic analysis. Theorems of plastic collapse. Method of combined mechanisms. Foulkes graphical method of plastic design with minimum weight. Matrix methods of plastic analysis and design with linear programming. Linear programming equations based on kinematic and plastic collapse theorems. Automatic evaluation of plastic collapse mechanisms. The matrix step-by-step elastoplastic analysis for the determination of load-displacement curves and critical loads. Modification of computer codes for elastic analysis to account for the elastoplastic analysis of framed structures. Elastoplastic stiffness matrix of beams based on a layered approach with distributed plasticity. Pushover analysis of structures. Performance-base design, reduction factor q, capacity curves, effectivity index. Structural design methodologies under earthquake loading.

E. Papadrakakis, Professor
K. Spiliopoulos, Associate Professor
N. Lagaros, Assistant Professor

8.8.19. ELEMENTS OF LAW AND TECHNICAL LEGISLATION

Elements of Law: Introduction. Fundamental concepts and legal aspects on the following branches of the law: Public Law (Constitutional, Administrative, Protection of Environment, Environmental Impact Studies). Civil Law (General Principles, Property Law, Obligations Law, Copyright Law) Commercial Law (Mercantile Law, Commercial Transaction Law, Company Law, Security Law, Industrial Property Law, Assurance Law, Merchant Marine and Bankruptcy Law) Labour Law (Personal and Collective, Workers' Safety and Health, Labour Accidents, Liability of Engineers) European Law (Sources, Institutions, Directives, Internal Market Legislation on Regional Development of Infrastructure).

Technical Legislation: National and E.U. Legislation on Public Works (Tendering, Authorities, Construction Companies, Contracts, Contract Misconduct, etc.) Urban Law (Object and Purpose of the Law, the Relationships with Rural Law, Protection of the Environment, Architectural Heritage, Development Sustenance). General Building Regulation.

A. Koutougkos, Professor

8.8.20. COMPOSITE MATERIALS

Technical background and development of composite materials. Production procedures. Mechanical behavior of composite materials. Hooke's law for orthotropic and anisotropic materials. Rule of mixtures. Micromechanical and macromechanical properties. Membrane, bending and combined loading of laminates. Failure criteria for plies and laminates. Experimental procedures for determining the properties of constituent materials, plies and laminates. Fracture mechanics of composite materials. Viscoelastic behavior. Analysis of damping.

Aging and fatigue. Interlaminar stresses and delamination criteria. Hygrothermal behavior. Analysis of structures made from composites. Applications using the finite element method.

I. Raftoyiannis, Assistant Professor

8.8.21. SANITARY ENGINEERING

Part A. Required qualitative characteristics of potable water and related legislation. Groundwaters and surface waters intended for abstraction of potable water (classification, protection). Water treatment plants: process design of conventional units (pre-chlorination/ozonation, coagulation, flocculation, sedimentation, filtration, disinfection). Advanced treatment through activated carbon, ion exchange, hardness removal, membranes. Design project.

Part B. Quantitative and qualitative characteristics of domestic liquid wastes. Required treatment and relevant legislation. Wastewater treatment plants: process design of units (preliminary and primary treatment, secondary treatment using suspended and fixed-film biomass). Mathematical model for the design of the activated sludge process, aiming at carbon and nitrogen removal. Sludge treatment (thickening, digestion, dewatering). Tertiary effluent treatment through filtration and additional sludge processing for subsequent reuse and utilisation (sludge sanitation). Design project.

A. Andreadakis, Professor
D. Mamais, Associate Professor
K. Noutsopoulos, Lecturer

8.8.22. HYDROELECTRIC PROJECTS

Hydroelectric energy and Hydro-potential. Reservoir design. Lay-out of conventional hydroelectric projects, small hydroelectric installations and pump-storage projects. Phases of preliminary design, final design, construction and operation. Environmental design of hydroelectric projects. Auxiliary and investigation works (topographical, geological, geotechnical, hydrological, climatological, electric loads at peak and base). Design of the energy production system and the associated works, intakes, tunnels, surge tanks, penstocks, power plant, tailrace channels and tunnels. Design of power water ways, loading assumptions, conduit lining. Design of power plants. Action turbines (Pelton). reaction turbines (Francis Kaplan). Reversible units. Pumps. Flow in turbine rotor and pump impeller. Cavitation and water hammer. Gates, valves. Turbines of small hydropower plants (bulbs, S-type). Basic principles, design criteria and operation of small hydroelectric projects, environmental considerations. The economics of hydroelectric projects. Bill of quantities, cost estimates, investments, capital amortization, construction management, energy production and operation. Hydrothermal cooperation.

