NATIONAL TECHNICAL UNIVERSITY OF ATHENS

The School of Mechanical Engineering

Curriculum Guide 2013-2014

Athens 2013

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1. BRIEF HISTORY OF NTUA

The National Technical University of Athens (NTUA) is the oldest technical university in Greece.

It was founded in the spring of 1837, almost simultaneously with the modern Greek State, following Greece's liberation from the Turkish yoke, as the "School of Arts". At that time, it was a technical school, operating on Sundays and holidays, and offering 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 NTUA took place in 1917, when a special bill gave NTUA a new structure and established the Schools of Civil, Architecture, Surveying, Mechanical & Electrical and Chemical Engineering.

Today, NTUA'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.

2. NTUA ORGANIZATION AND ADMINISTRATION

The current legal framework for higher education came into effect in 1982. In accordance with this, NTUA 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.

NTUA'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 NTUA staff and students.

3. THE SCHOOL OF MECHANICAL ENGINEERING

3.1. History

The National Technical University was founded in 1837 under the name Polytechnic School as an elementary technical educational institution operating on Sundays and holidays only. In 1840 its operation became continuous offering more courses.

By that time, it moved to its own building on Piraeus Street. The zeal of both student body and teaching staff raised the standard of the School. At that time the courses included mathematics, chemistry, design and mechanics organized in winter and spring terms.

During the period 1844-1862, apart from the Sunday and daily courses, a School of the higher level was created which included architecture and fine arts. During that period, a course for machinists was also introduced. Courses on magnetics and static electricity started in January 1856, and in June 1860 the first telegraph operators were trained.

During the periods 1862-1864 and 1864-1873, the Polytechnion was reorganized by adding more technical courses. A machine-shop and a telegraphic laboratory were then organized. In 1873, Polytechnion moved to its present buildings at Patission Street and was renamed Metsovion Polytechnion in honour of its benefactors from the town of Metsovon, Eripus.

Polytechnion went on operating in that form till after 1873. In 1881 a one-year course in Telegraphy was introduced.

In 1887, faculties for Civil Engineers, Machinists and Foremen were introduced and a detailed syllabus as well as an internal organization was established. The operation of the faculties continued until 1914. Then the School came under the Ministry of Public Works and took the name National Technical University of Athens.

By the time, the faculties included Civil Engineering, Mechanical Engineering, Architecture, Electrical Engineering and Telegraphic Engineering, all of them being four-year courses of highest educational level. In accordance with the law of 1914, lower level courses were removed to elementary education schools.

In accordance with legislation passed on in 1917, the National Technical University of Athens included the Highest Department of Mechanical and Electrical Engineering and Highest Departments for Architects, Chemical Engineers and Surveyors.

In the Department of Mechanical and Electrical Engineering new courses were inserted and new laboratories were set up. The courses offered were all obligatory but in 1960 and thereafter the department was divided into specialized Departments.

Thus in 1963, the division of Production Engineering was created and in 1968 the division of Naval Engineering.

Finally, in 1975, the Department of Mechanical and Electrical Engineering was divided into two independent departments. The Department of Mechanical Engineering included the divisions of Production Engineering and Naval Engineering.

With the application of the Enabling Law of 1982, the Department of Mechanical Engineering includes the following six Departments:

- Department of Industrial Management and Operational Research
- Thermal Engineering Department
- Department of Mechanical Constructions and Automatic Control

- Department of Nuclear Engineering
- Fluids Department
- Department of Manufacturing Technology

The division of Naval Engineering was separated from the Department of Mechanical Engineering and formed an independent Department. In 1986, the following two Mechanical Engineering options of courses were created:

- The option for Energy Mechanical Engineers
- The option for Design Mechanical Engineers
- In 1990, the option for Air/ Ground Transport Mechanical Engineers has been added.

The above three options, along with the existing option for Industrial Engineers, provide to the students the freedom to select courses and choose the direction of their studies.

Laboratories for student training and for research have been established aiming to support the following three main activities:

- Educational work, which includes teaching, tutorials, laboratory training, seminars and thesis support.
- Research and postgraduate studies (PhD) carried out in the six Departments of the School.
- Social work referring to the development of technology and cooperation with industrial, public and private institutions.

3.2. School Organization

3.2.1. Administration

Dean
Tatsiopoulos I., Professor(itat@central.ntua.gr)

Departmental Secretary
Dardamani Dimitra(reg_mech@mail.ntua.gr)

Contact Persons
Papantoni Artemis(artemis@fluid.mech.ntua.gr)
Petridi Stefania(reg_mech@mail.ntua.gr)
Poulla Dimitra(pdimi@central.ntua.gr)
Vardakosta Eirini(reg_mech@mail.ntua.gr)

The educational and research activities of the School are carried out in six departments:

3.2.2. Department of Industrial Management and Operational Research

Professors
I. Tatsiopoulos, PhD University of Lancaster, Diploma in Mechanical-Electrical Engineering NTUA

N. Marmaras, PhD Eng. Conservatoire National des Arts et Metiers, Diploma in Mechanical-Electrical Engineering NTUA

Associate Professors
V. Leopoulos, PhD Universite de Paris IX (Dauphine), Diploma in Mechanical-Electrical Engineering NTUA.
A.Tolis, PhD NTUA, Diploma in Mechanical Engineering NTUA

Lecturers
K. Aravosis, PhD NTUA, MSc Imperial College, Diploma in Mechanical Engineering, Aachen, Germany
K.Kiritopoulos, PhD NTUA, Diploma in Mechanical Engineering NTUA
N. Panayiotou, PhD NTUA, Diploma in Mechanical Engineering NTUA
S. Ponis, PhD NTUA, Diploma in Mechanical Engineering NTUA

Professors Emeriti
G. Kosmetatos, PhD DIC Imperial College, Diploma in Mechanical-Electrical Engineering NTUA
I.A. Pappas, PhD of Technical Sciences Eidgenossische Tech Hochschule Zurich, Diploma in Mechanical-Electrical Engineering NTUA

Scientific Assistants
S. Andrianopoulos, Diploma in Mechanical-Electrical Engineering NTUA
S. Protossigelos, Diploma in Mechanical-Electrical Engineering NTUA

Special Laboratory and Teaching Personnel
Ar. Georgiou

3.2.3. Department of Thermal Engineering

Professors
K. Antonopoulos, PhD Imperial College, MSc, DIC Imperial College, Diploma in Mechanical-Electrical Engineering NTUA.
M. Founti, PhD Imperial College, MSc, DIC Imperial College, BSc Nuclear Engineering University of London
D. Hountalas, PhD NTUA, Diploma in Mechanical Engineering NTUA
E. Kakaras, PhD NTUA, Diploma in Mechanical Engineering NTUA
C. Rakopoulos, PhD Imperial College, MSc, DIC Imperial College, Diploma in Mechanical-Electrical Engineering NTUA.
E. Rogdakis, PhD NTUA, Diploma in Mechanical-Electrical Engineering NTUA
A. Steggou-Sagia, PhD NTUA, Diploma in Mechanical-Electrical Engineering NTUA

Associate Professors
E. Giakoumis, PhD NTUA, Diploma in Mechanical Engineering NTUA
I. Koronaki, PhD NTUA, Diploma in Mechanical Engineering NTUA
C. Tzivanidis, PhD NTUA, Diploma in Mechanical Engineering NTUA
S.Karellas, PhD Technical University of Munich, Diploma in Mechanical Engineering NTUA

Professors Emeriti
S. Chatzidakis, PhD Eng. Universitat Karlsruhe, Mechanical Engineer Technische Hochschule Karlsruhe
X. Kakatsios, PhD Eng. Vienna Polytechnic, Mechanical Engineer Munchen Polytechnic
D. Kouremenos, PhD of Technical Sciences Eidgehossische Tech. HochshuleZurich, Diploma in Mechanical –Electrical Engineer NTUA.
N. Papageorgiou, PhD Eng. Tech. Universitat Braunschweig, Diploma in Mechanical Engineering, Tech. Hochschule Hannover

Scientific Assistants
D. Stavropoulos, Mechanical-Electrical Engineer NTUA

Special Laboratory and Teaching Personnel
Ch. Floros

3.2.4. Department of Mechanical Design and Automatic Control

Professors
I. Antoniades, PhD Eng. NTUA, Diploma in Mechanical Engineering NTUA
K. Kyriakopoulos, PhD, MSc Renselear Polytechnic Institute, USA, Diploma in Mechanical Engineering NTUA
E. Papadopoulos, PhD, MSc Massachusetts Institute of Technology, USA, Diploma in Mechanical Engineering NTUA
Ch. Provatides, PhD Eng. NTUA, Diploma in Mechanical Engineering NTUA

Associate Professors
Th. Kostopoulos, DSc, MSc Univ. George Washington, Columbia USA, Diploma in Mechanical Electrical Engineer NTUA

Assistant Professors
L. Alexopoulos, Ph.D. Duke University USA, MSc Duke University USA, Diploma in Mechanical Engineering, Aristotle University of Thessaloniki

Lectures
***V.Spitas**, PhD NTUA Diploma in Mechanical Engineering NTUA*

Professors Emeriti
M. Sfantzikopoulos, MSc, PhD Manchester University, Diploma in Mechanical-Electrical Engineering NTUA
N. Krikelis, PhD Northwestern University, Dipl. Ecole Superieure d'Electricite Universite de Paris, Diploma in Mechanical-Electrical Engineering NTUA

Scientific Assistants
G. Papandreou, Diploma in Mechanical-Electrical Engineering NTUA

Special Laboratory and Teaching Personnel
M. Drossakis, A. Kotsirea

3.2.5. Department of Nuclear Engineering

Professors
S. Simopoulos, PhD University of London, Diploma of Imperial College (D.I.C.), Imperial College, Diploma in Mechanical-Electrical Engineering NTUA

Associate Professors
E. Hinis, PhD NTUA, Diploma in Mechanical Engineering NTUA
M. Anagnostakis, PhD NTUA, Diploma in Mechanical Engineering NTUA

Assistant Professor
D. Petropoulos, PhD NTUA, Diploma in Mechanical Engineering NTUA
Lectures
P. Rouni, PhD NTUA, Diploma in Mechanical Engineering NTUA

Professors Emeriti
D. Leonidou, PhD London University, Diploma in Physics, University of Athens

3.2.6. Department of Fluids

Professors
K. Giannakoglou, PhD NTUA, Diploma in Mechanical Engineering NTUA
A. Zervos, PhD Pierre et Marie Curie, BSc, MSc University Princeton
K. Mathioudakis, PhD of Applied Sciences, Catholic University of Leuven, Belgium, Diploma in Mechanical Engineering NTUA
D. Papantonis, PhD Institute of Technology Toulouse, Diploma in Mechanical-Electrical Engineering NTUA
S. Tsagaris, PhD Technical University Vienna, Diploma in Mechanical-Electrical Engineering NTUA.

Associate Professors
I. Anagnostopoulos, PhD NTUA, Diploma in Mechanical Engineering NTUA
D. Mathioulakis, PhD, MSc Virginia Polytechnic Institute and State University, Diploma in Mechanical-Electrical Engineering NTUA
S. Voutsinas, PhD NTUA, Diploma in Mechanical-Electrical Engineering NTUA

Assistant Professors
D.Mpouris, PhD NTUA, Diploma in Mechanical Engineering NTUA

Lectures
N.Aretakis, PhD NTUA, Diploma in Mechanical Engineering NTUA
V.Riziotes, PhD NTUA, Diploma in Mechanical Engineering NTUA

Professors Emeriti
N. Athanasiades, PhD of Technical Sciences ETH Zurich, Diploma in Mechanical-Electrical Engineering NTUA
K. Papailiou, Doctorat d'Etat Universite Claude Bernard, Doctorat en Sciences Appliquees Universite Liege, Diploma in Mechanical-Electrical Engineering NTUA
G. Bergeles, PhD Imperial College, MSc DIC Imperial College, Diploma in Mechanical-Electrical Engineering NTUA

Special Laboratory and Teaching Personnel
D. Kolias, S. Tellakis

3.2.7. Department of Manufacturing Technology

Professors
D. Manolakos, PhD Eng. NTUA, Diploma in Naval Mechanical Engineer NTUA

Associatet Professors
G. Vosniakos, PhD, University of Sussex, MSc, Cranfield University, Diploma in Mechanical Engineering NTUA.

