NATIONAL TECHNICAL UNIVERSITY OF ATHENS

School of Rural and Surveying Engineering

Curriculum Guide 2009-2010

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The cover page is a reproduction from the original work by **N. Hatzikiriakos-Gikas** specially designed for each School of the National Technical University of Athens.

This Curriculum Guide has been put together by all staff members of the School of Rural & Surveying Engineering of NTUA. The final version has been edited by Professor **B**. **Nakos**.

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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 (910,000m^2) and open green site, 6 km from the centre of Athens. It includes buildings of 260,000m^2 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:

1. School of Civil Engineering
2. School of Mechanical Engineering
3. School of Electrical and Computer Engineering
4. School of Architecture
5. School of Chemical Engineering
6. School of Rural and Surveying Engineering
7. School of Mining and Metallurgical Engineering
8. School of Naval Architecture and Marine Engineering
9. 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 RURAL & SURVEYING ENGINEERING

1. HISTORY AND STRUCTURE

The School of Rural and Surveying Engineering was founded in 1917 as "Higher School of Surveying Engineering". The leading personality of the School of Rural and Surveying Engineering as well as the inspirer of the changes that occurred in 1930 was professor Demetrios Lambadarios. Professor Demetrios Lambadarios was a member of the Academy of Athens, Rector of NTUA during the years 1928 to 1933 and Dean of the School for many years. Today, the School's building in Zographou campus carries his name.

In 1974, the School's curriculum was extended to five years. The list of School's heads since the introduction of the new scheme in 1982 is the following:

Academic Year	President	Deputy President
1983-84	D. Balodimos	
1984-86	D. Balodimos	
1986-88	D. Balodimos	E. Marketos
1988-90	C. Koutsopoulos	G. Veis
1990-92	H. Billiris	C. Koutsopoulos
1992-94	H. Billiris	G. Veis
1994-96	D. Balodimos	G. Veis
1996-98	D. Balodimos	H. Billiris
1998-00	A. Balodimou	A. Georgopoulos
2000-02	A. Balodimou	A. Georgopoulos
2002-04	A. Georgopoulos	L. Tsoulos
2004-06	A. Georgopoulos	L. Tsoulos
2006-08	M. Kavouras	R. Korakitis
2008-10	M. Kavouras	R. Korakitis

In accordance with a decision of the general assembly taken on 26th of April 1983, the School was divided into three departments:

1. **Department of Surveying Engineering**
   Dealing with the development of spatial measurements, methods and techniques, and their application on surveying, photogrammetry, remote sensing, hydrography, geodesy, cartography and geophysical survey.
2. **Department of Geography and Regional Planning**

Dealing with the analysis, elaboration and interpretation of qualitative and quantitative entities in geographical space, and their inter-relationships and variation process in investigating problems of regional planning.

3. **Department of Infrastructure Works and Rural Development**
   Dealing with planning and construction which contribute to the development of rural areas.

Laboratories
The following Laboratories operate within the School's Departments:

1. **Department of Surveying Engineering**
   - Laboratory of **Higher Geodesy** (Director: Prof. K. Papazisi)
   - Laboratory of **General Geodesy** (Director: Prof. D. Stathas)
   - Laboratory of **Remote Sensing** (Director: Prof. D. Argialas)
   - Laboratory of **Photogrammetry** (Director: Prof. A. Georgopoulos)
   - Laboratory of **Cartography** (Director: Prof. L. Tsoulos)
   - **Dionyssos Satellite Tracking Center** (Director: Prof. D. Paradissis)
2. **Department of Geography and Regional Planning**
   - Laboratory of **Geography** (Director: Prof. K. Koutsopoulos)
   - Laboratory of **Physical Geography and Environmental Impact** (Director: Prof. A. Siolas)
3. **Department of Infrastructure Works and Rural Planning**
   - Laboratory of **Reclamation Works and Water Recourses Management** (Director: Prof. A. Mantoglou)
   - Laboratory of **Structural Mechanics and Technical Works** (Director: Prof. M. Sakellariou)
   - Laboratory of **Transportation** (Director: Prof. V. Psarianos)

Library
The School's Geodetic Library is situated on the basement of Veis building. It is one of NTUA's first specialist libraries. The library is open every working day, 9:45 to 13:45 hrs, during which students and staff may study and borrow books. Students are encouraged to make extensive use of the Library.

Geo-informatics Centre
This Centre was established to support research activity, both at undergraduate and postgraduate level, by students and staff dealing with collection, processing and interpretation of geographic information. The Centre is open every day, 9:00 to 17:00 hrs.

Facilities

The School is serviced by the following facilities:

- Computer Centre
- Printing and Photocopying Unit
- Technical Unit
- Student Restaurant
- Building Caretaking
- Secretariat

  Secretary: F. Kremizi
  Deputy Secretary: M. Konstantinidou
- Operation and Development Office

2. CURRICULUM PRINCIPLES

The School's curriculum is based on the scientific and technical activities of Rural and Surveying Engineers, Greece's production and development goals, as well as future prospects in those areas. The curriculum aims at providing students with the necessary scientific and technological education that will enable them to perform satisfactorily in a specific area of Rural and Surveying Engineering.

To succeed in his future goal, a graduate school should be in position to comprehend technical developments in his own scientific field, cooperate constructively with fellow engineers, and indeed contribute to scientific development. The School's curriculum also aims at preparing interested students for post-graduate studies.

Rural and Surveying Engineering activities may be divided into the following scientific fields:

1. Collection, processing and presentation of spatial and environmental elements (determination of position on the earth's surface, survey, cartography, land information systems)
2. Spatial analysis and organization
3. Transportation engineering
4. Reclamation and other hydraulic works
5. Construction and technical works

The wide range covered by these subjects leads to the necessity for considerable specialization of the curriculum. It should be stressed, however, that at present, such specialization does not appear to conform to prevailing professional conditions in Greece. The School's curriculum aims at reaching a compromise between what appears to be two "contradictory" tendencies. This is accomplished by recognizing specialized educational areas, and by dividing courses into *mandatory* and *elective*.

Mandatory are the courses required to lead the student into mastering the basic background in Rural and Surveying Engineering and prepare him for specialization in a certain field.

Elective are the courses dealing with specialized subjects and topics in an area chosen by the student, and providing the required knowledge for further studies and scientific research.

In accordance with the NTUA's educational system, studies last five years. Each year is divided into two semesters: the winter semester (September to January) and the spring semester (February to June). Out of ten semesters, the first nine are devoted to courses and practical exercise, while students spend the last one preparing their diploma thesis.

Under the new curriculum introduced in academic year 2001-02, 61 courses are required in total for the completion of studies:

- 47 mandatory courses (See Table I),
- 1 elective course on humanities (see Table II)),
- 7 elective courses on the major specialization area (see Tables III,VI, IX & XII),
- 4 elective courses on the minor specialization area (see Tables IV, VII, X & XIII), and
- 2 free selections.

The opportunity of selecting courses is established as early as from the first semester and special effort has been made in order to provide equal selection ability in all fields. Care is taken so that each semester should have no more than 7 courses, totaling about 30 teaching hours per week.

Students attending the 9th semester need to take a project course in the area of their major specialization, thus special project courses have been introduced in the curriculum, demanding collective work in one or more scientific areas.

Students have four options to choose their major and minor specialization areas:

- Surveying Engineering
- Urban and Regional Planning and Development
- Transportation Engineering
- Water Recourses Management

Table I. List of mandatory courses

Courses	*Semester*	*Notes*
Linear Algebra and Analytical Geometry	1	
Mathematical Analysis	1	
Differential Equations and Complex Functions	2	
Probability Theory and Statistics	2	
Descriptive Geometry	2	
Physics I (Mechanics)	2	The courses are given
Numerical Analysis	3	by the School of
Differential Geometry	3	Applied

Projective Geometry	3	Mathematical and Physical Sciences
Physics II (Electromagnetism)	3	
Introduction to Economical Analysis	5	
Introduction to the Legal System and Elements of Technical Legislation	9	
Business Administration	9	
Introduction to Informatics	1	
Programming Techniques	2	Courses of informatics
Database Systems	3	
Principles of Geo-information and Geographical Information Systems	4	
General Geology	1	General courses
Engineering Mechanics	3	
Foreign Language and Technical Terminology	4	
Technical and Topographic Drawing	1	Basic courses
Theory of Errors and Adjustments I	5	
Geodesy I (Introduction to Geodesy)	1	
Cartography I (General Cartography)	2	
Geodesy II (Surveying Instruments and Methods)	3	
Geodesy III (Land Surveying)	4	
Photo-interpretation and Remote Sensing	4	The courses are given by the Department of Surveying Engineering
Cartography II (Analytical Cartography)	4	
Summer Field Course in Geodesy I	4	
Geodesy IV (Higher Geodesy)	5	
Photogrammetry I (Introduction to Photogrammetry)	5	
Geodesy V (Satellite Geodesy)	6	
Photogrammetry II (Analytical Photogrammetry)	6	
Cadastre	7	
Digital Image Analysis for Remote Sensing	7	
Physical Geography and Environment	2	The courses are given by the Department of Geography and Regional Planning
Geography and Spatial Analysis	6	
Urban Planning	7	
Regional Planning	8	
Geotechnical Engineering	4	
Road Design I (Geometrical Features)	4	
Fluid Mechanics	5	The courses are given by the Department of Infrastructure Works and Rural Planning
Designing of Transportation Projects (Economical Elements)	5	
Applied Hydraulics	6	
Engineering Hydrology	6	
Hydraulic Works	8	
Design of Concrete Reinforced Structures	8	

Table II. Courses of Humanities (Selection of one course)

Courses	*Semester*	*Notes*
History of Civilization	1	The courses are given by the School of Applied
Sociology of Space	1	Mathematical and Physical Sciences
Philosophy of Sciences	1	

Table III. Courses of major specialization on Surveying Engineering

Flow 1			Flow 2		
Mandatory			Mandatory		
No	*Courses*	*Semester*	*No*	*Courses*	*Semester*
1	Satellite Geodesy and Navigation	7	1	Photogrammetry III (Digital Photogrammetry)	7
2	Introduction to the Earth Gravity Field	7	2	Digital Mapping	7
3	Theory of Errors and Adjustments II	8	3	Theory of Errors and Adjustments II	8
Selection of two courses			Selection of two courses		
No	*Courses*	*Semester*	*No*	*Courses*	*Semester*
1	Special Topics of Geodesy	6	1	Thematic Cartography	5
2	Special Topics of Satellite Geodesy	9	2	Special Topics of Remote Sensing	7
3	Marine Geodesy	9	3	Applied Optics	5
4	Cadastre and Land Information Systems	8	4	Cadastre and Land Information Systems	8
5	Summer Field Course in Geodesy II	6	5	Summer Field Course in Geodesy II	6
6	Summer Field Course in Higher and Satellite Geodesy	8	6	Summer Field Course in Photogrammetry Course or Summer Field Course in Remote Sensing	8
Selection of one course			Selection of one course		
No	*Courses*	*Semester*	*No*	*Courses*	*Semester*
1	Real Estate Valuation and Land Management	9	1	Real Estate Valuation and Land Management	9
2	Geodetic Astronomy	6	2	Satellite Geodesy and Navigation	7
3	Geophysical Exploration - Gravimetry	8	3	Special Topics of Geodesy	6
4	Applied Optics	5	4	Marine Geodesy	9
5	Metrology	8	5	Cadastre and Land Policy	9
6	Fundamentals of Digital Signal Processing	6	6	Radiometry and Microwave Remote Sensing	8