I. Stefanakos, Lecturer

8.8.23. GROUNDWATER FLOW

Introduction, definitions, continuum approach to flow through porous media. Aquifers and classification of aquifers, groundwater balance. Darcy's law in three dimensions, hydraulic conductivity, anisotropy, continuity equation. Mathematical statement of the flow through porous media, boundary conditions, seepage face, methods for solving groundwater problems, flow nets. Hydraulic approach to flow in aquifers, Dupuit assumption for phreatic aquifers. Analytical solutions for 1-D aquifers. Leaky confined or unconfined aquifers. Seepage through earth dams. The complex variable method, introduction to conformal mapping. Flow underneath engineering structures, method of fragments. Hydraulics of pumping and recharging wells, multiple well systems, method of image, wells near boundaries. Introduction to mathematical modeling of groundwater aquifers. Aquifer storativity, unsteady flow. Groundwater overdrafting, subsidence and sea water intrusion in coastal aquifers. Soil and groundwater contamination. Geoenvironmental contamination sources, categorization and legal framework. Focus on role of contaminated soil both as pollution source or filter. Physicochemical and biological interactions of the soil-water-contaminant interphase. Contaminant speciation, transport and behavior in the geoenvironment. Remediation and restoration technologies. Case studies of geoenvironmental contamination and remediation applications.

D. Dermatas, Assistant Professor
A. Nanou, Lecturer

8.8.24. COMPUTATIONAL HYDRAULICS

Introduction. Methods for solving linear and non- linear systems, algebraic equations and ordinary differential equations. Classification of second order partial differential equations. Finite differences method. Discretisation methods and boundary conditions. Applications: Flow of ideal and real fluids, unsteady flow in closed conduits (water hammer) and open channels (St. Venant equations, flood routing), groundwater flow, diffusion and dispersion in one and two dimensions. Introduction to turbulence models. Mathematical models of hydrodynamic behavior and pollution in rivers, coastal areas and lakes.

G. Xristodoulou, Professor
P. Papanikolaou, Assistant Professor

8.9. 9th Semester

8.9.1. EARTHQUAKE ENGINEERING 2

- Seismic response of single-storey structures – modal analysis.
- Effect of torsion on the seismic response – Torsionally flexible systems
- Combination of modal responses – Spatial combination.
- Basic issues of Eurocode 8 – Capacity design.
- Performance based seismic design.
- Static nonlinear (Pushover) analysis – Nonlinear time-history analysis.
- Seismic isolation – Principles of design of seismically isolated structures.

I. Psycharis , Associate Professor
C. Mouzakis, Assistant Professor

8.9.2. EVALUATION AND IMPACTS OF TRANSPORT INFRASTRUCTURE PROJECTS

Type of transport infrastructure projects (road, railway, airport, port terminals, freight villages, etc) and what they serve (interurban and urban transport of persons and goods). Identification and quantification of impacts (positive/negative) from the implementation of infrastructure projects. Classification of impacts occurring during the construction and operation of the transport infrastructure. Impacts on the natural environment (landscape, lakes in the vicinity, coastlines, rivers; air pollution; underground water pollution, etc), on man-made environment (human settlements and housing, agriculture, noise, visual intrusion, accidents and safety, historical/cultural heritage, etc) and on natural resources (energy, materials, etc). Environmental impact studies for transport infrastructure projects. The scope and objectives of evaluation for the construction and operation of transport infrastructure projects. The evaluation process. Evaluation criteria: socio-economic, financial, etc. Cost categories and their measurement. Identification of user benefits. Socioeconomic evaluation of impacts to the natural man-made /societal environment. Time dimension of costs and benefits, as well revenues for the private sector. Evaluation parameters of transport infrastructure projects related to Logistics. Methods of evaluation (Cost Benefit Analysis/BCA, Multicriteria Analysis/MCA) and their applications. Uncertainty and risk analysis. Private Public Partnerships (PPP) for Transport Infrastructure Projects. Transport Policies ((National, European Union) and their impacts on Transport Infrastructure Projects. Process of decision-making. SWOT (Strengths-Weaknesses-Opportunities-Threats) analysis. Examples.

D. Tsamboulas, Professor

8.9.3. ROCK MECHANICS-TUNNELS

Discontinuities and their effect on rockmass behaviour. Rock mass classification systems (Deere, RMR, NGI, GSI). In situ stresses. Models of mechanical behaviour. Failure criteria of intact rock and rockmass. Physical properties and mechanical parameters, laboratory and in situ tests. Stability of rock slopes (plane, wedge and circular failure).

Stress and deformation distributions around deep and shallow tunnels under elastic or elasto-plastic conditions. Rockmass loosening pressures, convergence-confinement curves, principles of the NATM method, temporary tunnel support and interaction with rockmass. Mechanical tunnelling methods (TBM). Pressures on the permanent lining of tunnels.

G. Tsiambaos, Professor

8.9.4. TRAFFIC MANAGEMENT AND ROAD SAFETY

- Planning, programming and design of projects and measures for traffic management. Improvement of traffic flow. Policies for parking management, preferential treatment of high occupancy vehicles, vehicles' traffic restrictions. Design of exclusive bus lanes. Bicycles. Pedestrians.

- Road safety. Collection and analysis of accident data. Data bases. Identification of hazardous locations. Numerical and Statistical Methods. Identification and evaluation of improvements. Traffic conflict technique. Correlation of accidents with driver and vehicle characteristics as well as with road, traffic and environment.