Special Laboratory and Teaching Personnel
P. Kostazos

3.2.8. PC Laboratory

Recognizing the importance of education employing the most modern computing means right from the first year of study, the NTUA decided (according to the Senate's Decision 18-7-97, 7th subject) the foundation of Distributed Laboratories of Personal Computers, (PCLABs) in each School of the Institution in order to achieve:

- The familiarization of the new students with the computing methods and tools, which are indispensable tools of today's engineers,
- The accomplishment of core course teaching, with priority to early semesters, with the direct use of modern teaching aids, computing systems and networks, and
- The modernization of educational programs and the upgrade of undergraduate studies, necessary to harmonize NTUA with the international tendencies and to maintain its "esteemed" role.

The School of Mechanical Engineering PCLAB operates since 2000 covering the education needs of its undergraduate students. The PCLAB has formal Regulations of Operation, a Director and an Associate Director that are assigned by the General Assembly of School. The PCLAB is staffed with the following personnel:

- Three School administrative employees for its administrative support and security
- The School's network administrator, who is assigned by NTUA's Network Management Center (NMC),
- One special administrator responsible for the PCLAB's management, and
- Postgraduate or in exceptional cases, undergraduate students, for support needs.

Since 2007, apart from a large preexisting room (capacity of 114 users), a new room (capacity of 50 users) has been added. All rooms are equipped with recent computer systems and with modern audiovisual equipment, as well as with a videoconference system.

In addition, the PCLAB is equipped with 4 Servers, 4 Stations for supervision of the operation of systems by the Administrator and administrative and security employees, as well as 57 workstations for the users in the preexisting double room and 20 workstations in the new room of PCLAB. Finally, there exist 3 PCs for the lecturers. It is also endowed with educational software of multiple and parallel use and is equipped with all kinds of peripheral devices (printers, scanner, etc.) as well as interactive and teaching aids for presentations (projective systems, smart tables, etc.). The PCLAB functions in a network, which is connected with the NTUA network.

The PCLAB has received funds by the 2nd Community Support Framework (EPEAEK). The Lab's Director is Professor K. J. Kyriakopoulos, its Assistant Director is Assistant Professor N.Petropoulos, and its administrator is Mr. P. Pavlou. Further information about the operation of PCLAB is provided in the School web pages.

3.2.9. Additional Information

For additional information, please contact the School at the following address:

Secretariat, School of Mechanical Engineering

National Technical University of Athens

15780 Zografos, Athens, Greece

Tel : (30) 210-772-3538, 3535, 3540, 3534, 4145, 4146, 1347, 2892, 1997, 4231

Fax : (30) 210-772-3541

E-mail address : reg_mech@mail.ntua.gr

URL : http://www.mech.ntua.gr

4. ACADEMIC PROGRAM

4.1. Brief Overview

The School academic program satisfies the scientific and professional needs of the Mechanical Engineer in Greece. Thus, attention is focused on the scientific and analytical ways of thinking as well as on their application in the profession of Mechanical Engineer.

The academic program has been designed to develop the students to acquire new knowledge in parallel to their professional education as Mechanical Engineers.

The wide field of Mechanical Engineering requires division in specializations. Therefore, students can follow one of the following options of study:

- Energy Engineering
- Mechanical Design
- Industrial Engineering
- Air & Ground Transport Vehicles

The four options of study are not specializations. Independently of the option selected, the degree awarded is the same and provides the same professional rights and the same core knowledge in Mechanical Engineering. The options allow students to follow a direction within the science of Mechanical Engineering, which attracts them most.

The studies last for ten six-month terms (semesters). The 1st, 3rd, 5th, 7th and 9th are winter semesters while the 2nd, 4th, 6th, 8th and 10th are spring semesters. The 1st-9th semesters are devoted to the courses, tutorials, laboratory exercises etc, while the 10th to the diploma thesis. Following the 6th semester in their studies, students can register for a Practical Project.

During the first four semesters, the students receive the necessary background on which the technological courses of the remaining semesters are based. The gradual differentiation of the program for each option of studies starts from the 5th semester.

The total attendance hours at the School should not exceed thirty-two (32) per week. The study-time spent at home is estimated to be twenty-five (25) hours per week.

4.2. Diploma Thesis

At NTUA the Diploma thesis implies a Master's level study and is quite different from other undergraduate level assignments. It is an extended written project involving in-depth work and even some original research by the student, which contributes by 20% to the final assessment for the degree. With the Diploma thesis, the specialization provided by the courses pursued during semesters 7 to 9, is complemented with knowledge on the student's chosen area of interest. The thesis main objective is the enhancement of student initiative. The application formalities for a Diploma thesis, the assignment procedure and the final text submission and examination are explicitly arranged in NTUA's Internal Regulations Rules. In summary it can be stated, that the Diploma thesis:

- is officially assigned as the sole student task for the last (10th) spring semester of studies. As a general applicable rule, only students that have successfully received approximately 80% of the obligatory courses are eligible for a Diploma thesis assignment.

- lasts at least for the nominal duration of a full semester. It is estimated that the total amount of work should be of the order of 500 student-hours. 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 commitment and his ability to fulfill the thesis requirements.
- can be assigned within a Department of the student's choice and is prepared under the supervision of a Faculty member of the chosen Department, who teaches the most relevant course. Each Faculty member has the right and obligation of supervising Diploma theses, in the field of the courses they teach, or in relevant scientific fields.
- should be presented in detail orally and in public to a three-member Faculty committee, after the student has successfully completed all taught courses and submitted a thesis final text to the satisfaction of the thesis supervisor. The thesis supervisor is, of course, one of these three members. A minimum of 30 minutes presentation is formally expected. The committee may then question and discuss thesis details, conclusions and outcome with the student, so as to evaluate the acquired knowledge and the student's actual contribution. Grading of the Diploma thesis in the scale between 0 to 10, is an immediate result of this procedure. A minimum grade of 5.5 is required for the thesis acceptance.

Each student prepares the Diploma thesis individually. If required by the nature of the thesis subject, and after the appropriate justification, the Diploma thesis could be carried out by a team of students, provided that each student's individual contribution to the work and to the thesis presentation is distinct. Each Diploma thesis is developed under the student's responsibility, with the continuous monitoring and help of the supervisor. The Department is responsible for its unhindered preparation and presentation; to this end they should allocate resources, equipment, supplies, consumables and financial means within the eligible costs in the framework of NTUA's budget. In addition the final Diploma thesis text may be printed at NTUA's printing facilities; the cost itself being covered out of the Department's funding. The Diploma thesis text should be composed using a word processor and it should conform to the basic generally accepted structure of an extended scientific essay. A certain number of the thesis hard copies are required for archiving purposes within NTUA's "Grey Literature" system. At least one such hard copy would be available for lending from NTUA's Library. Adequately prepared electronic copies would be also available in PDF format from NTUA's Library Electronic Depository (http://dspace.lib.ntua.gr/).

The main thesis evaluation criteria involve the following: (a) the degree of recording and documenting the existing knowledge level on the thesis subject with relevant literature research; (b) the quantity and the quality of the produced and/or processed knowledge and know-how i.e. in the form of theoretical results or data from lab experiments or field surveys and the like; (c) the elements contributing to the integrity of the thesis logical process e.g. data processing, sound mathematical or other modeling, computer coding, applications in practical problems, evaluation of results etc.; (d) structure of the written text e.g. continuity, correct use of terminology and language, precise formulation of concepts, adequate documentation of scientific conclusions, etc.; (e) originality; (f) student's eagerness and initiatives; (g) thesis oral presentation quality. The weighting factors of the above criteria depend on the nature of the thesis subject and are in the discretion of the examining committee.

Students, who successfully graduate following their Diploma thesis presentation, are awarded

a "Diploma of Advanced Engineering Studies". Currently, and after an application, NTUA provides its graduate students with a certificate, which states “the Diplomas provided by NTUA are considered by this institution as equivalent to the Master’s degree of recognized Anglo-Saxon universities”.

4.3. Marking Schemes

Marking in all courses is done by the 0-10 scale, without using fractions of an integer, and using as a basis for passing the mark 5. Diploma Thesis marking is an exception, since it is allowed to use half a mark (0.5) and the basis for passing is the mark 5.5. The overall mark for the diploma is calculated by summing the following: the arithmetic average of all course marks taken by the student during his studies, with a weighted coefficient of four fifths (4/5), and the thesis mark, with a weighted average of one fifth (1/5).

Excellent	9 to 10
Very Good	7 to 8,99
Good	5,5 to 6,99
Satisfactory	5 to 5,49
Bad below	5

5. COURSE PROGRAM

ACADEMIC YEAR 2009-2010

5.1. Mechanical Engineering, Semester 1-6 Courses*

5.1.1. 1st Semester

Code	Subjects	Hours
	Core Courses	
09.02.2008.01.01.02	Mathematics 1a	4
09.02.2143.01.01.02	Mathematics 1b	5
09.04.2161.01.01.02	Physics I	5
02.03.2012.01.01.02& 02.06.2012.01.01.02	Mechanical Engineering Drawing I	4
02.03.2238.01.01.02	Introduction to Computer Science	4
09.03.2248.01.01.02	Mechanics I	6
02.05.2013.01.01.02	Introduction into Mechanical Engineering	3
02.04.2241.01.01.02& 02.05.2241.01.01.02	Operating Systems	2
	Core Courses Total	**33**
	Electives	
	Group A	
09.01.2048.01.02.02	History of Science	2
09.01.2050.01.02.02	Sociology of Technology and Civilization	2
09.01.2199.01.02.02	Introduction to Philosophy	2
09.01.2221.01.02.02	Political Economy	2
	Total	**35**
	Group B	
	Foreign Language (English, French, German, Italian)	2

* The coding (xx.yy.zz.uu.vv.ww) indicates the following.

xx : School offering the course,
yy : Department offering the course,
zz : Course number,
uu : Term at which course is taught, 01=winter, 02=spring,
vv : 01=core (mandatory), 02=elective, 03=optional,
ww : School to which the course is offered

School codes: 01=Civil Eng., 02=Mechanical Eng., 03=Electrical & Computer Eng., 04=Architecture, 05=Chemical Eng., 06=Rural & Surveying Eng., 07=Mining & Metallurgical Eng., 08=Naval Architecture & Marine Eng., 09=Applied Math & Physical Sciences.

5.1.2. 2nd Semester

Code	Subjects	Hours
	Core Courses	
09.02.2282.02.01.02	Mathematics IIa	5
09.02.2283.02.01.02	Mathematics IIb	4
09.04.2170.02.01.02	Physics II	5
09.03.2010.02.01.02	Mechanics II	6
02.03.2147.02.01.02&	Mechanical Engineering Drawing II	5
02.06.2147.02.01.02		
02.04.2241.02.01.02&	Programming Languages	2
02.05.2241.02.01.02		
02.06.2105.02.01.02	Engineering Materials	4
02.03.2242.02.01.02	Introduction to Electric Circuits and Systems	4
	Total	**35**
	Electives	
	Foreign Language (English, French, German, Italian)	2

5.1.3. 3rd Semester

Code	Subjects	Hours
	Core Courses	
09.02.2246.03.01.02	Mathematics IIIa	4
02.05.2148.03.01.02	Numerical Analysis	4
09.03.2247.03.01.02	Mechanics III	6
02.03.2167.03.01.02	Machine Elements I	6
02.03.2245.03.01.02	Electromechanical Power Conversion Systems	4
02.06.2200.03.01.02	Introduction to Mechanical Workshop Technology	4
02.01.2160.03.01.02	Engineering Economics I	4
	Total	**32**
	Electives	
	Foreign Language (English, French, German, Italian)	2

5.1.4. 4th Semester

Code	Subjects	Hours
	Core Courses	
02.02.2132.04.01.02	Heat Transfer I	6
02.02.2097.04.01.02	Thermodynamics I	6
02.05.2110.04.01.02	Fluid Mechanics I	6
02.03.2078.04.01.02	Machine Elements II	6
02.03.2219.04.01.02	Mechanisms and Introduction to Machine Design	4
02.03.2039.04.01.02	Industrial Electronics	4
	Total	**32**
	Electives	
	Foreign Language (English, French, German, Italian)	2

5.1.5. 5th Semester

Code	Subjects	Hours
	Core Courses	
02.04.2079.05.01.02	Mechanical Measurements	6
02.01.2072.05.01.02	Production/Operations Management and Business Administration I	5
02.06.2156.05.01.02	Manufacturing Processes I	4
02.05.2021.05.01.02	Industrial Fluid Mechanics	4
02.02.2086.05.01.02	Steam Generators I	6
02.05.2045.05.01.02	Thermal Turbomachines	4
02.03.2089.05.01.02	Machine Dynamics I	4
	Total	**33**

5.1.6. 6th Semester

Code	Subjects	Hours
	Core Courses	
02.05.2131.06.01.02	Hydraulic Turbomachines	5
02.02.2032.06.01.02	Internal Combustion Engines I	6
02.05.2187.06.01.02	Environmental Technology	3
02.06.2093.06.01.02	Manufacturing Processes II*	4
02.01.2030.06.01.02	Operational Research I	4
02.03.2029.06.01.02	Analysis of Mechanical Structures I	4
02.03.2007.06.01.02	Introduction to Automatic Control Systems	6
	Total	**32**

* Obligatory for those who have not pass Machine Tools I.