7	Hydrography - Oceanography	8	7	Photographic Data Acquisition	6
8	Photogrammetry III (Digital Photogrammetry)	7	8	Fundamentals of Digital Signal Processing	6

Table IV. Courses of minor specialization on Surveying Engineering

Flow 1 (For those who have selected Urban and Regional Planning and Development as major specialization area)			Flow 2 (For those who have selected Transportation Engineering or water Recourses Management as major specialization area)		
Mandatory			Mandatory		
No	*Courses*	*Semester*	*No*	*Courses*	*Semester*
1	Cadastre and Land Information Systems	8	1	Satellite Geodesy and Navigation	7
2	Digital Mapping	7	2	Special Topics of Remote Sensing	7
Selection of two courses			Selection of two courses		
No	*Courses*	*Semester*	*No*	*Courses*	*Semester*
1	Real Estate Valuation and Land Management	9	1	Geographical Information Systems	7
2	Special Topics of Remote Sensing	7	2	Summer Field Course in Geodesy II	6
3	Thematic Cartography	5	3	Summer Field Course in Photogrammetry or Summer Field Course in Remote Sensing	8
4	Cadastre and Land Policy	9	4	Photogrammetry III (Digital Photogrammetry)	7
5	Summer Field Course in Photogrammetry or Summer Field Course in Remote Sensing	8	5	Digital Mapping	7

Table V. Project courses of specialization on Surveying Engineering

Flow 1 Selection of one course			Flow 2 Selection of one course		
No	*Courses*	*Semester*	*No*	*Courses*	*Semester*
1	Development and Management of Land information Systems	9	1	Development and Management of Land information Systems	9
2	Monument Recording	9	2	Monument Recording	9
3	Applications of Higher and	9	3	Special Applications of Photo-	9

	Satellite Geodesy			interpretation and Remote Sensing	
4	Fundamentals of Digital Systems Communication	9	4	Fundamentals of Digital Systems Communication	9
5	Engineering Geodesy	9	5	Engineering Geodesy	9

Table VI. Courses of major specialization on Urban and Regional Planning and Development

Mandatory					
No	*Courses*				*Semester*
1	Urban Geography				6
2	Geographical Information Systems				7
3	Economic Geography				7
Selection of two courses			Selection of one course		
No	*Courses*	*Semester*	*No*	*Courses*	*Semester*
1	Evaluation in Planning	8	1	Architectural Design Primer	9
2	Introduction to Urban Planning and Settlements' Network	5	2	Transport Geography	8
3	Applications to Natural Resource Management	7	3	Environmental Impacts	8
4	Methods and Application of Town Planning	8	4	Regional Policy and Regional Development	6
5	Methods and Applications In Spatial Planning	9	5	Real Estate Valuation and Land Management	9
6	Thematic Cartography	5			

Table VII. Courses of minor specialization on Urban and Regional Planning and Development

Mandatory		
No	*Courses*	*Semester*
1	Urban Geography	6
2	Economic Geography	7
Selection of two courses		
No	*Courses*	*Semester*
1	Evaluation in Planning	8
2	Geographical Information Systems	7
3	Introduction to Urban Planning and Settlements' Network	5
4	Methods and Application of Town Planning	8
5	Methods and Applications In Spatial Planning	9

6	Environmental Impacts	8

Table VIII. Project courses of specialization on Urban and Regional Planning and Development

Selection of one course		
No	*Courses*	*Semester*
1	Integrated Development Plans	9
2	Environmental Planning	9
3	Fundamentals of Digital Systems Communication	9
4	Development and Management of Land information Systems	9

Table IX. Courses of major specialization on Transportation Engineering

Mandatory					
No	*Courses*				*Semester*
1	Road Design II (Traffic Flow)				7
2	Road Design III (Junction Design and Operation)				8
3	Transportation Systems				8
Selection of two courses			Selection of one course		
No	*Courses*	*Semester*	*No*	*Courses*	*Semester*
1	Construction Equipment and Organisation of Construction Site Layout	6	1	Open-Channel Flow and Hydraulic Structures	8
2	Soil Mechanics and Foundations	7	2	Architectural Design Primer	9
3	Road Design IV (Elements of construction)	9	3	River Engineering	9
4	Railways	8	4	Operational Research	9
5	Infrastructure Engineering Works	9	5	Construction Technology	6
6	Engineering Materials	5	6	Environmental Impacts	8

Table X. Courses of minor specialization on Transportation Engineering

Mandatory		
No	*Courses*	*Semester*
1	Road Design II (Traffic Flow)	7
2	Transportation Systems	8
Selection of two courses		
No	*Courses*	*Semester*
1	Construction Equipment and Organisation of Construction Site Layout	6
2	Operational Research	9

3	Road Design III (Junction Design and Operation)	8
4	Road Design IV (Elements of Construction)	9
5	Environmental Impacts	8
6	Infrastructure Engineering Works	9

Table XI. Project courses of specialization on Transportation Engineering

Selection of one course		
No	*Courses*	*Semester*
1	Designing - Study - Operation of Road Works	9
2	Fundamentals of Digital Systems Communication	9

Table XII. Courses of major specialization on Water Recourses Management

Mandatory		
No	*Courses*	*Semester*
1	Open-Channel Flow and Hydraulic Structures	8
2	Reclamation Works	8
3	Groundwater Hydrology	8

Selection of two courses			Selection of one course		
No	*Courses*	*Semester*	*No*	*Courses*	*Semester*
1	River Engineering	9	1	Construction Equipment and Organisation of Construction Site Layout	6
2	Soil Mechanics and Foundations	7	2	Operational Research	9
3	Water Resources Protection and Management	9	3	Principles of Ecology and Environmental Chemistry	6
4	Infrastructure Engineering Works	9	4	Environmental Impacts	8
5	Engineering Materials	5			
6	Sanitary Engineering and the Environment	9			

Table XIII. Courses of minor specialization on Water Recourses Management

Mandatory		
No	*Courses*	*Semester*
1	Reclamation Works	8
2	Groundwater Hydrology	8
Selection of two courses		
No	*Courses*	*Semester*
1	Open-Channel Flow and Hydraulic Structures	8
2	River Engineering	9
3	Infrastructure Engineering Works	9
4	Water Resources Protection and Management	9
5	Sanitary Engineering and the Environment	9

Table XIV. Project courses of specialization on Water Recourses Management

Selection of one course		
No	*Courses*	*Semester*
1	Water Recourses Management	9
2	Fundamentals of Digital Systems Communication	9

Table XV. Laboratory courses

No	*Courses*	*Semester*
1	Introduction to Informatics	1
2	Programming Techniques	2
3	Physical Geography and Environment	2
4	Database Systems	3
5	Geodesy II (Surveying Instruments and Methods)	3
6	Engineering Mechanics	3
7	Principles of Geo-information and Geographical Information Systems	4
8	Photo-interpretation and Remote Sensing	4
9	Road Design I (Geometrical Features)	4
10	Geodesy IV (Higher Geodesy)	5
11	Thematic Cartography	5
12	Photogrammetry I (Introduction to Photogrammetry)	5
13	Engineering Materials	5
14	Special Topics of Geodesy	6
15	Geography and Spatial Analysis	6
16	Satellite Geodesy and Navigation	7
17	Cadastre	7
18	Photogrammetry III (Digital Photogrammetry)	7
19	Digital Image Analysis for Remote Sensing	7
20	Digital Mapping	7
21	Soil Mechanics and Foundations	7

22	Regional Planning	8
23	Reclamation Works	8

3. 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:

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

ii. Table of contents.

iii. 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:

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

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

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

iv. 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.

v. Originality.

vi. Student's eagerness and initiatives.

vii. 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.

4. 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:

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

b. 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

5. COURSE PROGRAMME

1st Semester

I. Mandatory courses

No	*Courses*	*Hours per week*
1	Linear Algebra and Analytical Geometry	4
2	Mathematical Analysis	5
3	Introduction to Informatics	4
4	General Geology	4
5	Geodesy I (Introduction to Geodesy)	4
6	Technical and Topographic Drawings	4
	Total	25

II. Selection of one course

No	*Courses*	*Hours per week*
1	History of Civilization	2
2	Sociology of Space	2
3	Philosophy of Sciences	2

III. Foreign Language (English, French, German or Italian) 2 hours per week

2nd Semester

I. Mandatory courses

No	*Courses*	*Hours per week*
1	Differential Equations and Complex Functions	4
2	Probability Theory and Statistics	4
3	Descriptive Geometry	4
4	Physics I (Mechanics)	5
5	Programming Techniques	4
6	Cartography I (General Cartography)	4
7	Physical Geography and Environment	4
	Total	29

II. Foreign Language (English, French, German or Italian) 2 hours per week

3rd Semester

I. Mandatory courses

No	*Courses*	*Hours per week*
1	Numerical Analysis	4
2	Differential Geometry	5
3	Projective Geometry	4
4	Physics II (Electromagnetism)	5

5	Database Systems	4
6	Geodesy II (Surveying Instruments and Procedures)	4
7	Engineering Mechanics	6
	Total	30

II. Foreign Language (English, French, German or Italian) 2 hours per week

4th Semester

I. Mandatory courses

No	*Courses*	*Hours per week*
1	Principles of Geo-information and Geographical Information Systems	4
2	Geodesy III (Land Surveying)	5
3	Photo-interpretation and Remote Sensing	5
4	Cartography II (Analytical Cartography)	4
5	Road Design I (Geometrical Features)	4
6	Geotechnical Engineering	4
7	Foreign Language and Technical Terminology (English, French, German or Italian)	2
	Total	28

II. Mandatory summer course:

Summer Field Course in Geodesy I

5th Semester

I. Mandatory courses

No	*Courses*	*Hours per week*
1	Introduction to Economical Analysis	4
2	Geodesy IV (Higher Geodesy)	4
3	Theory of Errors and Adjustments I	4
4	Photogrammetry I (Introduction to Photogrammetry)	5
5	Fluid Mechanics	3
6	Designing of Transportation Projects (Economical Elements)	3
	Total	23

II. Elective courses (One selection)

No	*Courses*	*Hours per week*
1	Applied Optics	4
2	Thematic Cartography	4
3	Introduction to Urban Planning and Settlement's Network	4