J. Golias, Professor
G. Yannis, Associate Professor

8.9.5. IRRIGATION ENGINEERING

Introduction. Modern irrigation works in Greece. Water requirements of plants: evapotranspiration-ground humidity-ground salinity. Irrigation networks: Small scale irrigation: non-permanent network, relevant calculations and technology. Transportation and storing: springs, pumps, reservoirs, control reservoirs, canals, closed conduits (gravitational flow) pressurized conduits, flow meters. Large scale irrigation: area irrigation, artificial rain, drip irrigation. General layout and hydraulic calculations. Source and irrigation water quality. Irrigation under water deficit and rainfed conditions. Legislation issues relating to irrigating water. Optimization of irrigation networks under pressure. Control of the hydraulic jump. Introduction to drainage methods and flood protection. Introduction to irrigation works management. The use of waste water to irrigation. Irrigation works consequences and environmental protection.

E. Baltas, Associate Professor
D. Panagoulia, Assistant Professor

8.9.6. WASTEWATER TREATMENT AND DISPOSAL

Review of treatment, disposal and reuse processes with reference to legislative requirements. Wastewater characterisation. Detailed design of wastewater treatment plants: layout, process calculations, hydraulic computations, technical considerations, equipment selection. Preliminary treatment (pumping, screening, reception of septage, grit and oil removal, odour control), primary treatment, activated sludge for carbon, nitrogen and phosphorous removal with selectors and appropriate flow configurations for bulking control. Selection and design of aeration systems. Rectangular and circural settling tanks. Tertiary treatment units. Sludge treatment processes and biogas utilisation. Operational problems and automation. Environmental impact considerations. Laboratory work and design project.

A. Andreadakis, Professor
D. Mamais, Associate Professor
K. Noutsopoulos, Lecturer

8.9.7. SOIL DYNAMICS

Introduction : problems and significance of soil dynamics. Dynamics of simple elastic structures. Concept and applications of response spectrum. Seismic sliding of rigid block supported on frictional surface. Seismic Overturning of rigid body. Soil behaviour under dynamic and cyclic loading. Liquefaction of saturated granular soils. Measurements of soil parameters in the laboratory and in situ. One-dimensional wave propagation, reflection and refraction, propagating and stationary waves. The viscous-damping analogue. Resonance. Seismic wave propagation through soil deposits (“soil amplification” of seismic motion). Analysis of case studies on the role of soil conditions (Mexico, Kalamata, Pyrgos, Northridge, Kobe, Aegion). Two–dimensional wave propagation, surface waves. Vibrations of surface and embedded foundations. Seismic response of piles. Applications of soil dynamics in recent projects in Greece.

G. Gazetas, Professor
N. Gerolimos, Assistant Professor

8.9.8. SPECIAL TOPICS ON STATIC AND DYNAMIC STRUCTURAL ANALYSIS

A review of fundamental stability concepts. Types of stability and buckling. Fourth - order differential equation of equilibrium of compressed bars. Buckling and stability matrix of elastically supported compressed bars. Buckling loads and effective lengths of compressed members. Applications on steel frames. The influence of boundary conditions on the effective length according to code provisions. Beams under combined compressed and bending. The influence of initial imperfections (load eccentricity - initial curvature) on the critical load. Elastic-plastic buckling. Resistance of compressed bars according to code provisions. Torsional and lateral-torsional buckling. Buckling of arches. Numerical applications via the FEM.

Basic concepts of dynamic behavior of continuous elastic systems. Free and forced flexural vibration of beams. The 4th order differential equation of motion. Solution via the separation of variables method. Special cases of dynamic loads. Impact loading on bridges and cranes. The influence of velocity of moving loads on the dynamic behavior of beams and crane beams. Vibrations of steel pedestrian bridges, floor systems and stadium tiers under crowd loads. Avoiding human perception of insecurity. Application on fatigue problems of vehicle and railway steel bridges. Support settlements. Dynamic influence lines for internal forces and displacements. Axial vibrations. Torsional vibrations. Damping and energy absorption devices. Viscoelastic beams. Timoshenko beams. Dynamic stability of elastic systems. Numerical applications via the FEM.

T. Avraam, Lecturer

8.9.9. CONSTRUCTION MANAGEMENT – SPECIAL SUBJECTS

Project orientation as a management strategy – the IPMA system for project management (Methods for project start, coordination, discontinuities management, project control and project close-down) – Managerial capability model according to ELOT 1429. Review of network analysis project scheduling methods (critical path, resources, time-space dependencies). Scheduling of Linear Projects – critical sequence & critical path. Fuzzy project scheduling. Cost Estimating of Construction projects. Applications of Computer Packages (Primavera, MS-Project).

J.P. Pantouvakis, Associate Professor

8.9.10. SPECIAL TOPICS IN TRAFFIC ENGINEERING

Macroscopic and microscopic traffic flow models. Shockwave theory and applications. Cal-following models. Cellular automata. Traffic control systems.

Traffic flow simulation in urban road networks. Simulation models. Traffic analysis software for junctions, urban corridors and networks. Traffic simulation software. Traffic software applications. Queuing theory. Main characteristics of a queuing system. Types of queues. Single and multiple channel queuing systems. Queuing theory applications in traffic applications. Use of specialized software for queue and delay computations. Traffic capacity in areas of traffic streams merging. General principles. Main variables. Queue and delay calculations. Weaving areas: length, layout, operational types, parameters and traffic capacity. Traffic flow analysis. Short-term traffic flow prediction. Methodologies. Intelligent transportation systems. Basic principles. Applications.