5.2. Mechanical Engineering, Energy Engineering Option (EEO)

5.2.1. 7th Semester (EEO)

Code	Subjects	Hours
	Core Courses	
02.02.2043.07.01.02	Thermodynamics II	4
02.02.2091.07.01.02	Internal Combustion Engines II	4
02.05.2016.07.01.02	Fluid Mechanics II	4
02.04.2075.07.01.02	Physical Principles of Nuclear Power Reactor Plants (Nuclear Engineering I)	4
02.05.2251.07.01.02	Hydroelectric Power	4
	Core Courses Total	**20**
	Electives	
	Group A	
02.02.2191.07.02.02	Heat Transfer II	4
02.02.2044.07.02.02	Thermodynamics Software	4
02.02.2081.07.02.02	Transport Phenomena	4
	Group B	
02.05.2189.07.02.02	Experimental Fluid Mechanics	4
02.05.2252.07.02.02	New and Renewable Energy Sources	4
02.05.2253.07.02.02	Optimization Methods in Aerodynamics	4
	Group C	
02.04.2254.07.02.02	Interactions of Ionizing Radiations with Matter	4
02.04.2255.07.02.02	Industrial Applications of Nuclear Engineering	4
	Total	**24**

- Students must choose two optional courses from any group from any cycle.

5.2.2. 8th Semester (EEO)

Code	Subjects	Hours
	Core Courses	
02.02.2195.08.01.02	Refrigeration I	4
02.02.2162.08.01.02	Combustion Theory, Combustion Systems	4
02.04.2001.08.01.02	Nuclear Power Reactor Set-up and Operation	4
02.05.2111.08.01.02	Computational Fluid Dynamics	4
02.05.2178.08.01.02	Wind Energy	4
	Core Courses Total	**20**
	Electives	
	Group A	
02.02.2025.08.02.02	Steam Generators II	4
02.02.2186.08.02.02	Computational Methods for Transport Phenomena	4
02.05.2202.08.02.02	Principles of Jet Propulsion	4
02.02.2285.08.02.02	Gas Exchange and Supercharging of Internal Combustion Engines	4
	Group B	
02.05.2194.08.02.02	Hydrodynamic Installations	4
02.05.2100.08.02.02	Design of Thermal Turbomachines	4
02.00.2288.08.02.02	Design of Innovative Mechanical Devices	4
	Group C	
02.04.2076.08.02.02	Radiation Protection and Dosimetry	4
02.04.2263.08.02.02	Biomedical Engineering – Medical Imaging & Radiotherapy	4
02.04.2287.08.02.02	Nuclear Measuring Systems	4
	Total	**28**
	Optional	
	Environment and Development (School-Wide course)**	3

* Responsible for the course «Computational Project» is the School President. Students who register for this course receive additional credit.

** Students who register for «Environment and Development» receive additional credit.

- Students must choose two optional courses from any group from any cycle.

5.2.3. 9th Semester (EEO)

Code	Subjects	Hours
	Core Courses	
02.02.2042.09.01.02	Equipment and Systems of Thermal Processing	4
02.02.2212.09.01.02	Pollution Abatement Technology for Thermal Plants	4
02.02.2183.09.01.02	Air-Conditioning	4
02.02.2182.09.01.02	Solar Energy	4
02.05.2216.09.01.02	Gas and Steam Turbine Operation	4
	Core Courses Total	**20**
	Electives	
	Group A	
02.02.2236.09.02.02	Combustion/Pollution of Internal Combustion Engines	4
02.02.2009.09.02.02	Refrigeration II	4
02.02.2233.09.02.02	Combustion/Pollution of Aircraft Engines	4
02.02.2272.09.02.02	Thermal Energy in Buildings	4
	Group B	
02.05.2080.09.02.02	Design of Hydraulic Turbomachines	4
02.05.2185.09.02.02	Viscous Flows in Turbomachines	4
02.05.2218.09.02.02	Aeroelasticity and Aeracoustics	4
	Group C	
02.04.2262.09.02.02	Thermal-Hydraulic Analysis of Nuclear Power Plants	4
02.04.2275.09.02.02	Radioenvironmental Analysis and Protection	4
02.05.2231.09.02.02	Bio-Fluid Mechanics and Biomedical Engineering	4
	Total	**28**

- Students must choose two optional courses from any group from any cycle.

5.3. Mechanical Engineering, Mechanical Design Option (MDO)

5.3.1. 7th Semester (MDO)

Code	Subjects	Hours
	Core Courses	
02.06.2035.07.01.02	Machine Tools	4
02.03.2023.07.01.02	Control Systems and Machine Regulation	4
02.03.2169.07.01.02	Hydraulics and Pneumatics	4
02.03.2192.07.01.02	Analysis of Mechanical Structures II	4
02.03.2220.07.01.02	Machine Dynamics II	4
	Core Courses Total	**20**
	Electives	
	Group A	
02.3.2174.07.02.02	Vehicles Design I	4
02.06.2258.07.02.02	Welding - Casting	4
02.06.2259.07.02.02	Materials Protection and Surface Engineering	4
	Total	**28**

- Students must choose two optional courses from any group from any cycle.

5.3.2. 8th Semester (MDO)

Code	Subjects	Hours
	Core Courses	
02.06.2060.08.01.02	Non-Conventional Manufacturing Processes	4
02.03.2290.08.01.02	Industrial Installations	4
02.03.2264.08.01.02	Computer Methods in Structures	4
02.03.2249.08.02.02	Microprocessors Based Control	4
02.06.2222.08.01.02	Manufacturing Systems I	4
	Core Courses Total	**20**
	Electives	
	Group A	
02.03.2244.08.02.02	Vehicles Design II**	4
02.06.2266.08.02.02	Failure of Materials	4
02.00.2288.08.02.02	Design of Innovative Mechanical Devices	4
	Total	**28**
	Group C	
	Environment and Development (School-Wide course)*	3

- Students must choose two optional courses from any group from any cycle.

* Students who register for «Environment and Development» receive additional credit.

** Can be taken only by those who have taken “Vehicle Design I”.

5.3.3. 9th Semester (MDO)

Code	Subjects	Hours
	Core Courses	
02.06.2235.09.01.02	Advanced Materials	4
02.03.2289.09.01.02	Design for Mechanical Structures	4
02.03.2276.09.02.02	Biomechanics and Biomedical Engineering	4
02.01.2036.09.01.02	Ergonomics	4
02.03.2274.09.01.02	Intelligent Control Systems and Robotics	4
	Core Courses Total	**20**
	Electives	
	Group A	
02.06.2277.09.02.02	Systems for Manufacturing Processes II	4
02.06.2278.09.02.02	Micro-Nanotechnology	4
02.06.2267.08.02.02	Manufacturing and Mechanics of Composite Materials	4
	Total	**28**

- Students must choose two optional courses from any group from any cycle.

5.4. Mechanical Engineering, Industrial Engineering Option (IEO)

5.4.1. 7th Semester (IEO)

Code	Subjects	Hours
	Core Courses	
02.01.2031.07.01.02	Operational Research II	4
02.01.2213.07.01.02	Quality Management	4
02.01.2198.07.01.02	Data Bases	4
02.06.2035.07.01.02	Machine Tools	4
02.01.2260.07.01.02	Logistics (Transportation – Distribution)	4
	Core Courses Total	**20**
	Electives	
	Group A	
02.01.2125.07.02.02	Business Games	4
02.01.2215.07.02.02	Introduction to Marketing	4
	Group B	
02.03.2169.07.02.02	Hydraulics and Pneumatics	4
02.06.2258.07.02.02	Welding - Casting	4
	Group C	
02.03.2023.07.02.02	Control Systems and Machine Regulation	4
02.01.2261.07.02.02&	Energy Management	4
02.02.2261.07.02.02		
	Total	**28**

- Students must choose two optional courses from any group from any cycle.

5.4.2. 8th Semester (IEO)

Code	Subjects	Hours
	Core Courses	
02.01.2216.08.01.02	Production Planning and Control I	4
02.01.2128.08.01.02	Work Study and Elements of Ergonomics	4
02.01.2210.08.01.02	Management Information Systems	4
02.01.2291.08.01.02&	Management of Operation and Maintenance	
02.03.2291.08.01.02		
02.01.2209.08.01.02	Production/Operations Management and Business Administration II	4
	Core Courses Total	**20**
	Electives	
	Group A	
02.03.2249.08.02.02	Microprocessors Based Control	4
02.03.2290.08.02.02	Industrial Installations	4
02.00.2288.08.02.02	Design of Innovative Mechanical Devices	4
	Group B	
02.01.2269.08.02.02	Project Management	4
02.01.2268.08.02.02	Occupational Safety and Health	4
	Group C	
02.06.2060.08.02.02	Non-Conventional Manufacturing Processes	4
02.06.2222.08.02.02&	Manufacturing Systems I	4
	Total	**28**
	Optional	
	Environment and Development (School-Wide course)*	3

- Students must choose two optional courses from any group from any cycle.

* Students who register for «Environment and Development» receive additional credit.

5.4.3. 9th Semester (IEO)

Code	Subjects	Hours
	Core Courses	
02.01.2073.09.01.02	Production Planning and Control II	4
02.01.2036.09.01.02	Ergonomics	4
09.01.2028.09.01.02	Elements of Law and Technical Legislation	4
02.01.2090.09.01.02	Operational Research Laboratory**	4
02.01.2279.09.01.02	Electronic Commerce (E-Commerce)	4
	Core Courses Total	**20**
	Electives	
	Group A	
02.03.2274.09.02.02	Intelligent Control Systems and Robotics	4
02.01.2229.09.02.02	Engineering Economics II: Business Planning	4
	Group B	
02.05.2231.09.02.02	Bio-Fluid Mechanics and Biomedical Engineering	4
02.02.2042.09.02.02	Equipment and Systems of Thermal Processing	4
	Group C	
02.03.2289.09.02.02	Design for Mechanical Structures	4
02.06.2277.09.02.02	Systems of Manufacturing Processes II	4
	Total	**28**

- Students must choose two optional courses from any group from any cycle.

** Obligatory for those who have not passed the course «Special Chapters of Operational Research»

5.5. Mechanical Engineering, Air and Ground Transport Vehicles Option (AGTVO)

5.5.1. 7th Semester (AGTVO)

Code	Subjects	Hours
	Core Courses	
02.05.2016.07.01.02	Fluid Mechanics II	4
02.03.2192.07.01.02	Analysis of Mechanical Structures II	4
02.05.2197.07.01.02&	Introduction to Aircraft Design and its Subsystems	4
02.06.2197.07.01.02		
02.03.2023.07.01.02	Control Systems and Machine Regulation	4
02.03.2174.07.01.02	Vehicles Design I	4
	Core Courses Total	**20**
	Electives	
	Group A	
02.05.2253.07.02.02	Optimization Methods in Aerodynamics	4
02.05.2211.07.02.02	Aerodynamics of Compressible Fluid	4
02.05.2189.07.02.02	Experimental Fluid Mechanics	4
	Group B	
02.06.2259.07.02.02	Materials Protection and Surface Engineering	4
02.30.2169.07.02.02	Hydraulics and Pneumatics	4
	Group C	
02.02.2091.07.02.02	Internal Combustion Engines II	4
02.01.2260.07.02.02	Logistics (Transportation – Distribution)	4
02.05.2252.07.02.02	New and Renewable Energy Sources	4
	Total	**28**

- Students must choose two optional courses from any group from any cycle.

5.5.2. 8th Semester (AGTVO)

Code	Subjects	Hours
	Core Courses	
02.03.2204.08.01.02	Lightweight Structures	4
02.06.2207.08.01.02	Crash Analysis of Structures	4
02.05.2202.08.01.02	Principles of Jet Propulsion	4
02.05.2111.08.01.02	Computational Fluid Dynamics	4
02.03.2244.08.01.02	Vehicles Design II	4
	Core Courses Total	**20**
	Electives	
	Group A	
02.05.2022.08.02.02	Aerodynamics of the Subsonic Airplane	4
02.05.2100.08.02.02	Design of Thermal Turbomachines	4
02.05.2178.08.02.02	Wind Energy	4
	Group B	
02.00.2288.08.02.02	Design of Innovative Mechanical Devices	4
02.06.2060.08.02.02	Non-Conventional manufacturing Processes	4
	Group C	
02.01.2210.08.02.02	Management Information Systems	4
02.02.2186.08.02.02	Computational Methods for Transport Phenomena	4
	Total	**28**
	Optional	
	Environment and Development (School-Wide course)*	3

- Students must choose two optional courses from any group from any cycle.