4	Engineering Materials	3

6th Semester

I. Mandatory courses

No	*Courses*	*Hours per week*
1	Geodesy V (Satellite Geodesy)	4
2	Photogrammetry II (Analytical Photogrammetry)	4
3	Geography and Spatial Analysis	4
4	Applied Hydraulics	3
5	Engineering Hydrology	4
	Total	19

II. Elective courses (Two selections)

No	*Courses*	*Hours per week*
1	Geodetic Astronomy	4
2	Special Topics of Geodesy	4
3	Photographic Data Acquisition	3
4	Fundamentals of Digital Signal Processing	4
5	Urban Geography	4
6	Regional Policy and Regional Development	3
7	Construction Equipment and Organisation of Construction Site Layout	3
8	Principles of Ecology and Environmental Chemistry	2
9	Construction Technology	3

III. Elective summer course:

Summer Field Course in Geodesy II

7th Semester

I. Mandatory courses

No	*Courses*	*Hours per week*
1	Cadastre	4
2	Digital Image Analysis for Remote Sensing	4
3	Urban Planning	4
4	Hydraulic Works	4
	Total	16

II. Elective courses (Three selections)

No	*Courses*	*Hours per week*
1	Satellite Geodesy and Navigation	4

2	Special Topics of Remote Sensing	4
3	Introduction to the Earth Gravity Field	3
4	Photogrammetry III (Digital Photogrammetry)	4
5	Digital Mapping	4
6	Geographical Information Systems	4
7	Applications to Natural Resource Management	4
8	Economic Geography	4
9	Soil Mechanics and Foundations	4
10	Road Design II (Traffic Flow)	3

8th Semester

I. Mandatory courses

No	*Courses*	*Hours per week*
1	Regional Planning	4
2	Design of Concrete Reinforced Structures	4
	Total	8

II. Elective courses (Four selections)

No	*Courses*	*Hours per week*
1	Geophysical - Exploration Gravimetry	3
2	Theory of Errors and Adjustments II	4
3	Cadastre and Land Information Systems	4
4	Metrology	3
5	Radiometry and Microwave Remote Sensing	4
6	Hydrography - Oceanography	3
7	Evaluation in Planning	4
8	Transport Geography	4
9	Methods and Applications of Town Planning	4
10	Environmental Impacts	4
11	Open-Channel Flow and Hydraulic Structures	3
12	Reclamation Works	3
13	Road Design III (Junction Design and Operation)	3
14	Railways	3
15	Transport Systems	3
16	Groundwater Hydrology	3
17	Environment and Development	3

III. Elective summer courses (One selection):

Summer Field Course in Higher and Satellite Geodesy
Summer Field Course in Photogrammetry
Summer Course in Remote Sensing

9th Semester

I. Mandatory courses

No	*Courses*	*Hours per week*
1	Business Administration	3
2	Introduction to the Legal System and Elements of Technical Legislation	3
	Total	6

II. Elective courses (Two selections)

No	*Courses*	*Hours per week*
1	Real Estate Valuation and Land Management	3
2	Special Topics of Satellite Geodesy	3
3	Marine Geodesy	4
4	Cadastre and Land Policy	3
5	Methods and Applications in Spatial Planning	4
6	Architectural Design Primer	4
7	River Engineering	3
8	Operational Research	3
9	Road Design IV (Elements of construction)	3
10	Infrastructure Engineering Works	4
11	Water Resources Protection and Management	4
12	Sanitary Engineering and the Environment	3

I. Project courses (One selection)

No	*Courses*	*Hours per week*
1	Development and Management of Land information Systems	4
2	Monument Recording	4
3	Applications of Higher and Satellite Geodesy	4
4	Special Applications of Photo-interpretation and Remote Sensing	4
5	Engineering Geodesy	4
6	Integrated Development Plans	4
7	Environmental Planning	4
8	Designing - Study - Operation of Road Works	4
9	Water Recourses Management	4
10	Fundamental of Digital Systems Communication	4

6. COURSES CONTENTS

1st Semester
Mandatory Courses

Linear Algebra and Analytical Geometry

Mathematical Analysis

Introduction to Informatics
Introduction to Informatics and Computer Science. Binary representation of arithmetic and character data. Computer architecture, hardware and software. Operating systems, programming languages and software development . Introduction to algorithms and programming control structures. Introduction to structured programming with the C++ programming language. Data types, operators and expressions. Declaration and use of memory variables. Stream-based input and output of data. Logical expressions and control-flow structures. Declaration and use of arrays. Functions and program structure. Variables and arrays as function arguments. Introduction to algorithms and complexity.

General Geology
Internal Dynamic Geology. Composition of the Earth, Temperature, Isostasy. Internal processes. Plate Tectonics theory. Tectonic processes and phenomena. Earthquakes. Influence of the geological structure to the Seismicity of the Hellenic territory. Igneous and Volcanic activity. Magmatic minerals and rocks. Metamorphism, metamorphic rocks. External dynamic processes. Weathering, Erosion, Denudation. Water influence, aquifers. Landslides. Erosion cycles, karstic and river erosion. Coasts, changes on the coasts and protection.

Geodesy I (Introduction to Geodesy)
Introduction and historical review. The planet Earth (structure, principal motions, shape and size). Reference surfaces (geoid, spheroid, sphere, horizontal plane). Basic definitions. Units of measurement. Measurements of distances, angles and height differences. Simple surveying methods. Elementary error theory. Reference systems – The Hellenic Geodetic Reference System. Computations on the plane and sphere. Coordinate transformations.

Technical and Topographic Drawings
Description of drafting tools. Principles of drafting. Establishment of drafting scales, graphic scales. Lettering, notes, line types and line weights. Harmonic and basic geometric operations and construction of various geometric shapes. Presentation of objects and shapes found in the built environment using "orthographic projection". Scaled drafting of solid geometric objects (floor plan, sections, elevations, axonometric projection). Application in an architectural design. Topographic drawing and its general rules. Accuracy of the topographic drawing. Grid, frame, legend, scale. Drawing a

topographic diagram via Cartesian and polar coordinates. Representation of the of the earth's relief (contouring). Notion of interpolation. Drawing rules for cadastral and topographic diagrams. Longitudinal section and Cross-section representation. Computer aided topographic drawing.

Elective Courses (1 selection)

History of Civilization

Sociology of Space
History, symbolism and challenges in the planning of space. Conflicts of interest. The social history of the city. Physical vs. artificial space. Private vs. public space. The social parameters of the space. The social character of the city. Transport sociology. Private and public means of transport. Mobility and its social parameters. The impact of urban form and structure on transport choices. Collective vs. individual behavior in the urban environment. Social dilemmas concerning the actual functional and organizational problems of the city. The social identity of the sustainable city of tomorrow.

Philosophy of Sciences

Courses of Foreign Languages

English Language
The aim of this two year English Language course is to cover basic issues of the grammar and vocabulary on an intermediate level and to enable students to consult technical bibliography and use the technical language. The syllabus covers the teaching of the current language in reading, listening and writing as well as basic issues on the grammar and syntactical structure for the intermediate students. Students who hold specific competence certificates can be exempted from this cycle.

French Language
The aim of this two-year French Language course is to cover basic issues of the language grammar and intermediate vocabulary and to enable students to consult technical bibliography and to use the technical language. The syllabus includes everyday language combined with technical terminology, details study and translation of technical texts which can also be of some practical use. Language problems classified in broad structure units, are examined. Question, negation, articles, pronouns, prepositions, conjunction, common adverbs etc. Examples with their translation and clarifications are given. Students who hold specific competence certificates can be exempted from this cycle.

German Language
The aim of this German Language course is to cover basic issues of the language and intermediate vocabulary and to enable students to consult technical bibliography and use the technical language.

Italian Language
The aim of this Italian Language course is to cover basic issues of the language grammar and intermediate vocabulary and syntactical structure for intermediate students.

2nd Semester
Mandatory Courses

Differential Equations and Complex Functions
First Order Differential Equations: linear, separable, homogeneous, Bernoulli and exact equations. Existence and uniqueness of solutions. Higher Order Linear Equations: the homogeneous equation, the methods of undetermined coefficients and of variation of parameters. Euler's equation. Systems of Differential Equations: solutions of a linear homogeneous system, the method of undetermined coefficients. Power Series Solutions: existence of solutions near an ordinary point and near a removable singularity, Bessel's and Legendre's functions. Laplace Transform: Definition and basic properties, sectionally continuous functions, the Dirac function, the initial value problem. Convolution. Partial Differential Equations: linear equations, the basic equations of mathematical physics, classification of second order equations, boundary value problems, the method of separation of variables. Complex Functions: elementary complex functions, differentiation and integration, Cauchy's Theorem and integral formula, power-series, Laurent series, basic theorems of complex functions, the Residue Theorem, conformal mappings, linear fractional transformations.

Probability Theory and Statistics

Descriptive and Perspective Geometry

Physics I (Mechanics)
Kinematics and dynamics of a point particle. Work, energy, momentum, conservation and applications. Kinematics and dynamics of a rigid body, rotational motion, moment of inertia, angular momentum, conservation and applications. Gravity and central forces. Mechanical and electric oscillations, fundamental quantities, equation of motion and solution, resonance, coupling of oscillators. Relativistic mechanics: simultaneity, length and time measurements, relativistic momentum and energy, Lorentz's transformation.

Programming Techniques
Principles and applications of structured programming in C++. Scope of variables, local and global variables, reference resolution. Searching and sorting algorithms. Recursive

algorithms and recursive functions. Input/output of data using text files. Pointers and dynamic memory allocation. Basic data structures (lists, queues, trees). Complex data structures and introduction to classes. User-defined data. Elements of object-oriented programming, member functions, encapsulation and access to class elements. Example applications of classes for surveying engineers. Principles of algorithm and source code optimization.

Cartography I (General Cartography)
Introduction to cartography. Basic cartographic principles, history and evolution of cartography, contemporary status and future trends of cartography. Map projections. Cartographic data collection and processing. Cartographic symbolization, cartographic generalization, landform representation and map labeling. Map composition and production. Development of mapping skills and cartometry, evaluating map distortions, designing cartographic symbols, applying generalization and map composition.

Physical Geography and Environment
Introduction to Physical Geography and Environment, Atmospheric condition and atmospheric pollution, meteorological phenomena, climatic distinctions, hydrological phenomena, physiographic and geomorphological conditions, soils, soil classification, flora and vegetation distribution, bio-climate, fauna and its distribution, quality of the natural space with emphasis on the landscapes aesthetic characteristics, protected natural areas of Greece – Laboratory exercises and educational excursions. The course has weekly two hours theory and two hours exercises.