J. Golias, Professor
M. Karlaftis, Associate Professor
E. Vlahogianni, Lecturer

8.9.11. SPECIAL TOPICS IN PORT ENGINEERING

Port operation: mooring, berthing of vessels along quayside. Return period. Tranquility of harbour basins: calculation of disturbances due to wind waves, overtopping of structures, port down-time, seiches. Probabilistic design of port structures: introductory concepts, stochastic analysis of surface waves, failure mechanisms, reliability assessment of structures, sub-systems, stability of mounds, partial coefficients of safety. Quay walls of sheet piles: types of walls, aseismic design of sheet piling, superstructure and anchorage. Ramps: geometry. Scour protection. Fenders and outfits. Dredging mechanical equipment. Port container terminal: design guidelines, cargo handling, stacking yards, berths, mechanical equipment, and operations. RoRo terminal.

V. Tsoukala, Assistant Professor

8.9.12. PAVEMENTS - SPECIAL TOPICS

Types of asphalt mixes (Hot, cold asphalt mixes). Asphalt mix design. Laboratory mix design with students participation- laboratory exercises. Laboratory asphalt mix testing. Asphalt mix plants. Anti-skid wearing courses. Modified asphalt/asphalt mixes. Other pavement material mixtures and pavement strengthening and reinforcement technologies. Asphalt mix laying and compaction. Pavement quality control practices. Quality Control Systems. Sustainable pavements (green roads). Environmental impacts and low noise pavements. Pavement recycling, technologies and implementation. Mechanical characteristics. Computational methods in pavements. Reinforcement of rigid pavements. Special Pavement Structures. Public Private Projects (PPP)–Tender documents (case studies). Laboratory accreditation aspects- ISO 9001:2008. Field measurement and technical visits. Accuracy, repeatability, reproducibility. New developments in pavement science and technology.

A. Loizos, Professor
C. Plati, Lecturer

8.9.13. SAFETY AND MAINTENANCE OF RAILWAY TRACK

Introduction to safety. Wheel/rail contact. Introduction to signalling systems and safety installations. Electrification. Derailment conditions. Trail control systems. High-speed trains, rail wear control and maintenance of railway tracks. Special structures. Line capacity. Capacity of railway stations. Special terminals. Interlocking diagrams and tables. Track occupation diagrams. Train schedules.

*K. Lymperis, A*ssistant Professor
A. Ballis, Associate Professor

8.9.14. ADVANCED TOPICS ON HIGHWAY DESIGN

Introduction to Digital Terrain Modeling (DTM). Highway design software: horizontal and vertical alignment, superelevation diagram, cross-sections, earthworks, three dimensional design. Topics in research and guidelines for road design. Road Safety Strategic planning. Road Safety Audits.

I.Golias, Professor
A. Kaltsounis, Lecturer

8.9.15. SPECIAL TOPICS OF FINITE ELEMENT ANALYSIS OF STRUCTURES

Mesh generation methods. Isoparametric Timoshenko beam elements in two and three dimensions. Natural mode triangular elements under plane and bending stresses. Isoparametric quadrilateral elements for plates and shells. Mixed type finite elements of displacement-stress and displacement-stress-strain formulations. Derivation of equilibrium equations. Adaptive finite elements, error estimation, h, p and hp adaptivity. Simulation methods of structures with finite elements. Simulation of shear walls, plates, beam-plate, diaphragm-column systems. Direct and iterative solution methods of equilibrium equations. Storage techniques for the stiffness matrix. Programming the finite element method. Data handling, memory management, stiffness matrix formation, stress computation. Applications with open and commercial finite element codes.

E. Papadrakakis, Professor
Viss. Papadopoulos, *Assistant Professor*

8.9.16. SPECIAL TOPICS IN HIGHWAY ENGINEERING

Types of intersections. Basic principles in highway intersection design. Vehicle movement at intersections. Elements of intersection design. Types and design of intersection islands. Speed-change lanes at intersections. Horizontal and vertical alignment, visibility and grading design at intersections. Interchanges. Three-leg designs. Four-leg designs. Determination of interchange configuration. Interchange spacing. Uniformity of interchange patterns. Route continuity. Coordination of lane balance and basic number of lanes. General ramp design considerations. Entrance and exit ramps. Acceleration and deceleration lengths. Illustrative design examples. Designing highways in mountainous terrain. Horizontal and vertical alignment. Superelevation diagram. Traffic noise characteristics and measurements. Noise control. Noise reduction designs. Safe system approach. Sustainable safety principles. Road design consistency. Driving behaviour. Positive guidance.