** Can be taken only by those who have taken “Vehicle Design I”.

* Students who register for «Environment and Development» receive additional credit.

5.5.3. 9th Semester (AGTVO)

Code	Subjects	Hours
	Core Courses	
02.05.2218.09.01.02	Aeroelasticity and Aeracoustics	4
02.05.2217.09.01.02	Engine Operation	4
02.03.2232.09.01.02	Flight Dynamics	4
02.06.2235.09.01.02	Advanced Materials	4
02.03.2236.09.01.02	Combustion/Pollution of Aircraft Engines	4
	Core Courses Total	**20**
	Electives	
	Group A	
02.05.2280.09.02.02	Gas Turbine Diagnostics	4
02.05.2185.09.02.02	Viscous Flows in Turbomachines	4
02.06.2267.08.02.02	Manufacturing and Mechanics of Composite Materials	4
	Total	**28**

- Students must choose two optional courses from any group from any cycle.

5.6. Diploma Thesis

5.6.1. 10th Semester (Diploma Thesis)

6. COURSE DESCRIPTION

6.1. Subjects offered by other Schools

Mathematics Ia, (09.02.2008.01.01.02)

Sets. Relations – Functions. Real numbers. Sequences. Series. Limits of real functions. Continuous functions. Basic theorems of continuous functions, uniform continuity. Expontential and Logarithmic functions, trigonometric, hyperbolic functions and their inverse. Derivative of functions. Indefinite integral. Power series. Fourier series.

Mathematics Ib (09.02.2143.01.01.02)

Linear Algebra: Introductory examples. Matrix Algebra. Determinants and inverse matrices. Linear systems. Vector spaces. Orthogonality. Linear transformations. Eigenvalues and Eigenvectors. Diagonalization. Quadratic Forms. Analytic Geometry: Vector calculus. Lines and planes in space. Conic sections. Quadratic surfaces. Special surfaces. Descriptive Geometry: Presentation of space figures using to plane orthographic projections. Presentation of fundamental figures. Methods for solving problems. Problems with lines and planes. Intersection of polyhedron with plane and development.

Physics I (09.04.2161.01.01.02)

Vectors. Newton's law. Equation of motion. Applications. Conservative force fields. Conservation of energy. The Galilean transformations. Center of mass. Conservation of momentum. Mass-flow and momentum. Collisions. Angular Momentum. Conservation of angular momentum. Oscillations (simple harmonic, damped harmonic, forced harmonic oscillations). Oscillations with two and more degrees of freedom. Normal modes. Oscillations of strings. Wave equation. Traveling and standing waves. Principle of superposition. Beats. Phase and group velocity. Sound waves. Introduction in atomic and nuclear physics.

History of Science (09.01.2048.01.01.02)

History of Scientific and Philosophical Ideas, from the Ancient World to the 16th century. Myth, Science, Philosophy. Presocratics, Plato, Aristotle. Hellenistic period. Greek Astronomy and Ptolemy. The Middle Ages in the East and the West. Renaissance, da Vinci, Kepler, Bacon, Galileo.

Sociology of Technology and Civilization(09.01.2050.01.01.02)

Orientation and methods (what is sociology all about, the study of society, sociological methods, what social sciences are all about). Population and social groups (the individual and the group, population and society, types of social groups – their making, prototypes and alternatives). Social institutions (social structure, societies and civilizations, economic and political institutions, social stratification, family and relatives). Social change (change, development, progress). Modern problems of the Greek society (urbanization, migration).

Introduction to Philosophy (09.01.2199.01.01.02)

Introduction to the historical, hermeneutic and systematic approach to philosophy. Periods and branches of western philosophy. Systematic presentation and analysis of the basic problems in philosophy, such as the sources and limits of knowledge, truth, causation, mind-body problem, the external world, universals, freedom of will, language and reality, being and becoming. The importance of philosophy today.

Political Economy (09.01.2221.01.01.02)

The aim of the course is to make students capable to comprehend the basic notions of contemporary economic science, with emphasis to microeconomic concepts and macroeconomic analysis. With the completion of the course, students shall possess the ability to interpret economic relationships and tendencies and to analyze the statistical data of the national and international economy, as well as to investigate the mechanisms which determine the immediately detectable economic phenomena. At the same time, students shall be also in a position to form a scientific opinion about economic policy.

Mechanics I (09.03.2248.01.01.02)

Introduction to Statics: Introduction. Basic concepts. Principles of Mechanics. Elements of vector analysis. Force and Moment. Equivalence and reduction of forces. Equilibrium of a mechanical system. Free body diagram. Supports. Center of gravity. Distributed loads. Centroids of composite bodies. Principle of virtual work. Friction. Structures. Statically determinate problems. Statically determinate trusses, method of solution. Beams and frames. Internal forces and N,Q,M diagrams. Flexible structures. Kinematics of the rigid body: Translation and rotation. General motion of a rigid body. Mechanisms. Instantaneous center of motion. Relative motion. Coriolis acceleration. Euler’s equations.

English Language [1, 2, 3, 4]

The aim of the two-year English course is to review English grammar and intermediate vocabulary and also to enable students to consult technical bibliography. The syllabus for the two-year English course comprises: (a) Grammar and syntactical structure for beginning and intermediate students, (b) Gradual enrichment of vocabulary on technical terminology through authentic technical texts for all the Departments of the N.T.U. (c) Translation practice.

Italian Language [1, 2, 3, 4]

(a) Beginning Section. 1st year of studies. Basic structure of Italian. Pronunciation and sentence rhythm exercises. Conversation. Short texts based on fundamental vocabulary. Tests for checking the assimilation of subject matter. (b) Advanced Section. 2nd year of studies. Progressive enrichment of vocabulary. Gradual familiarity with more complex grammar problems. Translation passages from Greek into Italian and vice-versa for consolidating the subject matter already taught. Exercises and tests. (c) Italian technical terminology in the areas of Physics, Chemistry, Mechanics, Electrical and Mechanical Engineering, Architecture, Surveying, Geology, Geodesy, Metallurgy.

German Language [1, 2, 3, 4]

The aim of the two-year German course is to enable the students to consult German technical literature and at the same time to acquire a certain degree of "active" facility in the language of everyday communication, both spoken and written. The syllabus comprises: 1st year: Introduction into the phonetic, morphological and syntactical structure of German. Reading of easy texts with grammatical analysis and corresponding exercises. 2nd year: gradual enrichment of vocabulary and grammar skills on the basis mainly of special technical texts of increasing difficulty. Translation practice. Elements of business correspondence.

French Language and Technical Terminology [1, 2, 3, 4]

The general objective is to familiarize the students with the French language of modern technology as it appears in today's current texts of practical nature. Language. Basic problems are studied in large unities, such as interrogation, negation, personal and relative pronouns, use of verb tenses, articles, preposition, conjunctions etc. and particularly the syntactic use of grammatical terms. Technical terminology. Technical texts of practical nature are translated and analyzed. They concern vehicles, machinery, devices, building

construction, chemical products etc. Moreover, certain basic and topical fields of modern technology are studied consecutively, such as roads (road construction, traffic, traffic signs etc.), the automobile (engine, chassis, fuels etc.), domestic electric devices (electric and heating installation, refrigerators etc.), foods (elaboration and maintenance processes, tinned food manufacture etc.) and so on.

Mathematics IIa (09.02.2282.02.01.02)

Euclidean space R^n . Functions of several variables. Limits, continuity. Derivatives of vector functions of one variable, applications in Mechanics and Differential Geometry. Differentiable functions. Basic Theorem of differentiable functions Theorem of inverse function. Theorems of implicit functions, functional dependence. Polar, cylindrical and spherical coordinates. Local extremes, constrained extremes . Double-triple integrals. Improper multiple integrals and integrals with parameter. Line integrals of first and second kind. Line integrals independent of the path, Green's theorem, simply – multiply connected domains of R^2 , R^3 , Elements of theory of surfaces, surface integrals of first and second type. Theorems of Stokes and Gauss. Basic theorems of Vector Analysis and theory of fields. Applications.

Physics II (09.04.2170.02.01.02)

Coulomb's law. Electric field. Electric Potential Energy. Electric Potential. Gauss's law. Conductors. Dielectrics. Capacitance - Capacitors. Magnetic field. Lorentz force. Hall effect. Law of Biot and Savart. Magnetic field of a linear current. Ampere's law. Magnetic induction. Faraday's law. Lenz's law. Displacement current. Maxwell's equations. Electromagnetic waves. Geometric Optics: Propagation of Light (Fermat's principle). Reflection. Refraction. Prisms. Lenses. Wave Optics: Polarization. Interference. Diffraction. Spectrometers.

Mechanics II (09.03.2010.02.01.02)

Dynamics of the rigid body**:** Basic equations of dynamics, D'Alebert's principle. Momentum angular momentum. Work and energy and conservation theorems. Impact. Lagrange's equations. Mechanical vibrations. Introduction to the Mechanics of the deformable body**:** Basic concepts and analysis of deformable body. Stresses and strains. Transformation of co-ordinates. Plane stress, plane strain. Principal stresses. Mohr's circle. Linear elastic stress-strain relations. Tension-compression of bars, statically determinate and indeterminate frameworks. Torsion of cylindrical bars. Simple bending of beams.

Mathematics IIb (Ordinary Differential Equations) (09.02.2283.02.01.02)

Ordinary Differential Equations. Introduction: Basics, Orthogonal Trajectories, Initial-Boundary Value Problems. Linearity versus Nonlinearity and Natural Phenomena. First Order Ode's**:** Separable Variables, Exact Equations, Integrating Factor, Linear Equations, Bernoulli and Riccati Equations, Homogeneous Equations, Lagrange and Clairaut Equations. Linear Equations**:** Basics, Fundamental Theorems for homogeneous equations, Homogeneous Equations with Constant Coefficients, Nonhomogeneous equations: Undetermined Coefficients Method (Euler), Variation of Parameters Method (Lagrange). Series Solutions: Series and Sequences of Functions, Series Solutions near an ordinary point, Legendre Equation, Series Solutions near a regular singular point: Fuchs and Frobenius Theory, Bessel Equation. Systems of Odes**:** Basics, Elimination Method, Fundamental Theorems for Homogeneous Systems, Homogeneous Systems with Constant Coefficients, Nonhomogeneous Systems. Laplace Transform: Basics, Properties, Inverse Laplace Transform, Applications for Odes, Heaviside function, δ-Dirac Function, Convolution. Stability: Basics, Linear Systems, Almost Linear Systems- Linearization, Lyapunov Method.

Mathematics IIIa (Partial Differential Equ. - Complex Functions) (09.02.2246.03.01.02)

Partial Differential Equations: Introduction: Basic Equations of Mathematical Physics, Classification, Initial-Boundary Value Problems. D' Alembert Solution for the Wave equation.

Fourier Series: Basics, Convergence theorems, Fourier Sine and Cosine Series, Bessel Inequality, Equality Parseval, Properties. Boundary Value Problems: Linear Boundary Value Problems, Eigenvalue Problems, Sturm-Liouville Problems: Properties, Regular-Periodic-Singular Eigenvalue Problems. Bounded Domain: Separation of Variables, Cartesian - Polar - Cylindrical - Spherical Coordinates for Elliptic, Parabolic, Hyperbolic Equations. Unbounded Domain: Laplace and Fourier Transforms and applications to Elliptic, Parabolic, Hyperbolic Equations. Complex Functions: Basics, Functions of complex variable, Differentiation, Cauchy-Riemann Equations, Harmonic Functions, Power Series and Elementary Functions, Integrals, Cauchy theorem, Laurent Series, Singular Points and Residues, Poles. Conformal Mapping and Applications.