3rd Semester
Mandatory Courses

Numerical Analysis

Differential Geometry

Projective Geometry

Physics II (Electromagnetism)
Electric charge, electric flux, potential and intensity of electric field. Magnetic dipole, magnetic flux, intensity and source of magnetic field. Interaction of magnetic and electric fields, induction, self-induction. General characteristic of waves, equation of wave. Transverse and longitudinal wave, wave superposition, standing wave. Maxwell's equations and E/M wave, energy of E/M wave. Geometrical optics: reflection, refraction, mirrors, prisms, lenses, optical instruments. Wave optics: scattering, refraction, reflection, polarization, interference and diffraction of waves.

Database Systems
Introduction to databases and data modeling. Classic data models (hierarchical, network). The Entity-Relationship semantic model. Introduction to the relational data model. Transition from the E-R to the relational data model. Database Management Systems: principles, services and architecture. Database languages, introduction to the Structured Query Language (SQL). Design of databases, introduction to UML. Logical design and normalization. Database integrity, optimization and security. Client-server architectures, introduction to xDBC and middleware. Lab based on the MS Access personal DBMS.

Geodesy II (Surveying Instruments and Methods)
Elementary error theory- Definitions of basic measurable geodetic elements. Instruments of angle and direction measurement (optical and digital theodolites). Methods of angle and direction measurement, computations and corrections. Practical exercises. Instruments of distance measurement (tapes, EDM, basic principles of GPS etc.). Methods of measurement, computations and corrections. Practical exercises. Instruments and methods of height difference measurements (spirit levelling and trigonometric heighting). Computations and corrections. Practical exercises. Satellite positioning systems: basic principles, instruments. The meaning and the use of geodetic networks (horizontal and height control networks). The use of intersections and resections in geodetic networks. Measurements and computations. Practical exercises.

Engineering Mechanics
Forces and moments: concentrated force, moment of a force about a point, addition of forces, rigid body equilibrium. Statically determinate beams and framed structures: geometrical stability, reactions, internal forces (normal-force, shear-force and bending – moment diagrams). Concepts of stress and strain: deformable body, normal stress and strain in axially loaded bar, stress and strain components in an infinitesimal orthogonal element of the body. Mechanical properties of a deformable body: stress-strain diagram, brittle and ductile behavior, Hooke law, Poisson ratio, shearing stress-shearing strain diagram. Torsion: shearing stresses and deformation in structural members with circular and rectangular cross sections in the elastic and inelastic range. Bending: simple and skew bending of structural members with symmetrical cross section, bending of structural members made of several materials deflection of beams, statically indeterminate elastic beam problems. Shearing stresses in structural members: shearing stresses in structural member with symmetrical cross section, shearing stresses in thin-walled members. Combined stresses in structural members: stresses from combined action of bending, transverse and axial loadings, transformation of plane stress, principal stresses, Mohr circle. Buckling of column: the Euler formula for a pin-ended column, elastic buckling of column with different end restraints. Laboratory tests: tensile and compressive tests for ductile and brittle materials, determination of elasticity modulus, torsion test.

4th Semester
Mandatory Courses

Principles of Geo-information and Geographical Information Systems
The course covers the principles of geo-information and the technological subject of geographic information systems (GIS). It includes: Theoretical basis of geo-informatics - historical evolution - concepts of space and time - geospatial relations - representation and models of geospatial knowledge (object-oriented and continuous-field models) - implementation of geospatial concepts and models in a GIS - geospatial databases - vector, raster and other advanced data structures - metrics and topology. Furthermore, it addresses more complex topics such as: Data sources and collection techniques – Application development – Standards, integration, and interoperability. Due to its laboratory character, the course implements the above concepts with a series of consecutive laboratory assignments, which form an integrated project.

Geodesy III (Land Surveying)
State reference coordinate systems. The meaning and the use of a traverse. Measurements and computations. High accuracy traversing. Urban traverse networks. Practical exercises. Detail surveying especially with modern methods- Surveying plotting. Field setting out of straight lines and basic curves. Land sharing. Longitudinal sections and cross sections of an axis. Area and volume computations. Practical exercises. Hydrographical surveying

Photo-interpretation and Remote Sensing
Introduction. Basic concepts and Principles of Photo-interpretation and Remote Sensing. Basics from physics and mathematics. Electromagnetic radiation. Sensors and images. Photo-interpretation and Remote Sensing instruments and measurements. Satellite Remote Sensing Programs and operational applications. Possibilities and constraints. Prospects. Photo-interpretation and Remote Sensing analogue and digital methods and techniques for Earth Observation and Monitoring by airborne and satellite systems. Applications in the scientific/technical and professional fields of the Rural and Surveying Engineer. Remote Sensing and GIS Integration, Applications for Land and Environment Inventories, Mapping and Monitoring.

Cartography II (Analytical Cartography)
Introduction (the relation between map and Earth surface). Scale, reference systems and coordinate systems. Distortions of lengths, areas and angles. Distortions of finite features. Principles of map projections. Normal projections (cylindrical, conical and azimuthal), Transverse and oblique projections. Projection systems in use in Greece and transformation between different projection systems. Cartometry and the relation between scale and measurements. Measurements of length and area and calculations of volumes. Geometric transformations. Interpolation and digital elevation models (algorithms for morphological analysis of landforms and hill-shading). Cartographic generalization (generalization operators and line simplification algorithms).

Road Design I (Geometrical Features)
Introduction. Determination and description of road geometry. Vehicle driving and braking forces. Vehicle movement in curves. Road-holding. Study elements of the horizontal alignment. Angular diagram. Marginal horizontal alignment element values. Study Speed. Operation speed. Speed limits. Calculation. Calculation of possible speed of heavy vehicles, travel time and fuel consumption. Safety criteria. Study elements of vertical alignment and marginal values. Road inclination and fitting. Visibility for stopping and overtaking. Administrative and functional categorization of roads. Parts of cross-section. Study elements of cross-section. Typical cross-sections. Calculation of soil needs with approximate and accurate methods. Corresponding cross-sections. Accuracy of soil calculations. Calculation of movement of grounds, graphically and with application of theory of linear optimization. Expropriations. Work budget.

Geotechnical Engineering
Geological environment: Plate tectonics, Seismicity, Structure, In situ stresses, Surface processes, Hydrological conditions, Geotechnical description of rocks and soils: Rock structure-rock material, Discontinuities, Stereographical projection, Mechanical properties. Site investigation-maps, Photointerpretation, In situ probes. Applications of Geotechnical Engineering-Slopes, Underground Constructions-Tunneling, Applications in Highway Engineering and Hydraulic Structures.

Summer Field Course in Geodesy I
Practical exercise based on the whole knowledge of geodesy taught in the first four semesters. Students' practice includes: establishment and measurements of a geodetic network and a traverse, detail surveying, setting out of a road axis and measurements for its longitudinal section and cross sections. Written or oral examination with the delivery of the final technical report and drawings.

Foreign Language and Technical Terminology Courses (English, French, German or Italian)

English Language and Technical Terminology
The aim of this English Language course is to cover basic issues of the grammar and vocabulary on an intermediate level and to enable students to consult technical bibliography and use the technical language. The syllabus includes gradual enrichment of the vocabulary on technical terminology through authentic technical texts of the students' major as well as comprehension and translation practice of such texts. The cycle is mandatory.

French Language and Technical Terminology
The aim of this French Language course is to cover basic issues of the language grammar and intermediate vocabulary and to enable students to consult technical bibliography and to use the technical language. The syllabus includes the gradual enrichment of the vocabulary on technical terminology through authentic technical texts

of the students' major and comprehension as well as translation practice of such texts. The cycle is mandatory.

German Language and Technical Terminology
The aim of this German Language course is to cover basic issues of the language and intermediate vocabulary and to enable students to consult technical bibliography and use the technical language. The cycle is mandatory.

Italian Language and Technical Terminology
The aim of this Italian Language course is to cover basic issues of the language grammar and intermediate vocabulary and syntactical structure for intermediate students, to enable students to consult technical bibliography and use the technical language. The cycle is mandatory.

5th Semester
Mandatory Courses

Introduction to Economical Analysis

Geodesy IV (Higher Geodesy)
Introduction. Shape and size of the Earth. Reference surfaces. Geometry of the ellipsoid. Reference Systems: Terrestrial Systems, (WGS84, ITRF) Geodetic Systems, Astronomical systems. Geo-centric and topo-centric systems. Reference Systems used in Greece. Deflection of the vertical Astro-geodetic methods. Dynamic Theory of heights. Dynamic, orthometric and normal heights. Reductions of geodetic measurements to the reference ellipsoid. Geodetic computations on the ellipsoid and in 3D Cartesian systems. Map projections used in Greece. Reduction of Geodetic data to the projection plane and computations. Datum and coordinate transformations.

Theory of Errors and Adjustments I
Introduction to adjustment theory. Principle of Least Squares. Statistical concepts. Estimation of a single variable from direct measurements (equally and unequally weighted). Estimation of standard errors. Multidimensional variables. Variance-Covariance propagation. Bivariate normal distribution, error ellipse. Least Squares adjustments by the methods of Indirect observations (observation equation), Estimation of Variance-Covariance matrices. Least Squares adjustments by the method of condition equations, Estimation of Variance-Covariance matrices. Geodetic applications.

Photogrammetry I (Introduction to Photogrammetry)
Introduction - Definitions. Photogrammetry and Surveying. Applications and implementation fields of Photogrammetry, Pros and Cons. The photogrammetric procedure. Data acquisition. Photogrammetric cameras. Camera geometry, Central projection - Interior orientation - reconstruction of the bundle of rays. Measuring and

correcting image co-ordinates. Reference systems. Geometric relations between image and space. 2D and 3D transformations. Vertical images - radial displacement. Collinearity condition. Exterior orientation. Photogrammetric Resection and Intersection. Co-ordinate determination. Single image Photogrammetry. Single image procedures. Stereo-photogrammetry - Geometry of stereo-pair. Parallax and height determination. Basic of principles of photogrammetric instruments. Functions and possibilities of analytical and digital photogrammetric workstations. Relative and Absolute orientation.

Fluid Mechanics
Introduction and basic properties of fluids, pressure, viscosity, elasticity. Hydrostatics, Pascal's principle, differential manometers, hydrostatic forces in submerged surfaces and tank walls. Kinematics and dynamics of fluids, flow lines, velocity, acceleration, continuity equation in differential control volumes, boundary conditions, parallel flow, equations of fluid flow in the direction of flow lines, Bernoulli equation. Macroscopic flow analysis in finite control volumes, Reynolds transport theorem. Fundamental equations of fluid mechanics, equations for conservation of mass, momentum, and energy. Real and ideal fluids. One-dimensional equations of conservation of mass, momentum and energy in pipes. Energy and piezometric lines.