I.Golias, Professor
A. Ballis, Associate Professor
A. Kaltsounis, Lecturer

8.9.17. SPECIAL TOPICS IN REINFORCED CONCRETE

Seismic performance and damages of reinforced concrete (RC) elements and buildings and earthquake-resistant design of RC structures.
The concepts of: Ductility, confirement of concrete, the behaviour of RC materials under cyclic actions, the logic of earthquake-resistant design, design models and structural detailing for beams, columns, joints, coupling beams, short columns and shear walls. Fire resistant design for RC structures: the nature of fire, the behaviour of RC constituent materials under high temperatures, practical fire resistant design.
Performance based inelastic design of RC structures. Design for damage rehabilitation and strengthening of RC structures. Application to a typical RC building using an appropriate analysis computer software for structural analysis and evaluation.
Design of concrete structures for durability. Exposure classes and design for environmental loading. Design regulations and Standards.

C Zeris, Assistant Professor

8.9.18. LIGHT METAL STRUCTURES

Introduction to cold-formed steel members and structures. Material properties. Corrosion - Hardening. Classification of steel sections. Plate buckling. Effective width of compression steel plates. Effective cross-sections with stiffeners. Moments and warping resistance. Axial, bending and shear distress of cold-formed members. Uniform and non-uniform torsion. Flexural-torsional distress and buckling. Diaphragms, longitudinal stiffeners. Design and calculation of connections. Secondary effects in connections. Beams and Corrugated metal sheets. Shear resistance of metal panels. Code requirements for thin-walled steel members.

I. Vayas, Professor
I. Raftoyiannis, Associate Professor
T. Avraam, Lecturer

8.9.19. QUALITY CONTROL AND QUALITY ASSURANCE

Basic statistical methodes. Compliance criteria. Control by attributes, control by variables. Producers' andconsumers risk. Sampling procedures. Sampling size. Operation and characteristic curves. Quality control charts: Shewhart charts, running mean charts, CuSum charts. Classical vs Bayesian methods. Adjusted and non-adjusted payments schedules. Quality control and assurance programs for construction works and services (EN 29000). Incorporating quality control and assurance procedures in contract documents.

A. Stathopoulos, Professor
C. Trezos, Assistant Professor

8.9.20. OFF-SHORE STRUCTURES

Introduction to hydro-dynamics affecting off-shore structures. Formulation of the interaction problem on sea waves and solid objects. Solution for specific cases. Loads on thin cylindrical elements due to wave action. Morrison's formula for vertical and inclined elements. Large volume compact objects. The MacCammy and Fychs cylinder. The catenaries. Solution of the equations. Mooring buoys. Floating moorings. Rigid moorings. Mooring systems and loadings due to wave action and operational loads. Design of crash barriers. The hydrostatic stability of floating structures. Underwater pipelines. Estimation of hydro-dynamic loads. The stability of underwater pipelines. Recommendations on the design and lying of undersea pipelines.

S. Azorakos, Lecturer

8.9.21. THEORY OF DISKS AND SHELLS

Historical review. Elasticity theory and analysis of real structures. The general equations of elasticity. Fundamental elasticity problems. Application on real structures. Boundary conditions. Strain compatibility conditions. Applications. Compatibility of deformations conditions. Applications. Calculation of deformations. The planar stress-strain problems. Approximate methods of solution (finite differences, Fourier series and integrals, energy methods). Problem solution in polar and skew coordinates. Orthotropic and variable thickness disks. Problems on pre-stressed disks. Orthogonal-triangular elements on point supports (finite elements). Computer aided problem solution of plane elasticity. Examples of application on real structures. Method comparison. Membrane theory of shells. Shell generation by surface rotation. Introduction to the bending theory of shells. Applications.

V. Koumousis, Professor

8.9.22. THEORY OF PLATES

Basic assumptions of the theory of thin plates. Deflection surface and its geometrical relations. Stress resultants. Differential equation of equilibrium of a plate element in cartesian and polar coordinates. Boundary conditions for rectilinear and curvilinear boundaries. Classical analytical solutions of plates (Navier, Levy), circular and annular plates. Plates with other geometrical shapes (skew, triangular, elliptic). Practical solutions of plates in Civil Engineering applications. Approximate and numerical solutions (Galerkin, Ritz, finite difference and finite element methods). Plates under in-plane forces, stability. Plates of variable thickness. Plates on elastic foundation. Large deflections of plates. Dynamic analysis of plates.

E. Sapountzakis, Professor
M. Nerantzaki, Assistant Professor

8.9.23. MASS TRANSPORT NETWORK OPERATIONS

Characteristics of transport modes (metro, tram, buses, electric buses). Transport capacity determination. Determination of network operation characteristics, planning and design principles, load factors, routing, frequency and crew scheduling. Traction: calculation of traction forces, train configuration, speed and time diagrams. Introduction to signaling systems and safety installations. Railway station signaling. Block sections. Interlocking diagrams and tables. Track occupation diagrams. Train schedules. Capacity. Examples and exercises.

M. Karlaftis, Associate Professor
K. Lymperis, Assistant Professor

8.9.24. NONLINEAR BEHAVIOR OF STEEL STRUCTURES

Fundamental concepts of nonlinear behavior: material nonlinearity, geometric nonlinearity, interaction of nonlinearities, equilibrium path (primary & secondary), bifurcation point (stable, unstable, unsymmetric), influence of initial imperfections, limit point, critical buckling loads and buckling modes, postbuckling strength, snap-through buckling, load vs displacement controlled tests, linear and nonlinear stability theory, elastoplastic behavior of cross-sections, members and structures subjected to simple and combined actions, failure criteria, structures prone to nonlinear behavior, examples.