Mechanics III (09.03.2247.03.01.02)

Eccentric loading, composite beams. Shear stresses and bending of conventional and thin walled beams. Deflection of beams. Energy methods, Castigliano's theorem. Buckling of beams. International standards of experimental methods for testing materials. Elastic and plastic mechanical behavior. Constitutive equations in the elastic and plastic region. Failure criteria. Non-destructive testing of materials. Experimental determination of stresses and strains

Elements of Law and Technical Legislation (09.01.2028.09.01.02)

This course is divided in two parts. The first one constitutes an introduction to law and the legal system in general, whereas the second focuses on technical legislation with specific attention being paid to urban and public procurement law, as well as to the construction regulation. In detail: A) Law and the legal system. The aim of this part of the course is to give students lacking a legal background a general overview of the legal system and the operation of legal rules and to focus on essential legal issues arising in fields such as: Public law (Constitutional and Administrative law, Environmental law), Private law (contracts, torts and land law), Corporate law (commercial transactions, securities, etc), Labor law (work accidents, constructor liability, etc) and European law. B) Technical legislation. This second part of the course focuses on issues directly accruing from the theory and practice of technical legislation. Public procurement: national legislation on public procurement (types of tenders, conclusion, execution and termination of contracts, resolution for non execution). EC legislation and implementing measures. Urban law: aim and sources of urban law: substantive matters: interaction with environmental protection and with the presentation of the architectural heritage and tradition.

Environment and Development (School-wide course)

This inter-departmental course aims to present and analyze different approaches relating to all particular subjects, including theory, tools and practical solutions, as well as to practice the students in environmental decision-making issues. The course is divided in three parts: *Part I*: Development and environment; sustainable development and critical aspects; Environmental and development policies; Remediation of damage; Prevention and precaution principles; Production, distribution and consumption models; Administrative and technological tools. *Part II – Thematic areas*: Analysis of particular thematic areas with presentation of actual incidents and case studies. Team project of interdisciplinary groups of students and presentation in class. *Part III – The role of Engineer*: Technological and ethical responsibilities of the engineer: capability and duty to provide alternative solutions. The course is supported by an e-book available to all students through the internet.

Design of Innovative Mechanical Devices (02.00.2288.08.02.02)

Design of Innovative Mechanical Devices is offered by one or more faculty members as an 8th semester optional course. In the beginning of each spring semester, and after an approval from their Sector, the faculty members who suggest a Computational Project, announce the topics at a Bulletin Board of the Department Registrar Office. In the case the topic is given by

two or more Departments, all Departments involved must approve it. The student chooses this course after consultation with the faculty member who suggested the topic, and includes it in the list of courses taken according to the normal registration process. After the completion of the project, the involved faculty member submits the project report, a short evaluation report, and a grade suggestion to the School's Chair.

6.2. Subjects offered by Industrial Management and Operational Research Department

Engineering Economics I (02.01.2160.03.01.02)

Introduction to Engineering Economics. Marginal analysis of resource allocation. Input value – resources production cost. Output value. Activity economic evaluation. Investment problems. Cash flow Analysis. Preparatory stages of an investment plan. Comparative economic evaluation – Investment selection criteria. The investment plan: Basic concepts and definitions. Partial sections of an Investment Plan. Development, scheduling and evaluation of Investment Plans. Systems Analysis and technical projects. Introduction to Risk Analysis.

Production/Operations Management & Business Administration I (02.01.2072.05.01.02)

Introduction: the enterprise, its goals and functions. Production Management. Product design and principles for setting standards. Quality control: from control of quality to total quality; x-bar/R charts. Work Study: methods, motion and time study; time measurement; trends in work organization. Production planning: product demand and production systems; inventory management; material requirements planning (MRP). Measurement of efficiency, production cost accounting. Business administration. Other enterprise functions: marketing, finance, personnel. Principles of organization. *Laboratory exercises on metrotechnics*.

Data Bases (02.01.2198.07.01.02)

Data Base Management Systems Architecture. ER model. Management Applications and Data Bases. SQL tutorial. Introduction to relational algebra. Normal Forms and schema normalization. Relational Data Bases. Introduction to hierarchical and network models. Small Data Bases on a spreadsheet. Data Base management with C and Basic languages.

Production/ Operations Management and Business Administration II (02.01.2209.08.01.02)

Industrial cost accounting: Main concepts in costing. Full costing accounting. Marginal costing accounting. Cost – benefit analysis. Financial functions. Management control & cost centers. Activity - Based Costing (ABC). Budgeting. Laboratory of Metrotechnics.

Business Games (02.01.2125.07.02.02)

This is a laboratory course where students learn how to apply their knowledge in business administration by managing a simulated enterprise. The students work in groups of 5-6 persons and they take decisions concerning basic business functions (production, marketing, finance, human resources, etc.). The empirical education process is accompanied by oral presentations.

Operational Research I (02.01.2030.06.01.02)

Introduction to the scientific field of Operations Research (OR): Definitions, a glance at the history of OR science, Basic Disciplines. Methodological approaches, taxonomy of OR problems. Mathematical modeling, and introduction to Linear Programming: Introduction to mathematical modeling, Theory of Linear programming, solving linear problems-The simplex method, big M method, duality theory and sensitivity analysis, irregular types of linear programming models, the transportation problem, the assignment model, integer linear programming models, typical integer problems. Networked Analysis: Project planning, development of a project network, the critical path method (CPM), the project evaluation and review technique (PERT), cost optimization, minimal spanning tree problem, shortest route problem, traveling salesman problem. Risk analysis: Probability-based decision making, Monte Carlo simulation, sensitivity analysis, multicriteria decision making methods, analytic hierarchy process (AHP), analytic network process.

Quality Management (02.01.2213.07.01.02)

Quality, specifications and tolerances. Quality control. Statistics in production (Histogram, distribution, normal distribution, distribution of the mean value of small samples). Meaning and the techniques of preliminary quality control (control charts, natural tolerances). Preliminary quality control by variables and by attributes. Comparison of the above techniques. Acceptance sampling by attributes (operating characteristic curve, acceptance quality level, rejectable quality level, average outgoing quality, average outgoing quality limit, acceptance quality control systems by attributes) acceptance quality control by variables (sample size, criteria). Quality control in the factory. Reliability. Average life and failure rate. Acceptance sampling by measuring the average life and the failure rate. (Characteristic curve, acceptance quality level, rejectable quality level). Quality management systems. Documentation requirements, document control – quality records. Management responsibility. Resource management. Product realization, design and development, purchasing, production and service provision, product identification and traceability, purchaser supplied product, control of monitoring and measuring devices. Monitoring and measurement, control of non-conforming product, internal audit. Certification agencies and Quality management system's certification.

Introduction to Marketing (02.01.2215.07.02.02)

Main concepts, Marketing definitions. The Marketing environment. Competitive advantage creation. Marketing strategy (marketing mix – the four Ps). Market Research. Industrial Marketing & Consumers Marketing. Consumers' buying behavior. Industrial buyers' buying behavior. Market segmentation in industrial markets & consumables. Product strategies and policies. Adoption process, buying process and dissemination process of new industrial products and technological innovation. Pricing & distribution policy. Distribution systems of consumer and industrial products. Promotion methods and techniques of consumer and industrial products.

Operational Research II (02.01.2031.07.01.02)

Basic Probability theorems. Theorems of conditional probabilities (Bayes Theorem). Total Probability Law. Random variables – Statistical Distributions (discrete and continuous). Link with Operations Research subject (examples). Markovian processes for decision making. Markov chains. Applied Queuing Theory – Introduction. Processes of birth and death. Poisson prototypes. Other Statistical prototypes. Specific Queuing prototypes and implementation methods. Modern computational methods of Optimisation. Evolutionary algorithms. Particle Swarm Optimisation, adaptive learning and mutation. Decision analysis and decision trees. Dynamic programming.

Work Study and Elements of Ergonomics (02.01.2128.08.01.02)

Methods study. Process and workflow diagrams. Motions study. Work measurement.

Performance assessment. Allowances, basic and standard time. MTM, Work Factor. Work study at the process industry. Introduction to Ergonomics. Generic Ergonomic Model. Ergonomic design of workplace and tools. Physical work – design for physical workload decrease. Thermal environment. Psycho-acoustics and noise environment. Vision and lighting. Time and work (biological rhythms, work during night, aging).

Production Planning and Control I (02.01.2126.08.01.02)

Selection of plant location. Selection of mechanical equipment. Group technology. Types of production processes. Plant layout. Methods for determining space requirements. Structural building elements. Layout algorithms. Interfactory products and material movements. Building's module. Roof, floor. Color, work psychology. Storage and warehousing material handling equipment. Automated warehouses. Order picking systems.

Management Information Systems (02.01.2210.08.01.02)

Introduction to Systems Analysis and Design. System engineering methodologies for technical, social and information systems (current situation analysis, goal setting, synthesis and analysis of alternative solutions, evaluation and solution selection). Structured analysis and design techniques. Applications of information systems in materials management, purchasing, production management, production and quality control, distribution and logistics, plant maintenance and preventive maintenance (ERP=Enterprise Resources Planning Systems). Management control and key indicators management (Data warehousing, MIS Reporting). Information systems strategy.

Operational Research Laboratory (02.01.2090.09.01.02)

Computer laboratory exercises and case studies on the following topics: Spread-sheets, Linear Programming, Integer Linear Programming, Simulation, Heuristic Methods, Expert Systems, Decision Support Systems, Decision Analysis, Analysis of Product Distribution Networks.

Ergonomics (02.01.2036.09.01.02)

Cognitive Tasks: perception, memory, sings categories. Man-machine interface design. Human Computer Interaction and usability engineering. Design of informational systems. Complex cognitive tasks (problem solving, diagnosis, decision making). User-centered design of information technology systems supporting complex cognitive tasks. Human errors, human reliability.

Production Planning and Control II (02.01.2073.09.01.02)

Objectives of Production Planning and Control. Classification of production management systems. Demand management and customer order processing. Sales and Operations Planning (aggregate planning) and Master Production Scheduling (MPS). Computer-Aided Production Management (CAPM). Production Data Management (PDM). Material Requirements Planning (MRP). Machine loading and detailed scheduling. Plant data collection (PDC) systems and production reporting. Just-In-Time (JIT) methodology in production and operations systems. Production and materials management in CIM (Computer Integrated Manufacturing) systems.

Engineering Economics II: Business Planning (02.01.2229.09.02.02)

Cost – benefit analysis. Cost – benefit analysis Case Studies. Introduction to environmental economics. Specific topics of Business Planning (special emphasis is given at the analysis of specific financial tools and funding methods, like Venture Capital). Building – Operation –

Transfer (BOT) Method. Public Private Partnerships (PPPs etc.). Innovation, Entrepreneurship and Business Planning. Groups of students' practice at Business Planning. Students collect actual data and develop, in groups, the complete business plan of a new or an existing company (preferably of the Environmental or Energy field) which they present in the class.

Operation Logistics (Transportation - Distribution) (02.01.2260.07.02.02)

Introduction to Supply Chain Management. Inventory management. Statistical Inventory Control. Demand Forecasting and Data Analysis. Importance of Physical Distribution. Transportation as a purchasing function. Multi-modal and Intermodal Transport. Transport negotiations and evaluation. Importance of product packaging. Transportation costing. Insurance. Telematics in transportation. Objectives of Distribution management. Relations to marketing. Distribution and customer service. Distribution channels. Supply Network Planning (SNP). 3rd party logistics. Green packaging. Standardization of transport and distribution equipment. Distribution processes. Routing and scheduling. Geographical Information Systems (GIS). Distribution algorithms. Purchasing management and e-procurement.

Energy Management (02.01.2261.07.02.02, 02.02.23.07.02.02)

Energy balance of Greece. Energy consumption by source and use. Development and trends of technology through time. Technologies of energy management and handling. Economical feasibility. Transportation of fuel and biofuels (logistics algorithms I). Transportation of fuel and biofuels (logistics computational techniques II). Storage and stacking methods of fuel and biofuels (logistics – techniques – technologies). Calculation of logistics cost. Investment analysis of power plants based on renewable energies. (NPV calculation) I. Investment analysis of power plants based on renewable energies. (Investment Evaluation) II. Investment analysis of power plants based on renewable energies. (Financing schemes) I. Investment analysis of power plants based on renewable energies (IRR Calculation) II. Forecasting – market research I (the importance of forecasting in the market research. Forecasting models). Energy control, evaluation and monitoring (e.g. in buildings). Benefits. Planning of energy evaluation and exploitation system. Energy conversion and distribution. Energy use. Estimations for basic applications (heating, air conditioning, steam generation, industrial activities, lighting). Estimations of results. Passive planning of energy consumption in buildings: principles. Climatic changes, solar radiation, thermal losses and benefits. Thermal comfort. Thermal energy and building. Heat insulation. Wind and building. Humidity and building. Lighting. Passive solar systems. Computational programs, inaccuracies, assumptions. Computational models, examples for buildings.