Designing of Transportation Projects (Economical Elements)
Railways: Introduction. Elements of train motion. Study elements of horizontal and vertical alignment. Super-elevation of railroads. Rail changes. Airports: Introduction. Types, forms and parts of airport settlement. Elements of aircraft flight. Categories of airports. Calculation of the length of the landing/taking off corridor. Taxiways. Vertical alignment and elevation set of corridors and taxi-ways. Earthworks. Financial-technical issues (General elaborating principles of financial-technical studies): Introduction. Developing design / planning. Basic principles. Investments, introductory concepts. Investment categories. Financial-technical studies and elaboration methodology. Financial and economical evaluation. Conclusions.

Elective Courses (1 selection)

Applied Optics
Atmospheric effects on the propagation of electromagnetic (E/M) waves. Elements of modulation, emission and reception of E/M waves. Blackbody radiation and characteristics. Emission of E/M radiation from atoms and molecules, linear and continuous spectra. Electronic structure of solids, energy bands in conductors and semiconductors. Semiconductor devices: diodes, transistors, light emitting diodes (LED). Photoelectric effect and quantum detectors (photodiodes, CCD). Thermal detectors, infra-red observation and imaging, I2 devices. Stimulated emission of radiation and principles of laser operation. Continuous wave lasers and applications (interferometric techniques etc). Pulsed lasers and applications (telemetry etc).

Thematic Cartography
Introduction (definition and principles of thematic cartography, categories of thematic maps, spatial information and cartographic language, visual variables, visual perception). Thematic data (data sources, spatial reference, absolute values and derived data). Methods of data processing (data classification, statistical processing, spatial interpolation). Methods of thematic data visualization (qualitative and quantitative data, isarithmic mapping, choropleth mapping, oblique axonometric/perspective projections, cartograms, dot mapping and focal and multi-focal projections). Bivariate and multi-variate mapping. Graphs. Atlases. Thematic mapping and multi-media. Composition and production of thematic maps.

Introduction to Urban Planning and Settlement's Network
The settlements network of the periphery. Network theories. Hierarchy, growth poles, administrative poles. Settlement pattern in Greece. The settlements' problem. Abandonment of settlements, settlement pressure, expansion of present settlements. Settlements' network in second house areas. Co-operative housing, delineation settlements, town planning, institutional framework. Greek and international law.

Engineering Materials
Aggregates: Physical and mechanical properties, deleterious substances, shape and surface texture, gradation, grain-size distribution curves. Cements: Chemical composition, hydration, clay cements, Portland cements. Concrete: Composition, workability, disintegration, admixtures. Hardened concrete: Water/cement ratio, compressive strength, tensile strength, flexural strength, creep, durability. Special concrete: Lightweight concretes, heavyweight concretes, architectural concrete, fiber reinforced concrete. Steel: Categories, mechanical properties, fatigue, erosion. Asphalt materials: Composition, mechanical properties. Other materials: Glass, wood, soil, rock, geosynthetics.

6th Semester
Mandatory Courses

Geodesy V (Satellite Geodesy)
Introduction to Satellite Geodesy. Satellite Positioning Systems (GPS, Galileo). General principles. Conventional and satellite reference systems, time, clocks. GPS. Broadcast signal. Broadcast message, satellite orbits, satellite ephemerides. Code and phase measurements, measurement errors. Single, double and triple phase differences. Error sources. Instruments. Data processing, quality criteria, accuracy. Special measurement techniques, accuracies. Geodetic (satellite) networks, adjustments. Applications.

Photogrammetry II (Analytical Photogrammetry)
Revision of basic notions - Recap of Photogrammetry I. Special subjects of interior and exterior orientation. Planning a photo-flight. Systems and software for the navigation of

a photoflight - Specifications. Notions of digital photogrammetry. Aerial triangulation and phototriangulation: Basic principles, methods and procedures. Accuracies. Combined triangulation adjustments. Photogrammetric surveys and products. Photogrammetric production of Digital Terrain Models. Extraction of DTM's from LiDAR and other systems. Accuracy of stereo-restitution - Specifications. Orthophotography: Basic principles, procedure, instruments and software. Photogrammetric processing of satellite imagery. High resolution satellite images. Geometric models for scene orientation. Accuracies and products.

Geography and Spatial Analysis
This course offers an overview of modern geography and most important spatial analysis techniques. It is focused on the following areas: Introduction to Human Geography, Geography of Population, Environment and Natural Resources, Framework for Geographical Methods and Techniques, Field Work and Questioning, Spatial Sampling, Descriptive Spatial Statistics, Point Pattern Analysis, Spatial Correlation and Regression, Location-Allocation Models, Other Multivariable Techniques, Application of All the Techniques to Geographic Problems.

Applied Hydraulics
Introduction, real and ideal fluids. Steady vs unsteady flow. Laminar vs turbulent flow in pipes. Reynolds number. Velocity distribution near pipe boundaries. Boundary layer theory. Coefficient of friction. Flow in pipes, Darcy-Weisbach equation and Moody diagram. Basic principles and applications in steady flow in closed conduits under pressure. Water distribution systems under pressure. Local energy loses, flow of water between reservoirs, pumps and water turbines. Pipe networks, Hardy-Cross method, flow distribution in open channel cross sections. Manning equation, St. Venant equations. Uniform and non-uniform flow in open channels. Specific energy. Critical and non-critical flow. Froude number. Hydraulic jump.

Engineering Hydrology
Introduction to Hydrological Processes. Elements of Geomorphology. Statistical Analysis of Hydrological Information. Measurement and Analysis of rainfall and snow data. Hygrometry: Networks and Data analysis. Floods. Routing through reservoirs of stream sections. Meteorological and Hydrological analysis.

Elective courses (2 selections)

Geodetic Astronomy
Introduction to Positional Astronomy. The celestial sphere and definitions of reference systems and frames (celestial, terrestrial and horizon systems). Elements of spherical trigonometry and the position triangle of a star. Conversion of co-ordinates between systems. Definition and use of time scales (sidereal, Universal, Atomic and Terrestrial Time). Effects on the co-ordinates: proper motion, stellar parallax and aberration of light. Precession, nutation and polar motion. Astronomical refraction. Calculation of the

apparent place of a star. Determination of astronomical azimuth: general methods and use of Polaris. Determination of the astronomical co-ordinates: latitude by the Sterneck method and longitude by the Mayer method. Field observations using modern, digital equipment. Determination of the deflection of the vertical and of the variation of geoid undulation.

Special Topics of Geodesy
Urban surveys and street tracing - Legal specifications – Application of rights of property – Shoreline determination. Special methods for precise height difference determinations – Instrumentation – Geometric corrections – Geodetic refraction. Special surveys – Mine and cave surveys – Underwater surveys. Field and computational work is included.

Photographic Data Acquisition
Introduction. Historic evolution - Application fields. Conventional cameras and special purpose cameras. Light sensitive materials. Metric and semi-metric cameras. Camera calibration. Digital cameras, video-cameras. Aerial photography films. Camera platforms. Structure and functions of the photographic camera, shutter, diaphragm. The photographic lens - Elements of photographic optics. Darkroom, developing and printing of B/W film. Camera paraphernalia. Light theory and measuring.

Fundamentals of Digital Signal Processing
Introduction to signals and systems, types of signal (analogue-digital, deterministic-stochastic), statistical processing of signals. Linear time invariant systems and their properties. Signal convolution and correlation, sampling theory of continuous time signals. Transforms. Spectrum analysis, Fourier transforms, properties of Fourier transforms, discrete Fourier transforms, fast Fourier transform. Applications of the discrete Fourier transform, frequency response, power and energy spectrum, frequency domain convolution. Filter design techniques, types of filters, stochastic and deterministic filters, digital filters, finite impulse response filters (FIR), infinite impulse response filters (IIR), autoregressive (AR), moving averaging (MA) and autoregressive moving average (ARMA) filters, design of digital filters. Kalman filters, least squares design, Bayesian sequential estimation and phase estimation. Non linear systems and non-linear filters, morphological filters, median filters, rank order filters, non-linear convolution, linearization of non-linear filters. 2D signal processing with emphasis on image and video processing, 2D convolution and image filtering, 2D Fourier transform, properties and application, Discrete Cosine Transform (DCT), other image transforms, non linear image filtering (morphological). Applications of signal and image processing on geosciences, remote sensing and geo-informatics.

Urban Geography
The system of cities: the process of urbanism, the town's interactions. Towns' hierarchy and areas of influence. Towns of periphery. B. The town system: Elements that constitute the urban area, urban evolution and urban transports. Land use, town limits

and formal definitions. C. The problems of urban space. Transportation, transports, housing, social problems.

Regional Policy and Regional Development
The aim of this course is to provide background knowledge on policy issues, related to regional development. The course consists of both theory and applications. More specifically the focus is on: Theories of Regional Development; Sectoral and Regional Planning Aspects; Regional Development Issues and Regional Policy in Greece: Regional Development and Regional Policy in the European Union. The Applied part involves studies with sectoral or regional policy documentation on Greek or EU problems.

Construction Equipment and Organisation of Construction Site Layout
Equipment for Civil Engineering Works. Earth moving and grading machinery. Machines for building asphalt concrete pavements. Excavators. Loading equipment, trucks and conveyors. Machines for compacting road - beds and pavements. Stone - processing equipment. Stone crushers and mills. Concrete plant. Machines for preparing concrete mixes. Facilities for transporting concrete. Construction Management Techniques. Elements of Health and Safety in Construction.

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, reduction of stratospheric ozone, the greenhouse effect. Introduction to pollution control technology. Economic development and the environment.

Construction Technology
Formation of the understanding of the construction process of buildings, which leads to the logical selection of the proper combination of materials for the elaboration of technical projects. Structural elements and technology. Construction process implementation. Specification and criteria prioritization of design principles (economy, use, strength, security and special site conditions). Preparatory ground works. Load bearing frame and foundation. Non-structural elements. Insulation. Wall finishes. Floors. Finishing details and equipment. Landscape design . Time coordination.

Elective summer course

Summer Field Course in Geodesy II
Summer field course based on geodetic subjects taught up to the 6th semester. The subject of the course is a complete Topographic and Cadastral Survey of a village or a town, outside the greater Athens area, following professional technical specifications. The site and the exact topic are decided each year by the Department of Surveying Engineering after arrangements made with organizations and local authorities. The final results are used for infrastructure technical works and development.

7th Semester
Mandatory Courses

Cadastre
The importance of Land and the concept of real estate property. Ownership, use, acquisition and ownership restrictions, special rights. Elements of technical legislation, title implementation. Urban, forest and rural Land-parcel topology. Cadastral issues from transforming rural grounds to urban. Cadastral concept and evolution through the years. Cadastral systems. Cadastral Books – Cadastral Maps – Cadastral Identification Numbers. Implementation, keeping and updating procedures of the Hellenic Cadastre. Digital Cadastral Map. Analog diagrams, digital and analytical data. Digital transformation and orthophotography. Hardware. Software. Hellenic Cadastre. Users, recoverability. Implementation procedure. Cadastral information collection methods. Legislation, technical specifications and operational cost. Administrative structure, setting-up, management and maintenance-updating of the system.