Analysis methods for nonlinear problems: equilibrium (Euler) method, energy method and energy criteria, dynamic method, linear and nonlinear theory, perfect and imperfect systems, single and multiple degree-of-freedom systems, continuous systems, interaction of buckling modes, recommended analysis methods, examples.

Numerical algorithms for solving nonlinear problems: nonlinear finite element method, application of loading in steps, Newton-Raphson and modified Newton-Raphson methods, convergence criteria, criteria for the selection of analysis method, number of steps, number of iterations and convergence limits, load vs displacement controlled analyses, arc-length methods, examples with application of finite element software.

Comparison of analytical and numerical methods and code provisions for nonlinear problems: beam-columns subjected to simple and combined actions, influence of boundary conditions and slenderness, frames, moment-rotation equations, calculation of equivalent buckling lengths, plates, local buckling, flexural-torsional buckling, built-up members, arches, shells, examples of application in actual structures.

C Gantes, Professor
I. Raftoyiannis, Associate Professor
T. Avraam, Lecturer

8.9.25. MECHANICS OF MASONRY

Masonry materials, construction types of masonry, mechanics of arches, mechanical and deformation characteristics of unreinforced masonry, the mechanics of unreinforced masonry under compression, tension and tension due to bending. Masonry under heterosemous biaxial stresses. Buckling of masonry (under eccentric compression). Unreinforced masonry subjected to shear. The mechanics of reinforced masonry. Pathology of unreinforced masonry buildings, methods of in-situ and in-Laboratory investigation. Design of masonry against normal and accidental actions.

E. Vintzilaiou, Professor

8.9.26. ROAD AND AIRFIELD PAVEMENTS

General Issues of airfield pavements. Differences between road and airfield pavements. Airfield pavement types and their implementation. Pavement loading due to aircraft loads. Pavements and runway length. Airfield pavement design principles. FAA pavement design method. Structural classification of airfield pavements (ACN/PCN). Evaluation of ICAO method. FAA procedure for determination of pavement structural condition index. Pavement management systems at project and network level. Long Life Pavements (LLP). Pavement visual inspection and pavement surface damages. Road and airfield pavements structural evaluation procedures. Non-Destructive Testing (NDT). Structural evaluation indexes. Geophysical methods in pavements. Estimation of pavement bearing capacity. Implementation of pavement structural evaluation. Pavement reinforcement. Functional characteristics. Evaluation of surface condition and pavement performance. Basic principles of preventive maintenance and pavement preservation. Pavements Rehabilitation. Pavements in Concession Systems PPP, BOT. Road and airfield pavement management and monitoring systems. Exercises and applications.

A. Loizos, Professor
C. Plati, Lecturer

8.9.27. EXPERIMENTAL HYDRAULICS

Introduction. Measurements and experimental research. Dimensional analysis. Rayleigh's method and the Π theorem. Experimental errors. Processing of experimental data. Hydraulic similitude and basic laws. Complete and partial similarity. Model construction. Scale effects. Applications. Overview of techniques and instruments for measuring hydraulic parameters. Laboratory experiments in the areas of flow in open and closed conduits, jet diffusion, maritime hydraulics and coastal engineering.

P. Papanikolaou, Assistant Professor
V. Tsoukala, Assistant Professor

8.9.28. ENVIRONMENTAL GEOTECHNICS

The overarching goal of the course is to develop environmental thinking related to (1) assessing the severity of a contaminant release in the subsurface, (2) recognizing the physical-chemical-biological mechanisms that affect the fate and transport of the released contaminant and, (3) selecting appropriate remedial measures and/or technologies. Course objectives are met if at the end of the semester students (a) can locate reliable data on the effects of contaminants on human health, (b) are confident in applying principles of mass transfer, groundwater flow and contaminant transport to problems of contamination and restoration of the subsurface, (c) are able to address the geoenvironmental aspects of landfill and clay barrier design, (d) are familiar with a wide range of remediation technologies, (e) are able to take initiatives related to modeling (i.e., related to the formulation of a simplified problem that admits solution) and, (f) are aware of some social or public policy dimensions of subsurface contamination and restoration problems.

Course contents include the following. Cases of restoration of contaminated sites. Legislation. Sources and characteristics of contaminants. Risk assessment. Groundwater flow. Soil-contaminant interaction. Mechanisms affecting the fate of contaminants, contaminant transport, applications (practice in the use of an educational software in the School's PC lab). Landfill liner design and materials. Remediation technologies for contaminated sites.

M. Pantazidou, Associate Professor

8.9.29. ENVIRONMENTAL IMPACTS

- Theoretical introduction: Sustainable development and environmental policy. Dimensions of environmental policy. Environmental impact assessment: study, public hearing, monitoring, implementation. Environmental impact study: objective, technical content. Strategic environmental assessment.
- Environmental impact statement for a real technical project.