Occupational Safety and Health (02.01.2268.08.02.02)

Different approaches to the problem of Occupational Safety and Health (OSH). The systemic approach to OSH. Accident analysis methods. Occupational risk assessment methods. Statistical analysis of occupational accidents and work related diseases. The cost of OSH. Managing OSH at the enterprise. OSH legislation.

Project Management (02.01.2269.08.02.02)

Project management concepts and definitions. Analysis of a project to correlated tasks, phases and milestones. Network scheduling techniques (CPM, PERT, GERT, PETRI-Nets). Design and solving of a project chart. Organizational structures. Organizing and staffing the project office and team. Resource allocation. Overallocation resolving techniques. Project cost and cash flow. Project control and monitoring. Project quality assurance. Project risk management. Computerized project planning and monitoring. Case studies.

Electronic Commerce (E-Commerce) (02.01.2279.09.01.02)

Main concepts, E-business & E-Commerce Definitions. E-Business Strategy Implementation.

E-business models analysis in sales and marketing with the use of the Internet (E-marketing). E-Commerce applications for selected sectors (E-tailing, E-recruitment, E-learning, E-banking, E-government). Customer Relationship Management (CRM) systems & flexible sales. Security systems and e-payment. Infrastructure and software technologies for the implementation of E-Business applications. E-business evaluation with the use of Key Performance Indicators. Considerations about e-business applications and future trends. The course includes a ten-week assignment concerning the development of a dynamic Web Site with the use of HTML and JavaScript or VBScript.

Management of Operation and Maintenance (M&O)(02.01.2291.08.02.02)

Operation and maintenance of engineering facilities: Introduction. Management of technical processes. Management of maintenance processes Maintenance: Production and Control (precautionary maintenance, maintenance commands, technical works for maintenance). Replacement of technical equipment: Introduction. Replacement of equipment with similar equipment, replacement with advanced – improved equipment. Sudden and/or continuous technological progress. Replacement of parts and components. Theory of replacement: Isolated parts and their replacement in integrated technical systems. Problems of inspection and maintenance. Maintenance and Reliability of technical equipment: Introduction, definitions, calculation of reliability function, for different technical systems. Definition of optimal reliability level. Analysis and evaluation of failure and investigation of parameters leading to failure of engines and/or mechanical constructions. Analysis of instrumentation and industrial software used for the investigation of reliability, maintenance and failures.
Frequent failures of parts and structures in industrial environment. Real-time continuous and sampling methods for failure and machine operation monitoring. Destructive and non-destructive integrity assessment techniques. Calculation of residual service life and replacement decision making. Temporary repair-replacement solutions and their application. Lubrication and setting of their inspection-relubrication-replacement intervals. Technical methods of managing unforeseen sudden failures in the industry.

6.3. Subjects offered by the Thermal Engineering Department

Thermodynamics I (02.02.2097.04.01.02)

Basic thermodynamic concepts and definition – The first law of Thermodynamics – The ideal gas – Thermodynamic cycles – The Carnot cycle and its application to a perfect gas - Reversible and irreversible processes - The second law of Thermodynamics – The Thermodynamic temperature scale – The concept of Entropy – T-s and h-s charts - The thermodynamic probability - Mixtures of inert ideal gases – Entropy and irreversibility, Maxwell and Tds relationships – Two phase systems –The properties of vapors - Tables and charts for vapors - Real gases - Particular irreversible processes – Throttling – Joule-Thomson effect – Equations of state for the real gases (Van der Waals) – Heat capacities of real gases - Basic thermodynamic cycles – Thermodynamics of flow processes.

Thermodynamics II (02.02.2043.07.01.02)

Ideal and nonideal solutions - Binary Vapor-Liquid Equilibria - Partialmolar properties - The classification of solutions, Dilute solutions, Activity and activity coefficient, Estimation of activity coefficient at infinite dilution - Models for the Excess Gibbs Energy and subsequent activity coefficients for the binary systems - Heat effects of mixing processes - Isenthalpic throttling of a mixture - Virial equation for the gas mixtures - Azeotropes - Regular solutions - Absorption - Absorbers - Separation of Solution Components - The Fractionator (Stripping - Rectifying section) - Mc Cabe-Thiele and Ponchon methods - Liquid-liquid equilibrium - Liquid-solid equilibrium. Statistical thermodynamics. Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac distribution functions. The partition function. Thermodynamic properties of a system. Applications.

Heat Transfer I (02.02.2132.04.01.02)

An elementary treatment of the principles of heat transfer for a one semester course with a separate discussion of heat conduction and convection - Steady-state and unsteady-state conduction in one- and multiple dimensions is treated from both the analytical and the numerical viewpoint and a similar procedure is followed in the presentation of convection heat transfer. Analytically: Conduction; the Conduction Rate Equation, the Thermal Properties of Matter. One-Dimensional, Steady-State Conduction: the Plane Wall, Radial Systems (the Cylinder, the Sphere), Composite Structures, Critical Thickness of Insulation, Conduction with Thermal Energy Generation, Application of Resistance Concepts, Heat Transfer from Extended Surfaces. Two-Dimensional, Steady-State Conduction: Finite Difference Equations and Solutions. Transient Conduction. Convection: The Convection Transfer Problem and Equations, The Convection Boundary Layers, Boundary Layer Analogies, The Convection Coefficients. Convection and Internal Flow: Hydrodynamic and Thermal Considerations, The Energy Balance, Laminar and Turbulent Flow in Circular Tubes and Convection Correlations, Noncircular Tubes, Heat Transfer Enhancement. External Flow and Convection (The Flat Plate in Parallel Flow, The Cylinder in Cross Flow, The Sphere, Flow Across Bank of Tubes). Free Convection: The Governing Equations, Empirical Correlations. Boiling and Condensation. Heat Exchangers: Heat Exchanger Types, Heat Exchanger Analysis; Use of the Log Mean Temperature Difference, NTU-Method. Radiation: Fundamental Concepts, Blackbody Radiation (The Planck Distribution, Wien's Displacement Law, The Stefan-Boltzmann Law), Surface Emission, Absorption, Reflection, Transmission. Kirchhoff's Law.

Internal Combustion Engines I (02.02.2032.06.01.02)

Description and general operating principles of spark ignition (Otto), compression ignition (Diesel) and Gas Turbine engines; General introductory concepts from Thermodynamics; Combustion of perfect gas mixtures with variable specific heat capacities; Theoretical air cycles of Otto, Diesel and Gas Turbine engines; Actual operating cycles of Otto, Diesel and

Gas Turbine engines; Energy balance; Special conditions of combustion in internal combustion engines; Problems associated with various fuels combustion, mixture preparation, combustion chamber configurations; Load regulation; Introduction to pollutant emissions. Internal Combustion Engines Laboratory.

Combustion Theory, Combustion Systems (02.02.2162.08.01.02)

Introductory notions. Characteristics, classification and physical mechanisms of combustion phenomena. Laminar and turbulent diffusion and premixed flames. Mathematical modeling of gas-combustion phenomena. Evaporation-combustion of liquid fuels. Combustors and conventional combustion systems for gas and liquid fuels. Contemporary combustion technologies for biomass and Municipal solid waste. Fuel Cells. Measuring Systems. Emissions form combustion systems. Laboratory sessions accompany the lectures.

Steam Generators I (02.02.2068.05.01.02)

World energy demand. General description of thermal plants. Water/steam properties. Preliminary knowledge, Historical evolution of steam generators' manufacturing, Sizing criteria of modern steam generators, Classification of modern steam generators (Natural, forced or once through circulation), Feedwater quality, Pumps - Fans. Thermodynamic cycles of Steam Power plants, Rankine cycle's thermal efficiency, Specific heat consumption, Potential of increasing thermal efficiency, Calculations of thermal circuits, Condensation – Cooling water, Thermal Power Plant's evolution (High efficient Steam Power plants), Steam generator's energy balance, Loses, Gross-net efficiency of steam generator, Self-consumption. Combustion in the steam generator. Physico-chemical composition and fuel properties, Characteristic temperatures. Stochiometric combustion. Air ratio. Co-combustion of more than one fuels. Incomplete combustion. Combined cycle plants, Cogeneration of Heat and Electricity, Industrial cogeneration plants. Economics of electricity production, Fluegas emissions, Environmental impact. Laboratory exercises measuring thermal plant's efficiency, Measurements of steamboiler's thermal efficiency.

Heat Transfer II (02.02.2191.07.02.02)

General principles of heat Transfer. Transient conduction. Analytical methods for transient phenomena – Periodic conduction. Nature of thermal radiation - Basic principles of thermal radiation - Blackbody radiation – Wien's displacement law – The Stefan-Boltzmann law – Exchange of radiation between real surfaces – Kirchoff's law – Radiation exchange between two or more surfaces – Electrical analogy – Shape factors – Gas radiation – Infrared thermography.

Internal Combustion Engines II (02.02.2091.07.02.02)

Nature and origin of forces action and propagation through the slider-crank mechanism of reciprocating engines; Special dynamic phenomena in piston reciprocating engines, such as crankshaft non-uniformity of rotation, balancing of inertia forces and moments, and crankshaft torsional vibration; Control and operating characteristic curves of SI and Diesel engines for various loads; Part load operation; Advanced study of the actual Otto and Diesel engines operating cycle – Experimental facilities and techniques, Control and Tuning – Basic phenomena in piston engines heat transfer - Cooling systems

Transport Phenomena (02.02.2081.07.02.02)

Introduction to heat and mass transfer. Fick's law of diffusion. Species conservation laws in simultaneous diffusion and convection. Mass transfer in laminar and turbulent flows. Similarity principles. Special chapters in transport phenomena: Boiling and condensation – Characteristics and applications of heterogeneous mixtures – Classification of two-phase (gas-solid, gas-liquid, bubbly) flows – Characteristic numbers – Basic equations – Evaporation.

Refrigeration I (02.02.2195.08.02.02)

Introduction to industrial refrigeration. Refrigeration via mechanical vapor compression. Typical refrigeration cycle. Refrigeration with sub- and super-heat. Real refrigeration cycle. Multi-step vapor compression systems. Stirling cycle. Typical cycle of liquefaction of air. Liquefaction cycle of air low-high pressure. Liquefaction of air with partial expansion. Minimum work for air liquefaction. Compression via fluid beam. Thermo-electrical refrigeration. Magnetic refrigeration. Refrigeration via absorption. Refrigeration systems using NH_3/H_2O and $H_2O/LiBr$. Refrigeration via adsorption and re-absorption. Psychrometry. Sensible heat. Cooling and dehumidifying. BHF factor. Laboratory.

Combustion / Pollution of Internal Combustion Engines (02.02.2236.09.02.02)

General working principles for Diesel and Otto engines. Combustion in Otto engines. Combustion chamber design of Otto engines for reduced specific fuel consumption and emissions. Systems for fuel metering, mixture preparation and ignition in Otto engines. Thermodynamic analysis of combustion in Otto engines. Combustion in Diesel engines. Diesel engines combustion chambers. Fuel injection in Diesel engines. Advanced topics in Diesel engines combustion. Heat release rates in Diesel engines. Pollutants formation and emission in piston I.C. engines. Control methods for reducing the emitted pollutants from piston I.C. engines.

Equipment and Systems of Thermal Processing (02.02.2042.09.01.02)

Heat and Mass Transfer of Mixtures. Humidification Operations, Gas-Liquid Operations; Fundamental Relationships, Equipment. Cooling Towers. Gas Absorption, Stripping: Countercurrent Multistage Operation, Continuous-Contact Equipment - Absorption, Stripping of One Component, Multicomponent Systems. Tray and Packed Towers. Drying: Batch and Continuous Drying; Mechanisms; Equipment. Condensers. Solid-Fluid Operations: Adsorption Operations and Equipment. Distillation: Continuous Rectification - Binary Systems; Method of Ponchon-Savarit, Method of McCabe-Thiele, Continuous-Contact Equipment. Multicomponent systems; Lewis-Matheson Calculation, Method of Thiele and Geddes. Liquid Extraction and Equipment: General Design Considerations. Regulations and Standards. Energy Audits and Surveys; Evaluating the Findings; Implementing Recommendations. An Individual Project (with Computational Methods) is required to deepen knowledge in the field of Absorbers, Cooling Towers, Driers, Distillation Columns, Condensers.