Digital Image Analysis for Remote Sensing
Computational Image Interpretation. Image Histogram. Contrast enhancement, linear histogram stretching, histogram equalization, histogram saturation. Display alternatives, color processing. Filters, edge enhancement, high pass filtering, smoothing, low pass filtering, gradient, Laplacian. Spatial registration, geometric manipulation, coordinate transformation, interpolation. Radiometric Errors and corrections. Feature extraction: spectral rationing, principal component analysis, vegetation indices. Mathematical concepts for image classification, discriminant functions, Bayes theory. Density slicing. Supervised training and classification: parallelepiped, table look-up, decision tree, minimum distance, maximum likelihood. Unsupervised clustering, Algorithms: K_means, ISODATA. Post classification processing. Object oriented classification: Segmentation nearest neighbor classification. Classification accuracy. Data merging. Geographic information systems. Change detection. Applications.

Urban Planning
Introduction to urban planning: Aim, objectives, laws. Urban standards and functions. Types of plans, land uses. Systematic planning and post-modern trends. Urban

mechanisms and motives. Ways of interference. Control plan of Athens – general Urban Plan. Implementation Deed. Centres. Industrial areas. Habitation. Fundamental meanings.

Hydraulic Works
Analysis of flow in closed conduits. Municipal water supply: Demand prediction – Water quality. Reservoir design. Water supply network design and technology. Urban drainage networks design and management. Principles of operation and maintenance. Elements of other hydraulic works.

Elective courses (3 selections)

Satellite Geodesy and Navigation
Introduction to space techniques. Reference systems (conventional and satellite) in detail. Transformations. Influence of the atmosphere. Clock performance. Broadcast and precise orbits. Establishment, measurements and analysis of precision networks (short and extended). 3D, horizontal and vertical results. Data processing. Navigation and Guidance. Accuracy measures. Distance and azimuth. Differential GPS and Real Time Kinematic, measurements and analysis. Mercator projection. Hydrography, ship sea trials.

Special Topics of Remote Sensing
Advanced topics of airborne and satellite analogue and digital Remote Sensing images, methods and techniques. Advanced topics of Recognition, Analysis, Interpretation, Processing and Evaluation of remotely sensed imagery. Digital Image Processing Systems and Software for educational, research and professional use. The interdisciplinary character of Remote Sensing methodologies and Integrated Surveys. Introduction to Integrated Land, Development and Environment Information Systems. Remote Sensing applications in Natural Resources Inventories, Land Use/Cover Monitoring and Mapping, Environment and Integrated Development.

Introduction to the Earth Gravity Field
This subject introduces the use of the Earth's gravity field in applications related to the Earth disciplines and Engineering. Particular emphasis is given to its use in Geodesy under the advent of the last decade methodologies. The main emphasis is given to the determination of the geoid as a local and global height datum by various data combinations and approaches, to the determination and the evaluation of global gravity field expansion models, as well as to the use and management of terrestrial gravity anomalies.

Photogrammetry III (Digital Photogrammetry)
The digital image. Image resolution in image and object space. Radiometric transformations and preprocessing of digital images. Image convolution and digital filters. Smoothing and edge enhancement. Colour interpolation and image resampling.

Geometric transformations of digital images. Digital rectification. Digital orthophotography: procedure, geometric distortions, specifications. Other digital projections. Epipolar resampling. Digital image matching. Image correlation and least squares matching. Feature-based matching. Automation of photogrammetric procedures: automatic orientation processes, automatic DTM collection, automatic aerial triangulation. Digital photogrammetric workstations. The photogrammetric process in the digital environment.

Digital Mapping
Introduction. The nature of spatial features. Digital representation of the geographic space. Organization of spatial elements in digital environment, Data models suitable for geographic information. Spatial Data structures, Comparison of vector and raster models. Data Base Management Systems – DBMSs, Cartographic Data Bases. Conceptual design – conceptual models, Database design (conceptual – logical – physical level). Acquisition, Processing and Display of cartographic elements [methodology, encoding]. Establishing a geographic framework of reference (geo-reference), Transformations for the two-dimensional space. Supporting peripherals [specifications, functionality]. Raster to Vector and Vector to Raster transformations. Cartographic generalization in digital environment. The statistical surface – modeling & spatial interpolation. Cartographic data - Quality principles. Exchange – transfer standards. Map composition & production in digital environment. Expert systems in cartographic composition.

Geographical Information Systems
The aim of this course is to provide the students with an overview of the theory and a series of applications of Geographical Information Systems and it is focused on the following areas: Introduction (Introduction to GIS, Presentation of ArcGIS), Data Input (Georeferencing, Import GPS Data, Heads up Digitizing, COGO Data Input, Digitizing Data Editing, Non-Spatial Data Input, Relating Tables), Data Handling (Geodatabases, Changes in Projection Systems, Adding Layers, Dissolve, Erase, Split, Rubbersheet), Data Analysis (Preparing Data for Analysis, Performing the Analysis (step wise), Model Builder), Presentation (Designing a Map, Creating a Map).

Applications to Natural Resource Management
Introductory views of natural resources, ways of natural resource, classification, methods of natural resources, principles of sustainable management, Greek conditions on managing natural resources (vegetation, soils, energy resources, visual, metallurgical) methods for integrated environmental management and environmental impact. The course has weekly two hours theory and two hours exercises.

Economic Geography
The aim of the course is to study the process of constructing general principles and theories that explain the operation of the economic system in space. The course consists of both theory and applications. More specifically the theoretical part includes:

Introductory Concepts; Introduction to Economic Geography; Location in a Simplified Economic Landscape; Central Place Theory Christaller-Loesch; Urban Systems Hierarchy; Relaxation of the Simplifying Assumptions; A Heterogeneous Land Surface; Spatial Variation in Transportation costs; Spatial Variation in Production Costs; Demand Scale and Agglomeration; The Decision Making Process: a behavioral view; Economic Development in Space and Time; New Technologies and Regional Development; Theories of Entrepreneurship. The applied part, on the other hand, elaborates on qualitative and mixed methodologies (e.g. multi-criteria analysis) for the support of spatial economic activities decisions.

Soil Mechanics and Foundations
Introduction: Soil structure, Types of soils, In situ stresses, Permeability, Flow nets. Soil properties: friction, cohesion, effective stresses, compressibility, shear strength, consolidation. Soil classification, Site Investigation, In situ testing. Earth pressures: Rankine and Coulomb theories. Retaining walls: Gravity, Cantilever, Reinforced earth. Seismic analysis of walls. Bearing capacity of shallow foundations: Terzaghi‘s theory, allowable pressure, influence of eccentricity and inclination of loads, influence of underground water. Settlements: estimation of settlements based on the compressibility diagram and on SPT. Allowable settlements. Time rate of settlements. Slopes: Types of failure, Factor of safety, Method of friction circle, method of slices, Sarma‘s method. Soil improvement. Proctor and CBR tests. Principles of pavement analysis.

Road Design II (Traffic Flow)
Primary traffic concepts. Traffic counts. Methods. Technologies. Fundamental relationships between primary traffic concepts. Traffic models. Capacity analysis. Levels of service. Traffic incidents. Driver characteristics – perception/reaction times. Time headways. Junction access control. Junction time waiting. Traffic bottleneck. Traffic signals. Urban networks. Coordination. Traffic simulations models. New methods of traffic control in rural roads. Gradual speed reduction. Entrance ramp control in highways. Traffic separation over lanes. High-occupancy vehicle lanes.

8th Semester
Mandatory Courses

Regional Planning
The scope of the course is to provide the theoretical and methodological background that would enable a student to participate in the design and implementation of regional and development plans. The course consists of both theory and applications. More specifically the theoretical part includes: Introductory Concepts in Planning; Theory in Planning; Planning Process; Goal and Objectives Setting; Delineation of Regions; Regional Data Base Development; Scenario Analysis; Scenario Evaluation; Development of Policy Packages; Regional Planning in Greece; Institutional Framework for the Implementation of Regional Plans; Regional Planning in Europe. The applied

part on the other hand elaborates on the implementation of a Regional Plan for one of the administrative units of the country following the methodological steps presented during the theoretical part of the course.

Design of Concrete Reinforced Structures
Basis of design: fundamental requirements, limit states, actions, characteristic and representative values of actions, design values of action, combination of actions, mechanical properties of reinforcing steel and concrete. Structural elements and structural systems of concrete reinforced structures: idealization of the element and the structure, analysis methods for ultimate and serviceability limit states. Section and member design for bending, longitudinal force, shear, torsion, punching and buckling. Applications to slabs, beams, column and foundation elements. Control of cracking and deformation. Details of reinforcement, spacing of bars, concrete covers, minimum and maximum reinforcement percentage, minimum requirements in dimensions of structural members.

Elective Courses (4 selections)

Geophysical - Exploration Gravimetry
The principles and measuring techniques of geophysical exploration. Basic requirements and techniques for the measurement of gravity on the Earth's surface, in the sea, from the air and from space. Review of introductory elements from the theory of the gravitational potential and the modelling of the earth's gravity field parameters. Instruments and techniques for measuring gravity, corrections and reductions of gravity measurements. Gravity networks and surveys. Field data acquisition techniques, treatment, representation and interpretation of the gravity data for geophysical exploration purposes. Practical examples to such diverse exploration applications as petroleum, groundwater, and environmental engineering shown by case histories and short projects.

Theory of Errors and Adjustments II
Adjustments by the method of observation equations with constrained parameters. General Least Squares adjustments. General Least squares adjustments with constrained parameters. Sequential Least Squares Adjustments (Bayes and Kalman approaches), Weighted Stations. Measures of accuracy for absolute and relative positioning, confidence intervals and regions based on population and sampling distributions. Hypothesis testing. Optimization, adjustment and error analysis of Geodetic Control Networks in one two and three dimensions. Free Networks. Accuracy and reliability estimations. Statistical tests for deformations.

Cadastre and Land Information Systems
Geographical Information Systems. Land Information Systems. The developmental nature of modern Cadastre systems. Use and recoverability of a modern Cadastre. Digital Map. Digital and analytical data. Spatial data collection and management

methods. Hardware. Software. Updating using data from various sources. Proprietary and thematic data Collection and Management. Data bases. Planning principles, structure, management, data presentation, production. Rational L.I.S. development. Operation, management and policy sections. L.I.S. as a means of managing resources and decision making. Basic L.I.S. sub-systems and their content. Priorities. Servicing sections. Applications. Modern Cadastre and L.I.S. systems in use.

Metrology
Measurements - Elements of evaluating measurements. Function principles of geodetic and photogrammetric instruments - Errors of instruments - Corrections. Greek and international guidelines for checking the instruments (DIN, ISO etc). Certification, accreditation and standardization according to ISO. Specialized actions for determining errors and calibrating geodetic and photogrammetric instruments. Laboratory applications of the calibration methods.