K. Hadjibiros, Professor
D. Dermatas, Assistant Professor
V. Tsoukala, Assistant Professor
M. Papadopoulou, Assistant Professor

8.9.30. ENVIRONMENTAL FLUID MECHANICS

1. Introduction: concepts and definitions. Molecular diffusion. The diffusion equation: derivation using Fick's Law and solution. 2. The advection-diffusion equation: derivation and solutions. 3. Mixing in rivers: turbulent diffusion and dispersion. The turbulent advection-diffusion equation. Longitudinal dispersion. The advection-dispersion equation. 4. Chemical, physical and biological transformation processes: concepts and definitions, reaction kinetics and their incorporation in the advection-dispersion equation. 5. Processes at interfaces: the air-water interface (aeration models) and the sediment- water interface

(sediment models). 6. Atmospheric mixing: turbulence in the atmospheric boundary layer and related transport models. 7. Water quality modeling. Methodology. Simple models. Numerical models and stability criteria. 8. Integrated examples and applications. 9. Jets and plumes: basic characteristics, dilution and mixing in the near and far field, diffusers and outfalls. 10. Introduction to contaminant transport in groundwater.

A. Stamou, Professor
A. Nanou, Lecturer

8.9.31. QUANTITATIVE METHODS IN TRANSPORTATION

Public transport planning and organization methods. Routing and scheduling. Public transport preferential treatment in networks. Network optimization. Optimization methods. Real-time systems management and transport telematics. Central and distributed control. Decision support methods in transportation. Knowledge- and rule- based methods; fuzzy set theory applications. The role and responsibility of the transportation engineer. Theory and applications of logistics; fleet management.

A. Stathopoulos,Professor
M. Karlaftis, Associate Professor

8.9.32. PRESTRESSED CONCRETE

Introduction. Basic concepts. Materials, prestressing systems and anchorages. Partial losses due to friction, anchorage slip, creep, shrinkage and relaxation, Serviceability limit state design: flexural and shear design. Final design of prestressed concrete structures. Ultimate limit state design. Prestressed concrete technology and detailing. Design of anchorage systems. Statically indeterminate prestressed concrete structures.

C Trezos, Assistant Professor

8.9.33. STEEL BRIDGES

Conceptual planning of bridges. Types of composite bridges. Actions on bridges. Loading combinations. Global analysis. Ultimate limit state. Serviceability limit state. Shear connection. Plate buckling. Fatigue. Bearings.

I. Vayas, Professor
I. Raftoyiannis, Associate Professor

8.9.34. STOCHASTIC METHODS IN WATER RESOURCES

Introduction: general concepts, utility, types of problems. Simulation: general concepts, categories of simulation, uses of stochastic simulation, simulation models, random numbers. Random variables, statistical parameters, stochastic processes, stationarity, ergodicity, auto-correlation, cross-correlation. Spectral analysis of time series. Univariate stationary stochastic models: Markov models and their physical basis, AR(1), AR(2), ARMA(1,1), ARMA(p, q), MA(q) and SMA(q) models. Long-term persistence (Hurst phenomenon) and simple scaling processes. Seasonal models. Multivariate models. Introduction to disaggregation models. Introduction to point processes. Applications to water resource problems.

D. Koutsoyiannis, Professor

8.9.35. MODERN DESIGN METHODS FOR REINFORCED CONCRETE STRUCTURES

- Theoretical background: Comprehension of the behaviour of concrete at material and structure levels.
- Analysis: Constitutive modeling of concrete behaviour. Implementation in analysis. Simulation of cracking. Use of constitutive models in finite element software Examples. Presentation of the “Force Compression Path” method.
- Codes’ provisions: Presentation of all periods’ codes’ provisions valid for reinforced concrete structures in Greece, cross-correlations and corresponding between them. Structural characteristics, categorization and vulnerability of existing buildings, according to their period of construction.

- Design: Physical models of reinforced concrete structural elements. Implementation in ultimate limit-state design. Design procedure. Applications.

E. Vougioukas, Lecturer
E. Badogiannis, Lecturer

8.9.36. COMPOSITE STRUCTURES

Introduction, materials, cross section classification, cracked and un-cracked analysis, elastic and inelastic analysis, composite slabs, composite beams, composite columns, shear connection, conceptual design of multi storey buildings, fire resistant design, seismic design of buildings.

I. Vayas, Professor
T. Avraam, Lecturer

8.9.37. COMBINED TRANSPORT - SPECIALIZED SYSTEMS

Combination of Transport systems. Systematic analysis of maritime, rail, road and air systems. Development trends. Intermodal/Combined Transport: unitized units, transport modes, equipment, planning and operation of intermodal terminals. Combined passenger transport - Public transport systems. Transportation projects: operating cost, marginal cost and demand management. Environmental and energy considerations.