Steam Generators II (02.02.2025.08.02.02)

Combustion chambers. Pulverized coal combustion. Combustion in grates, fluidized beds. Drying and pulverization of solid fuels. Burners for solid, liquid and gaseous fuels. Characteristic design data. Elements of heat exchange surfaces configuration. Combustion chamber's calculation, Determination of actual combustion temperature. Flame's dimensions. Heat flow density. Thermo-technical calculations, Heat transmission, Radiation, Calculation of the membrane walls' temperature. Thermal stresses, Steady state phenomenon, Quasi - stationery phenomena, Elements of mechanical strength calculation. Main steam generator auxiliary parts, Evaporators, Superheaters, Economizers, Reheater, Air preheater. Electro-static precipitators, Fouling and slagging. Circulation, Pressure losses, Single-face or Two-face flow. Steam generators' functional comparison of natural, once through or forced circulation. Steam generators' water treatment, Fluegas emissions, ash, Significance of combustion's phenomenon, Combustion processes.

Computational Methods for Transport Phenomena (02.02.2186.08.02.02)

Transport by molecular motion, transport in laminar or turbulent flow - Hyperbolic, parabolic and elliptic equations - Variational methods for steady-state and time-dependent transport phenomena (weak formulation, functionals, the Ritz method, the method of weighted residuals). Finite difference method (discretization, steady-state and transient diffusion,

Steady-state and transient transport by diffusion and convection) - Finite element method (physical or direct approach, variational formulation, steady-state and transient transport phenomena) - Boundary element method - Errors, convergence and stability of numerical methods - Computer programs for each method - Applications.

Solar Energy (02.02.2182.09.01.02)

Solar radiation (basic concepts, angles, direct and diffuse radiation, spectral distribution, attenuation by the atmosphere, tilted and tracking systems, correlations, measurement of solar radiation, values in the Athens area) - Theory of flat-plate collectors (heat transfer analysis, temperature distribution on the absorber plate, collector efficiency factor, heat removal factor and flow factor, collector efficiency, measurement of collector performance, various designs of flat plate collectors) - Concentrating collectors - Solar systems for space and service water heating (design methods, the f-chart method) - Design methods for thermal solar systems (Utilizability, the f-chart method) - Energy storage - Other applications (Solar cooling, conversion to mechanical energy, solar ponds, passive systems, economics).

Air-Conditioning (02.02.2183.09.01.02)

Thermal comfort - Psychrometrics (thermodynamic properties of moist air, humidity parameters, psychrometric charts, typical air-conditioning processes) – Air duct design (frictional losses, dynamic losses, duct design methods) - Climatic conditions - Solar heat gain - Air-conditioning loads (heat gain, cooling load, heat extraction rate, ASHRAE load calculation method, loads from walls - fenestration - lighting - people - appliances - ventilation and infiltration, transfer function method) - Air-conditioning systems: direct expansion, all-water (fan-coil units), all-air (variable volume or variable temperature, dual conduit, multi-zone systems), air-water (induction unit), heat pump – Applications (design of installations) – Laboratory.

Refrigeration II (02.02.2009.09.02.02)

Cooling systems components. Reciprocating compressors, rotary, screw and centrifugal. Air condensers, water-cooled. Evaporators for air and water cooling. Systems and accessories for expansion, regulation and protection of refrigerating facilities. Industrial refrigeration of storehouses. Cooling loads. General principles. Location criterions. Location and size of chambers. Construction elements. Pre-cooling, cooling, deep freeze. Controlled atmosphere cooling. Conditions of storage and transport of perishable products.

Combustion / Pollution of Aircraft Engines (02.02.2233.09.02.02)

Aircraft burners. Aircraft fuels, types, specifications. Pollution, limits and limitations. Propulsion burners. Solid/liquid fuel boosters. Fuel injection systems. Fuel jets. Fuel droplet's distribution. Primary air. Fuel preparation, ignition, flame. Heat/mass transfer of fuel jet and of droplets. Heat transfer to the walls. Burner cooling by air injection. Chemical reaction equations. Chemical reaction kinetics, deviations. Pollution and pollutants. Combustors modeling. Transient operation, stability. Experimental checking of burners. Characteristic operational curves of burners. Afterburners with constant/adjustable orifice. Afterburner's combustion. Supersonic combustion. Transient phenomena in afterburners. Afterburner's modeling.

Thermodynamics Software (02.02.2044.07.02.02)

MATHCAD computing and engineering calculation documentation. Absorption refrigeration systems and Working fluid (H2O-LiBr and NH3- H2O). Principle of operation. Various designs of absorption refrigeration cycles. Single-effect absorption system. Multi-effect absorption refrigeration cycle. Applications in cogeneration. Stirling Engines. Mechanical configuration. Applications. Free-Piston machines. Solar dish Stirling. Low temperature difference engines. Cogeneration. Isothermal and adiabatic analysis. Parasitic losses. Examples : CPU-3, Ford-

Philips 4-215 power units and PPG-102 refrigerator. General Theory of real gases - Equation of states - Estimation of the thermodynamic properties of real gases – Compressed gases – Chemical potential – Fugacity of pure gases and binary mixtures – Equation of states for binary mixtures – Thermodynamics of surface phenomena. ASME Steam Properties for Industrial Use based on IAPWS-IF97. Introduction. Structure of the New Formulation. Advantages of IF97 over IFC-67. Executable Programs using IAPWS-IF97 Steam Properties. Simulation codes for the operational behavior of the power cycles. Modern cogeneration and trigeneration case studies.

Energy Management (02.02.2261.07.02.02, 02.01.2261.07.02.02)

Energy balance of Greece. Energy consumption by source and use. Development and trends of technology through time. Technologies of energy management and handling. Economical feasibility. Transportation of fuel and biofuels (logistics algorithms I). Transportation of fuel and biofuels (logistics computational techniques II). Storage and stacking methods of fuel and biofuels (logistics – techniques – technologies). Calculation of logistics cost. Investment analysis of power plants based on renewable energies. (NPV calculation) I. Investment analysis of power plants based on renewable energies. (Investment Evaluation) II. Investment analysis of power plants based on renewable energies. (Financing schemes) I. Investment analysis of power plants based on renewable energies (IRR Calculation) II. Forecasting – market research I (the importance of forecasting in the market research. Forecasting models). Energy control, evaluation and monitoring (e.g. in buildings). Benefits. Planning of energy evaluation and exploitation system. Energy conversion and distribution. Energy use. Estimations for basic applications (heating, air conditioning, steam generation, industrial activities, lighting). Estimations of results. Passive planning of energy consumption in buildings: principles. Climatic changes, solar radiation, thermal losses and benefits. Thermal comfort. Thermal energy and building. Heat insulation. Wind and building. Humidity and building. Lighting. Passive solar systems. Computational programs, inaccuracies, assumptions. Computational models, examples for buildings.

Gas Exchange & Supercharging of Internal Combustion Engines (02.02.2285.08.02.02)

Mechanism, timing and characteristics of flow through the inlet and exhaust valves of four-stroke engines; swirl, squish, divided combustion chambers, blowby, throttle valve of Otto engines; Charging efficiency; residual gas, exhaust gas recirculation); Blowdown and displacement of exhaust gas, silencers, exhaust gas recirculation; Systems and gas flow scavenging through the ports of two-stroke engines, performance parameters and scavenging models; Turbulence; Mechanical supercharging, exhaust gas turbocharging (constant pressure and pulse t/c); Intercooling and aftercooling; Matching the mechanical supercharger or the exhaust gas turbocharger with the four-stroke and the two-stroke internal combustion engine for various operating schemes; High performance turbocharging (turbo-compound, two-stage, variable geometry turbines, Miller, adiabatic engines) and control systems of turbocharger boost pressure; Efficiency, mechanical and thermal stress and emissions from turbocharged engines; Transient response; Various issues associated with the turbocharging of spark ignition engines.

Thermal Energy in Buildings (02.02.2272.09.02.02)

Outdoor and indoor boundary conditions. Climatological data, ambient temperature, solar radiation etc. Insulation materials, outdoor and indoor convection coefficients. Analytic, computational and experimental methods for building heat transfer. Transfer functions and thermal networks of buildings. Transient and steady state heat transfer in building envelope. Conduction and convection in buildings. Thermal mass influence in building’s thermal behavior. Bioclimatic design in buildings, passive solar systems. Active and apparent thermal capacitance. Night ventilation and thermal mass of building envelope, infiltration. Thermal response of various building materials. Energy savings in buildings and modeling of thermal mass via thermal networks. Thermal inspection of buildings. Thermal Circuit Theory. Basic Thermal Elements. Reference Temperature. Temperature Node. Pure Temperature Source.

Pure Heat Source. Conductance. Switch. Quasi Heat Source. Quasi Temperature Source. The Heat Continuity Equation in an Enclosure. The Mesh Approach. The Nodal Approach. The Ventilated Cavity. A Basic Circuit for Thermal Response. Circuit Transforms. Delta-Star Transformation. Series-Parallel Transformation.

Pollution Abatement Technology for Thermal Plants (02.02.2212.09.02.02)

Energy and environment. Environmental impact from heating installations. Energy technologies and operations for the reduction of the environmental impact, Environmental Impact Assessment studies. Introduction to the environmental management systems, (EMAS – ISO 14000). Elements of the environmental management systems, Methodology for the development of the environmental management systems, Application examples of the environmental management systems. Formation mechanisms and capture possibilities of the main gaseous pollutants (NO_x, SO_2). Acid dew point and controlling mechanisms. CO_2 emission and the greenhouse effect. Studies of reducing CO_2 emissions in several countries. Reduction of CO_2 emissions from electricity production. Clean coal technologies, Carbon Capture and Sequestration (CCS). Electrostatic precipitators, Operating principles and theory, Efficiency, Structural design, Economic data. Technical measurements for gaseous pollutants' emissions (O_2, CO_2, O_2, SO_2, N_2O, C_xH_y, NO_x) and particles. *Laboratory exercises measuring the concentration of gaseous pollutants*

6.4. Subjects offered by Mechanical Design and Control Systems Department

Mechanical Engineering Drawing I (02.03.2012.01.01.02, 02.03.2012.02.01.02)

Introduction to mechanical engineering drawing. Types of mechanical engineering drawings. Free hand sketching. International standardization. Paper sizes. Drawing scales. Types of lines and their use. Multiview projection. Sectional and auxiliary views. Dimensioning of the engineering drawings. Threads and screws. Drawing of the basic machine elements. Tolerances and fits. Surface roughness assignment. Mechanical assembly drawings. Drawings of welded structures. Introduction to computer aided design/drafting (CAD). The course is complemented with free hand sketching and conventional drawing exercises, drawing of real machine components and assemblies, CAD applications, machine tool workshop practice.

Introduction to Computer Science (02.03.2238.01.02)

Introduction to Computing. Numbering Systems. Binary arithmetic and coding. Boolean Algebra. Logic arithmetic & Circuits. Computer Architecture. Microprocessor architecture and operation. Typical microprocessors. Peripheral Devices. Assembly Languages. Introduction to computing languages and compilers. Introduction to operating system principles. Computer communications & Networks. Introduction to Scientific computations using the MATLAB™ environment. Computing applications in Mechanical Engineering. Laboratory sessions: (α) Introduction to the Windows™ environment and applications (β) Introduction to MATLAB™.

Mechanisms and Introduction to Machine Design (02.03.2219.04.01.02)

Mechanisms and their accession in machines. Structure and modeling of mechanisms. Kinematical analysis of classical mechanisms using modern methods. Dynamic response of simple mechanical systems with specific properties. Dynamic response of simple mechanical systems with specific properties. Elements of mechanisms, cams. Generalization of mechanism' s concept in flexible mechanisms (with pneumatic and electrical elements). Three-dimensional mechanisms. Applications. Design of machines through the principle of structural composition. Tetrahedron theory-constituents. Design-structural components of mechanisms. Bibliography. Laboratorial exercise 1: Modeling of complex mechanism. Laboratorial exercise 2: Analysis of mechanism (in MATLAB environment).

Machine Elements I (02.03.2167.03.01.02)

Introduction to mathematical modeling of mechanical parts and assemblies. Engineering materials and their selection methods. Loading and failure models on machine elements. Design for life and Fail safe engineering design approaches. Calculation of static and fatigue loading. Calculation of the fatigue strength of parts using Woehler, Soderberg and Goodman-Smith diagrams. Elements of fracture mechanics and Paris charts. Stress intensity and stress concentration coefficients in machine elements. Cumulative effect of fatigue and Miner;s rule. Strength calculation for combined loading. Shafts and axles. Calculation of wended joints and adhesive layers. Mechanics and calculation of threads and bolted connections. Shaft-hub connections (keys, splines, friction elements, press-fits). Couplings, cluthes and brakes.Ball-roller bearings and dry sliding bushings. Rotary seals for shafts. Springs and other flexible machine elements. Wire ropes and linear flexible machine elements and their applications. Protective coatings for machine elements.