Radiometry and Microwave Remote Sensing
Introduction. Atmospheric radiation transfer process. Electro-Optical sensors. Radiometric instruments. Measurements and applications in the scientific field of the Rural and Survey Engineer. Hyperspectrometry and applications. Radar fundamentals. Geometry of SAR images. SAR imagery processing and interpretation. SAR interferometry. Digital Terrain Models based on the interferometry. Comparison with other methods. Applications of SAR imagery analysis and processing methods and techniques in land use/cover inventories mapping and monitoring. Applications of the SAR imagery processing and interpretation in Hydrology, Oceanography, Geology and Forestry.

Hydrography - Oceanography
Oceanology (creation of the oceans, part of an ocean), physics of sea water (physical and chemical properties), Tides (Newtonian and Laplacian theory of tides, tide gauges, tidal maps, energy from tides), Currents (horizontal and vertical circulation of sea water, Ekman spiral, geostrophic currents, thermohaline currents, upwelling and downwelling, current measurements, current maps), The law of the Sea (history of sea law, UNCLOSS I, II and III, delimitation of territorial waters in Greece, issues on adjacent and opposite coastlines).

Evaluation in Planning
The aim of this course is to elaborate on the theory and applications of the various evaluation methods and techniques available for the support of the decision process in the various fields of planning. Such fields involve decision processes where choice among specific alternatives has to take place in order to best serve the goals of the planning process. Evaluation methods and techniques have a broad range of applications in. regional and urban planning, environmental planning, transportation planning, water resource management, etc. The course consists of both theory and applications. Theory includes: Principles of Decision Theory; Types of evaluation problems; Evaluation

methods in spatial planning; Quantitative evaluation methods (e.g. cost-benefit analysis); Qualitative evaluation methods – Multi-criteria analysis; Mixed evaluation methods, S.W.O.T. Analysis, Scenario Analysis and finally Feasibility Approaches. Applications, on the other hand, involve the study of the above methods in real cases supported by the related software tools for each case.

Transport Geography
Geography of transport networks. Urban and interurban geography of the different means of transport. Land use and transport. The crucial factors determining traffic volumes and routes. Geography of transport impacts: pollution, noise, accidents. Geography of degradation areas due to transport infrastructure. Social geography and sociology of transport. Geography of the sustainable mobility vision. Planning objectives and principles.

Methods and Applications of Town Planning
Introduction to town planning forms and procedures. Institutional framework. Problems of application. Techniques and models of town planning. Computer use in planning elaboration. How to realize approved plans. Practice in reformation areas. Ways and methods of reforming urban space.

Environmental Impacts
The course covers the following topics: Introduction to Environmental Impact issues – Principles of Environment Analysis of basic Environmental Variables, Analysis of other variables included in the Environmental Impact Assessment, Techniques and Methods of Impact Evaluation, Techniques and Methods of Impact Prevention and Impact Restoration, Environmental Impact Statement, EIA screening, EIA scooping, EIA public participation, Socioeconomic Impacts, Procedures of Strategic Environmental Assessment (SEA), Legislative framework of EIA and SEA in Greece, the EU and the International treaties regarding EIA.

Open-Channel Flow and Hydraulic Structures
Introduction. Saint-Venant equations. Uniform flow. Non-uniform gradually varied flow: Computation of flow profiles. Hydraulic jump. Introduction to hydraulic structures. Abrupt drops as discharge measurement devices and flow control structures, culverts, bridge piers, weirs (sharp-crested and broad-crested), spillways, gates, transition structures, stilling basins.

Reclamation Works
Introduction. Soil water- crops -atmosphere continuum. Irrigation water quality. Estimation of irrigation needs. Irrigation methods. Design discharges for irrigation systems. Sprinkler irrigation. Water Hammer-Protection measures. Irrigation canals. Drainage theory and drainage systems.

Road Design III (Junction Design and Operation)
At-grade junctions: introduction. Study criteria. Distances between junctions. Basic forms of at-grade junctions. Vehicle occupancy areas. Borderlines' adjustment. Hypsometric adjustment. Road surface widening. Selection and adjustment of mandatory turning lanes. Forms and ways of median and split-median adjustment. Visibility. Pedestrian circulation. Equipment. Accesses. Markings. Capacity of non-signalized junctions. Function of exclusive and non-exclusive turning lanes. Circular junctions. Grade-separated junctions: Introduction. Categories and forms. Selection criteria. Types of connective branches. Typical cross-section. Maneuvers. Weaving. Divergence. Weaving areas. Acceleration/ deceleration lanes. Adjustment of entries and exits from and towards main branches. Vertical signing. Ramp capacity analysis. Traffic control in entry highway ramps.

Railways
Introduction. General designing principles. Designing and operation of stable trajectory means. Railway systems/networks. Over-structure and infrastructure. Railway vehicles. Basic elements of construction. Introduction in dynamic distress of stable railway vehicles. Electric motion. Basic principles. Railway stations. Types/categories. Signs and security installations. Automations. Metropolitan railways. Special railways (cog railway, rope railway). General principles. Correlation and connection of railway systems/networks with other transport systems. High-velocity railways. General principles.

Transport Systems
Introductive concepts. The transport system concept. Necessity of theoretical systematic transport assessment. Transports and Economy - general principles. Finance and policy of transport. Transport networks. Combined transport. Designing and planning of transport systems. Traffic system evaluation.. Qualitative control and transport systems. Supplies and transport systems. Strategic design/planning and transport systems. Transport policy of the EU – Trans-European networks - Remaining countries. Modern financial forms of transport systems. Methodology of study development of transport systems.

Groundwater Hydrology
Introduction. The role of groundwater aquifers and their significance in water resources management. Classification of groundwater aquifers. Hydraulic parameters of porous media and groundwater aquifers. Darcy's law. Dupuit assumptions for phreatic aquifers. Inhomogeneity and anisotropy. Continuity equation and fundamental equations of flow in groundwater aquifers. Initial and boundary conditions. Methods of solution in special cases using analytical approaches. Hydrologic maps and flow nets. Well hydraulics and pumping tests. Solution of governing equations using finite differences. Artificial recharge and evaluation of aquifer capacity.

Environment and Development
Development and Environment (legal, social, economic, political and cultural components. Development of sustainable development, development of worth-living integrated development, confrontation of two opinions. Environmental and developmental policies. Preventive principle, precautionary principle, models of production, distribution, consumption. Environmental economy, Strategy, Methods and techniques of monitoring, recording and estimation of impacts, Environmental danger and uncertainty, Decision-making systems, Multi-criteria methods, Life cycle assessment. Analysis of specific areas of - cases of development and environment-practices of confrontation. Projects of interdisciplinary teams of students on the practices that will be presented in the class, likely with the method of debate. Technological and ethical obligations of engineer: the engineer can and considers his obligation to offer alternative solutions.

Elective Summer Courses (1 selection)

Summer Field Course in Higher and Satellite Geodesy
Instrumentation and measurement training. Network planning and measurements. Data analysis. Kinematic positioning, data analysis. Road mapping.

Summer Field Course in Photogrammetry
Carrying out of an integrated project, which constitutes a practical implementation of the various photogrammetric problems. The themes include digital rectification of a terrestrial object, e.g. a building façade or a monument etc., using control points or distances, or the stereo-restitution compilation from stereo-pairs on an analytical or digital workstation of either aerial or terrestrial images taken with a metric or a non-metric camera, or the compilation of photogrammetric restitutions including fieldwork and laboratory work, or the confrontation of special problems through the development of suitable software, or the utilization of specialized photogrammetric software packages, or the adaptation of existing software for the confrontation of various photogrammetric problems.

Summer Field Course in Remote Sensing
Students carry out a practical project of analog and/or digital remote sensing methods and techniques for specific subjects of interest to each student for the investigation and monitoring of Natural Resources, Environment and Development, Applications in land cover/use mapping, monitoring and planning, land policy, town and regional planning and integrated development. Field work for image processing and classification algorithms may be required.

9th Semester
Mandatory Courses

Business Administration
Introduction to Business Administration. The Nature of the Firm. Types of Firms. The Business Environment (internal and external environment). Aims and Objectives of the Firm. The Organization of the Firm. Organization Theories. Structure of Organizations. Principles of Organization. Firm's Operation. Engineering Works and Firms. Introduction to Total Quality. Business Administration. The Notion of Administration. Total Quality Management. Special Topics: The Functioning of the Market. Profit & Loss Analysis. Break-Even Point Analysis. The Production Function. Introduction to Balance Sheets and Financial Statement Analysis. Financial Ratios. The Flow Chart.

Introduction to the Legal System and Elements of Technical Legislation

Elective courses (2 selections)

Real Estate Valuation and Land Management
Real Estate Valuation. Content. Concepts. Definitions. "Real Estate Market" analysis and operation. Equilibrium and adequacy conditions. Demand-Supply interdependence. Prices evolution. The need to define the Value. Law previsions. Real Estate taxing. "Real Estate Market" affecting factors. Classification. Impacts. Spatial interdependence. Real Estate **use** as an element primarily affecting price setting. Use restrictions. Best use. Classic valuation methods accordingly applied. Developing a Real Estate "Massive Valuation" system. Valuation using G.I.S. GRSA methodology. Developing CAV systems. CAMA system. Real Estate Value as a Cadastral or modern L.I.S. element. Ministry of economics' "value objective definition system". Land Management. Management means. Land Information management system. Investment financial capabilities and legal restrictions for Real Estate Development. Special categories and special applications.

Special Topics of Satellite Geodesy
Short historical review of geodetic satellite technologies. The dynamic behavior of the Earth (Precession, Nutation, Movement of the poles) and its monitoring with satellite measuring techniques. Celestial, terrestrial and satellite-based reference systems and their mutual transformations. Fundamental problems and description of satellite orbits. Transformations from Keplerian elements to Cartesian coordinates and vise versa. Familiarity with the International Service GPS (IGS) and its various geodetic products. The technologies of Very Long Baseline Interferometry (VLBI), Satellite Laser Ranging (SLR) and Interferometric Synthetic Aperture Radar (In-SAR) and their geodetic applications. The use of satellite altimetry techniques. Modernization of the GPS and the upcoming GALILEO system. Integration of satellite positioning systems with GIS/WebGIS in new application areas such as Location Based Services (LBS).

Marine Geodesy
Hydrographic Surveying I (scales and rules, position lines, measurement accuracy), Physics of sound (principles, measurements, sound losses), Positioning (Ro-Ro, Hyperbolic, Acoustic, Inertial and Azimuth systems), Echo-sounders (transducers, vertical echo-sounding, side scan sonar, measurement errors, boomers, sparkers, narrow-beam sounders, multi-beam sounders), Hydrographic Surveying II, Delimitation of sea zones (baseline systems, bays, cluster of islands).