A. Ballis, Associate Professor

8.9.38. BOUNDARY ELEMENTS

Introduction. Boundary Elements and Finite Elements. Historical development of the BEM. **Preliminary Mathematical Concepts.** The Gauss-Green theorem. The divergence theorem of Gauss. Green’s second identity. The Dirac delta function. **The BEM for Potential Problems in Two Dimensions.** Fundamental solution. The direct BEM for the Laplace and the Poisson equation. Transformation of the domain integrals to boundary integrals. The Dual reciprocity method. The BEM for potential problems in anisotropic bodies. **Numerical Implementation of the BEM.** The BEM with constant boundary elements. Programming of the method in

FORTRAN. Multiply connected domains. The method of subregions. **Boundary Element Technology.** Linear elements. Higher order elements. **Applications.** Torsion of non-circular bars. Deflection of elastic membranes. Heat transfer problems. Fluid flow problems. **The BEM for the plate problem.** The Rayleigh-Green identity for the biharmonic operator. Fundamental solution. Integral representation of the solution. The boundary integral equations. **Two-Dimensional Elastostatic Problems.** Equations of plane elasticity. Betti's reciprocal identity. Fundamental solution of the Navier equations. Integral representation of the solution.

M. Nerantzaki, Assistant Professor

8.9.39. AIRPORT PLANNING

Air industry, privatization, deregulation. Forecasts. Dynamic strategic planning, Master Plan, strategic plans. Airfield design. Airport classification and design standards. Runway, taxiway, aprons layouts and geometry. Approach surfaces. Airfield capacity and delays. Demand management, slots. Air traffic management. Configuration of passenger buildings, design requirements. Ground access, parking facilities, on the airport access, baggage system distribution. Marking. Cargo terminal and other airport facilities. Multi-airport systems. Environmental impacts. Organization and financing. User charges.

P. Psaraki – Kalouptsidi, Associate Professor

8.9.40. TECHNICAL SEISMOLOGY

Introduction. Earthquake generation. The seismic rift. Propagation of seismic waves. Seismometry. Accelerographs. Analysis of accelerograms. The influence of local parameters in disturbing strong seismic shocks. Earthquake and geology. Geological and geophysical imprint of a geodynamic system. Measurements of distortion of Earth's crust. Seismic hazard analysis. Criteria and parameters of earthquake resistant design. Seismic-tectonic properties of Greek territories and the seismic prerequisites of the National Building Code. Interdisciplinary technical seismology projects.

K. Spyrakos, Professor
C. Mouzakis, Assistant Professor

8.9.41. WATER RESOURCES SYSTEMS TECHNOLOGY

The module is an introduction to water resources systems design, analysis and management. Issues and challenges in hydro-system management are described and analysed with an emphasis on state of art developments and new technologies. A series of topics are covered, including: hydrological planning, reservoir design using non-conventional stochastic methods, hydrological planning of safety structures, spillway design, flood proofing of river flow diversion works and multi-reservoir management. These topics are addressed using tools from stochastic hydrology, systems theory and optimisation. The aim of the module is to provide a clear understanding of the basic principles of hydro-systems and to bring the student in touch with new tools and technologies that support their design and optimal operation under uncertainty and risk. Particular emphasis is given to optimisation with one or multiple criteria using traditional and novel optimisation methods including genetic algorithms.

M. Mimikou, Professor
C. Makropoulos, Assistant Professor

8.9.42. HYDRAULIC STRUCTURES – DAMS

- Characteristic and hydraulic design of reservoirs. Environmental aspects of reservoir formation. Types of dams and technical-economical selection criteria. Environmental aspects of dam construction. Dam design specifications.
- Design of embankment dams (earth fill and rock fill). Exploitation of earth materials. Environmental aspects of borrow areas and quarries. Construction of embankment dams, jobsite development, areas for stockpiling and dumping.

- Engineering of gravity dams. Design and construction of a) conventional concrete, b) roller compacted concrete and c) face symmetrical hard fill gravity dams.
- Engineering, design and construction of concrete faced rock fill dams.
- Basic engineering of arch cams
- Types of spillways, hydraulic and structural design and environmental aspects of spillway design and construction. Engineering of flood control structures and energy dissipation works.
- Engineering of river diversion works, i.e canals, surface pipes, tunnels and cofferdams. Hydraulic and structural design of river diversion systems
- Flow control in spillways and water conveying systems, using gates and valves. Instruments for monitoring the behaviour of embankment and gravity dams. Dam failures and incidents. Risk and dam safety.

I. Stefanakos, Lecturer

8.9.43. COMPUTATIONAL GEOTECHNICS

Continuum Mechanics in Computational Geotechnics (theory of elasticity, failure criteria). Common constitutive models for non-linear soil behaviour. Simple numerical methods: slope stability analysis with the method of slices. Introduction to the Finite Difference and the Finite Element methods for the solution of boundary value problems in geotechnical engineering. Finite Difference Analysis of the nonlinear response of piles to lateral loading. Inverse analysis and optimization methods in the design of pile foundations (Programming with MATLAB). Application of the Finite Element method in engineering practice (introduction to PLAXIS code): simulation of laboratory tests, bearing capacity and settlement of foundations, groundwater flow, deep excavations and retaining structures, tunneling, static soil-structure interaction. Case studies.

N. Gerolimos, Assistant Professor

9. ALPHABETICAL COURSE LISTING