Cadastre and Land Policy
Cadastre and Land Policy. Basic concepts, relations, interactions and interdependencies at the constitutional, legal, technical, economic, political and social levels. Critical evaluation of Land Policy measures in Greece. Legal Infrastructure, administration activities and impact assessment. Edge technologies, Cadastre and Land Policy. The contribution of Integrated Cadastral Land Information Systems and of the Rural and Surveying Engineer towards planning, implementing, monitoring and evaluating specific Land Policy measures.

Methods and Applications in Spatial Planning
The course focuses on analytic methods and techniques used in spatial planning. It seeks to convey to students the importance of analysis, estimation and projection in understanding and planning the spatial development trajectory of different places. The methods are primarily exploratory and descriptive, using secondary data on population and the economy. More specifically, the main components of the course are: Issues of methodology and data in planning, Measures of Concentration and Inequality, Population dynamics and projections, Cohort-Component Analysis, Economic Base Theory, Shift-Share Analysis, Input-Output Analysis, Gravity models, the Garin-Lowry Model.

Architectural Design Primer
Development and evaluation of the underlying perceptual and conceptual architectural design principles. Composition and implementation of a building program in order to initiate a methodology for problem solving. Evolutionary process in architecture. Local and international architecture. Gentle architecture. Fundamentals of climatic zones. Typology and dimensional coordination. Architectural elements. Architecture of open spaces. Greek architectural heritage. and construction of identity. Postulation of Greek and international architectural cases. Building codes and standards.

River Engineering
Introduction. Flood hydrograph models. Properties of water and sediment. Bed forms of alluvial streams. Velocity distribution. Bed roughness-shear stress. Sheet erosion. Universal Soil Loss Equation. Sediment discharge. Bed-load transport and suspended load transport equations. Einstein's theory. Computation of a non-eroded stream. Channel rectification techniques-Flood protection measures.

Operational Research
Subject and Methodology: Historical development, nature and definition of Operational Research, basic characteristics, methodology, categories of problems. Linear Programming: The allocation problem, formulation of the general LP model, the Simplex method, duality theory, sensitivity analysis, transportation problem, assignment problem, decomposition principle. Non Linear Programming: Introduction, optimality conditions, unconstrained and constrained optimization algorithms. Dynamic Programming: Introduction, one-dimensional dynamic processes and applications. Investment Analysis: Investment problems, discounting cash-flows, preparation stages of investment projects, investment selection criteria, investment planning, cost-benefit analysis.

Road Design IV (Elements of Construction)
Historical evolution of road surfaces. Constructional requirements. Road surface types. Development of road surfaces. Climate. Road works in grounds with low seating ability. Constructional road structure. Sub-base – base – surface layer. Analytic (theoretical) calculation of road surface thickness. Empirical methods of calculation. Mechanic characteristics of materials. Asphalt –Asphalt mixtures. In-cohesive surfacing and territorial materials. Stabilised (elaborated) materials. Dimensioning manufacture of stiff road surfaces. Non-slip road surfaces. General principles of maintenance, aid, management of road surfaces. Draining works. Stabilisation of slopes. Small technical works. Special issues (Tunnels, Bridges etc). Environmental road construction. General principles.

Infrastructure Engineering Works
Analysis and design of special structural members of concrete reinforced structures: special types of slabs, brackets and corbels, deep beams, shear walls. Seismic design of concrete constructions: structural response, seismic loading, provisions for seismic design according to EC8 and Greek code. Analysis and design of retaining walls: function and types of retaining walls, earth pressure, external stability, reinforcement.

Water Resources Protection and Management
Introduction – basic concepts. Historical background. Legal issues and related tools in water resources protection and management - The EU Water Framework Directive. Prediction and management of water demand for various uses (urban water supply, irrigation, environmental protection). Water resources economics. Systems analysis in water management: optimisation (classical and multi-criteria) and simulation. Assessment of water availability – Introduction to hydrological modelling - Rainfall-runoff models. Time series analysis and Monte Carlo simulation. Water quality and water pollution.

Sanitary Engineering and the Environment
Basic concepts of chemistry and microbiology of water. Basic types of wastes and their consequences to the environment. Disposal of wastes to water receivers and assimilative

capacity of receivers. Ground disposal. Wastewater treatment methods. Usual types of treatment for urban and agricultural wastes.
Chemistry and microbiology of water – Basic concepts. Wastewater pollutants and their impacts on the environment. Wastewater disposal to rivers, channels and the sea. Assimilative capacity of water bodies. Disposal of wastewater to soils. Introduction to wastewater treatment processes. Theory of settling and design of sedimentation tanks. The activated sludge process - Theory and design example. Disinfection. Overview of sludge treatment and disposal processes.

Project Courses (1 selection)

Development and Management of Land Information Systems
The course aims to specific knowledge building in theory and practice on aspects related to land administration systems. It includes compilation procedures and the multipurpose character of the cadastre. The practical exercise focuses on compilation procedures of cadastre in urban areas and the updating and maintenance of the system, which includes transactions and land use changes due to urbanization. This is of significant importance for the Hellenic Cadastre in urban areas. The multidisciplinary approach of the course is based on cooperation with professors in the field of Urban Planning, Geodesy and Photogrammetry.

Monument Recording
The notion of a monument - Documentation, restoration and protection of monuments. International laws and conventions governing the monument documentation. Specifications and presentation of monument recording. Survey and photogrammetric techniques. Establishment, measurement and adjusting survey and control point networks. Planning terrestrial photography. Contemporary geodetic instruments and terrestrial photogrammetric cameras (metric, semi-metric, non-metric). Digital cameras and video camcorders. Modern restitution methods (CAD systems, photorealism), analytical and digital photogrammetric restitution systems and products. Monument archives. Monument restitution applications. This course is carried out by close co-operation of the Laboratories of Photogrammetry and General Geodesy.

Applications of Higher and Satellite Geodesy
Motions of the Earth and Time. Gravity field, geoid. Reference Frames. Map projections used in Greece. Coordinate transformations between reference frames. New forms of networks. Satellite networks of high reliability for real-time applications. Virtual networks. Networks for crustal studies. Network optimization. The zero order design (Datum problem) of a network and its realization. Internal and external reliability and statistical significance tests of the parameters with respect to models for deformation studies. Semester's pre-dissertation exercise.

Special Applications of Photo-interpretation and Remote Sensing
Theory and applications of image interpretation, digital remote sensing and geographic information systems to the geo-sphere and biosphere. Landforms, drainage patterns and soils: Photo-interpretation, spectral characteristics. Landform Photo interpretation keys. Landform suitability for site selection, design, and planning of engineering and transportation infrastructure, locating aggregate materials and for waste and sewage disposal. Water resources and the protection of the environment. Vegetation interpretation and classification. Water Resources Management, soil erosion and degradation. Agricultural applications, crop management and production, and forestry applications. Hazard assessment, mapping and monitoring (fires, insects, diseases, pollution, storms, oil-spills, forest cuts, etc.). Monitoring of ecological conditions, habitat mapping, desertification, wetland mapping. Land Policy, Environment and Development Applications of image interpretation, remote sensing and digital image analysis in a GIS environment

Engineering Geodesy
High precision geodetic measurements and instrumentation. Design, field work, computations and analysis of deformation surveys (for buildings, technical constructions and the Earth's crust). Underground works for tunnelling. Industrial Geodesy – Instrumentation and methods. Large scale surveys, Geometrical documentation, (buildings and constructions). Geodetic works in athletic installations and stadiums – Horizontal measurements of athletic records. On each of the above mentioned topics, a group of students carries out an extended case study, including field and computational work.

Integrated Development Plans
The scope of the course is to enable students to apply the theoretical knowledge gained during the courses for solving spatial planning problems based on the Integrated Development Planning Approach. The course consists of both theory and applications. Some further specialized knowledge is provided to support the applications run during the course. More specifically the students are working on real cases (regions) applying participatory approaches. Among others emphasis is placed on Scenario Analysis and Evaluation by use of modeling and evaluation techniques (back-casting scenarios, multi-criteria etc.). The whole exercise is simulating real case environments where students are trained among others on project management and interdisciplinary cooperation.

Environmental Planning
The Environmental Planning is a course-thematic unit which targets to direct the senior students to phase real planning problems through an integrated qualitative and quantitative environmental considerations. Subjects such as: Environmental carrying capacity of the region, ways of evaluating qualitative variables, social and economic dimensions of the environmental planning constitute part of the placed questions which students should respond. Knowledge from previous courses such as GIA, Statistics,

Cartography, etc. are needed in order to attend the course. By the end of the course the students present an integrated environmental planning program for the studied region.

Designing - Study - Operation of Road Works

The project comprises of a complete study of road construction, which is constituted by 4 stages. In the first stage, the category of road is determined, based on the level of connection and the traffic volume it serves. Also, the design speed and the typical cross-section are defined, elements which specify the characteristics that will have the mapping out of road. At the second stage the area of passage the road is selected, after recognition on the spot. Also, depiction of the wider area is taking place with use of aerial photographs for the manufacture of maps. At the third stage, the road geometry is studied, and the junction layout is selected. Afterwards, hydraulic study of the road is executed, the study of the essential technical works, the traffic evaluation and road surface calculation. Finally, in the fourth stage, the axis and the borderlines of the road are materialised in the field.

Water Recourses Management

Introduction – Basic concepts of water resources management. Estimation of geomorphological parameters of a drainage basin. Typical analysis of precipitation data for purposes of assessing water availability: quality control and estimation of spatial averages. Estimation of evaporation from water surfaces. Reservoir water balance and reservoir reliability. Hydrologic design of dam spillways. Stochastic simulation and its use in assessing reservoir reliability. Geotechnical, architectural and environmental issues in the construction and management of dams and reservoirs.

Fundamental of Digital Systems Communication

Introduction to signals and systems, types of signal (analogue-digital, deterministic-stochastic), statistical processing of signals. Linear time invariant systems and their properties. Signal convolution and correlation, sampling theory of continuous time signals. Transforms. Spectrum analysis, Fourier transforms, properties of Fourier transforms, discrete Fourier transforms, fast Fourier transform. Applications of the discrete Fourier transform, frequency response, power and energy spectrum, frequency domain convolution. Filter design techniques, types of filters, stochastic and deterministic filters, digital filters, finite impulse response filters (FIR), infinite impulse response filters (IIR), autoregressive (AR), moving averaging (MA) and autoregressive moving average (ARMA) filters, design of digital filters. Kalman filters, least squares design, Bayesian sequential estimation and phase estimation. Non linear systems and non-linear filters, morphological filters, median filters, rank order filters, non-linear convolution, linearization of non-linear filters. 2D signal processing with emphasis on image and video processing, 2D convolution and image filtering, 2D Fourier transform, properties and application, Discrete Cosine Transform (DCT), other image transforms, non linear image filtering (morphological). Applications of signal and image processing on geosciences, remote sensing and geo-informatics.

7. ALPHABETICAL COURSE LISTING