Machine Elements II (02.03.2078.04.01.02)

Introduction to motion and power transmission systems. Power flow in mechanical systems and efficiency. Belt drives and friction drives. Law of gearing and matrix equations of gear meshing. Contact surfaces, rolling curves and meshing gear tooth profiles. Contact ratio and

stages of tooth meshing. Kinematical Analysis and calculation of slidind velocity and efficiency. Gear types (cylindrical spur-helical gears, bevel and spiral bevel gears, worm-gear sets, hypoids, spiroids etc) and their calculation under common loading types (bending strength, pitting, scoring etc). Compliance, profile modifications and load distribution on gear teeth. Transmission errors and gear tolerances. Gear manufacture. Gear failure and inspection. Chain drives. Speed reducers and gearboxes. Planetary mechanisms and differentials. Special drives (harmonic, cyclo-drive etc). Lubrication and introduction to tribology. Journal Bearings and air bearings.

Machine Dynamics I (02.03.2089.05.01.02)

Dynamics and its role to the behavior of machines, structures and installations. Modeling of engineering structures as lumped mass systems. Introduction to Finite Element Modeling (one dimensional structures). Elements of experimental dynamic analysis of mechanical systems and sensors. Vibration transmission from solids to air and acoustical problems. Measurement and suppression of industrial noise.

Power Hydraulics and Pneumatics (02.03.2169.07.01.02)

Introduction to power and motion transmission using power-hydraulics and pneumatics. Energy and mass flow in power hydraulics. Hydraulics fluids (properties and selection). Transient phenomena and water hammer effect. Geometry and calculation of the displacement pumps. Pipes and fittings. Flow control equipment (check valves, pressure relief valves, flow control valves etc). Ancillary hydraulic equipment (tanks, filters, heat exchangers etc). Hydrostatic actuators (cylinders and hydraulic rotary motors)I and their design and application. Hydraulic accumulators. Hydraulic actuation control units (servo- valves, analogue valves) and metering systems. O-rings and high pressure seals. Hi-lo dual speed systems and motion synchronization. Pneumatic air compressors. Storage tanks and air conditioning systems for pneumatics. Pneumatic cylinders and motors and their calculation and design. Pneumatic flow control valves and automation systems. Pneumatic circuits.

Introduction to Automatic Control Systems (02.03.2007.06.01.02)

Introduction, brief history, control system principles, mathematical models of physical systems, transfer functions, state equation, functional block diagram, properties of feedback control systems, transient response, basic feedback controllers, methods for control system design, root locus, frequency response, compensation, applications.

Analysis of Mechanical Structures I (02.03.2029.06.01.02)

Mechanical structures, materials, isotropic and anisotropic structures, structures made of composite materials. Geometrical modeling of 2D and 3D structures, mesh generation techniques. One-, two- and three-dimensional finite elements. Two-dimensional structures (membrane, plate, shell). Elasticity and thermoelasticity problems. Acoustic problems. Practical.

Design For Manufacturing & Cost (02.03.2289.09.01.02)

Product design specification. Conceptual, embodiment and detail design. Design principles. Principal design guidelines. Variant design. Value engineering analysis. Mechanical engineering design in conjunction with the technical characteristics of the manufacturing processes. Design of cast, forged, formed, machined and welded components. Design for accuracy and interchangeability. Tolerance analysis and synthesis. Tolerances and machining accuracy. Tolerancing methods. Accuracy and surface integrity and quality. Design for assembly. Design for manufacturing / assembly cost reduction. DFC indices. Machining and sheet metal fabrication economics. Design of part families. Case study assignment. Laboratory applications and demonstrations.

Control Systems and Machine Regulation (02.03.2063.07.01.02)

Modeling of dynamical systems, power state variables, bond graphs, derivation of state space equations, linear systems analysis, solution of state space equations, controllability and observability, classical and modern control, state feedback control, optimal control, the general optimal control problem, linear-quadratic optimal control problem, optimal regulator, relation to the classical control, optimal control and reference input tracking systems, state reconstruction – observers, applications.

Lightweight Structures (02.03.2204.08.01.02)

Selected elements in theory of elasticity. Torsion of solids sections (Prandtl stress function solution, the membrane analogy, warping function solution, torsion of a narrow rectangular strip). Stress equilibrium of thin plates in bending, torsion and plane-stress. Analytical solutions for typical boundary conditions; relevant finite elements. Elements of shell theory. Analytical solutions; relevant finite elements. Bending, shear and torsion of open and closed thin-walled beams. Stress analysis of aircraft components. Distribution of shear stresses (build-in end, shear lag). Stress concentration. Boundary element methods in elasticity problems; application to crack-propagation analysis. BEM analysis of noise from vibrated plates and shells.

Analysis of Mechanical Structures II (02.03.2192.07.01.02)

Isoparametric finite elements: Numerical integration; architecture of a typical finite element code. Practical-1: Software development by the students. Optimization: objective functions and constraints; special and general optimization methods; fully stresses design; optimality criteria methods; several other optimization techniques. Practical-2: Optimization of a typical structure (e.g., ten-bar truss).

Industrial Electronics (02.03.2039.04.01.02)

Analog Circuits: Diodes (Zener, Photo-diodes, applications: inversion). Bipolar Transistor (CB, CC, CE). Low frequency Amplifiers. Operational Amplifiers (Applications to signal conditioning and control) Digital Circuits: Gates (hardware realization, Boolean Algebra). Medium Scale Integration Circuits (decoders, multiplexers, adders, ROM, PLAs). FLIP-FLOP. Sequential Circuits (Introduction, counters). Applications: Signal Conditioning & Transmission, TRIAC & Thyristors. Industrial control systems. Laboratory sessions: a) operational amplifiers in control b) inversion.

Flight Dynamics (02.03.2232.09.02.02)

Origin of force fields on the aircraft. Atmospheric gusts. Dynamics under steady elevators. Dynamics under elevator control. Automatic pilots.

Electric Circuits and Systems (02.03.2242.02.01.02)

Models of circuit discrete elements. Resistors and energy storage elements. Sources. Systems of elements. Transformers. Linear circuit analysis via the linear graph method. Voltage division. Kirchhoff laws. Thevenin and Norton theorems. Linear system properties. Superposition. Stability. Circuit time response and sinusoidal steady state response. Frequency response. Transfer functions, filters. Three-phase networks. Average and reactive power. Balanced and unbalanced loads. *Lab exercises*: circuit time and frequency response, parameter identification.

Electromechanical Power Conversion Systems (02.03.2245.03.01.02)

Fundamental principles of electromagnetism. Magnetic circuits and permanent magnets. Electromechanical power conversion, development of torque and voltage. Elecromagnetic

actuators, electromagnets, voice coils. Generators, motors and loads. Torque-speed characteristics. Basic equations, equivalent circuits, characteristic curves, power flow, efficiency and losses in electric machines. DC generators and motors. Synchronous generators and motors. Three-phase and single-phase induction motors. Stepper, universal, and brushless motors. Introduction to drives and motor control. *Lab exercises*: motor response, parameter identification and characteristics of motors/generators.

Vehicles Design II (02.03.2244.08.02.02)

Theory: Advanced tire mechanics, tire models. Vehicle's centre of mass and moments of inertia. Vehicle dynamics, equations of motion, external forces and moments, linear 2 degrees of freedom model, control and stability, non-linear 6 degrees of freedom model. Kinematics and dynamics of four-wheel-steering vehicles. Bibliography. Computer simulation: Case studies in vehicle dynamics by computer simulation. *Laboratory:* Experimental study of the dynamic behavior of a vehicle moving in the Polytechnioupolis road network, installation of the CORRSYS measurement instruments aboard a vehicle, data collection, treatment of the collected data on a digital computer.

Vehicles Design I (02.03.2174.07.01.02)

Introduction, vehicle's definition, classification of vehicles. Mechanics of pneumatic tires. Performance characteristics of road vehicles. Handling characteristics of road vehicles. Architectures of HEVs. Concept of hybridization of the automobile. HEV fundamentals. Batteries, ultracapacitors, fuel cells. HEV component sizing and design optimization.

Machine Dynamics II (02.03.2220.07.01.02)

The concept of the signal. Frequency analysis, Fourier series, spectra. Fourier transform, convolution, cross- and autocorrelation. Modulated signals, demodulation. Discrete signals. Sampling Theorem. Discrete and fast Fourier transform. Restrictions of the Discrete Fourier Transform, aliasing, leakage, resolution. Vibrations and fault diagnosis. Vibration measurements, and international standards. Fault diagnosis: basic principles, unbalance, misalignment, looseness, impacts, fault detection in bearings and gears. Experimental modal analysis – Introduction. Theoretical concepts. Determination of natural frequencies and mode shapes in the frequency and time domains.

Industrial Installations (02.03.2290.08.02.02)

Basic design principles of Industrial Installations(reliability, redundancy, availability, criticality, risk, assessment).Lifting equipment. Transportation equipment. Electrical Installations for consumers.

Microprocessors Based Control (02.03.2249.08.02.02)

Introduction to control systems using microprocessors -μP and microcontrollers –μC (ADC, DAC, Sampling & Hold–S/H). Introduction to microprocessor and microcontrollers architecture and programming. Assembly and interfacing of MC86HC11. Signal representation in digital systems, Z-transform, frequency domain analysis, state equations of sampled systems, time domain analysis. Controllability & Observability. Design and Implementation of Sampled Data control systems. State observation (observers – Kalman filtering) Model Identification. Introduction to Adaptive Control. Laboratory sessions: a) design and simulation of a digital control system for a medium scale plant b) assembly programming for μP & μC and simple controller implementation (e.g. alarm, servo-motor control) c) on-line identification of the dynamic parameters of 2-DOF manipulator.

Computer Methods in Structures (02.03.2264.08.02.02)

Introduction in commercial CAD/CAE codes. Application to linear and nonlinear *n*-DOF systems under several excitations. Training in commercial CAD/CAE software: development

of geometric models; static and dynamic analysis of the relevant structures.

Intelligent Control Systems & Robotics (02.03.2274.09.01.02)

Advanced analysis and design techniques of automatic control systems for nonlinear engineering systems. Parameter identification and adaptive control. Neural networks. Robotic systems (manipulators, vehicles, underwater and aerial vehicles): Analysis, Control, Programming & Integration. *Laboratory exercises*: System simulation, robotic manipulator control, navigation and control of mobile robots, navigation and control of an underwater vehicle.

Biomechanics and Biomedical Engineering (02.03.2231.09.02.02)

Introduction. Current and future abilities of the Biomedical Engineering. Bone structure. Elementary anatomical units. Cortical bones and Haversian system. Cancellous bones and trabeculae. Bone remodeling: osteoclasts and osteoblasts. Relationship between bone remodeling and principal stresses (Wolff's law) or strains (Frost's law). Mechanical behavior of bones. Soft tissues: Mechanical behavior of muscles and tendons. Artificial tendons. Application to athletics, plastic surgery and ophthalmology. Orthodontic applications: The role of the periodontal ligament. The tooth as an elastically supported rigid structure under bone remodeling. Centre of rotation, centre of resistance. Elementary gait analysis and rehabilitation principles. Inverse dynamics. Methods to obtain medical images from a CT scanner (raw data, DICOM, etc.). Development of a 3D-CAD model. Development of finite element models. Application of the finite element method in implants design (total hip arthroplasty, knee, elbow, shoulder, fingers, etc.). Simplified hip model in bending. Plates for bone osteosynthesis: craniofacial, calcaneous, long bones, an so on. Dental implants. High-tech (CAD/CAM/CAE) orthodontic appliances.

6.5. Subjects offered by Nuclear Engineering Department

Mechanical Measurements & Laboratory (02.04.2079.05.01.02)

(a) Theory. Statistics of measuring systems - Error analysis - Applied regression analysis - Recording results - Planning and conducting experiments - Comparative experiments - Factorial experiments - Simulation - Computer simulation techniques. The digital computer on-line to measuring systems to perform real-time data acquisition, processing and control. (b) Laboratory work. Application of the laws of statistics - Comparative and factorial experiments - Experiments of evaluation - Real-time computer based measuring systems.

Physical Principles of Nuclear Power Reactor Plants (Nuclear Eng. I) (02.04.2075.07.01.02)

Basic atomic and nuclear physics concepts. Nuclear reactions. Fission and Fusion. Fission Nuclear Reactors. Neutron populations physics. Diffusion of monoenergetic neutrons. Neutron moderation. Neutron thermalization. Thermal neutrons diffusion.

Operating Systems and Programming Languages (02.04.2241.01.01.02, 02.05.2241.01.01.02, 02.04.2241.02.01.02, 02.05.2241.02.01.02)

The software of digital computers. The role and structure of operating systems. Categories of operating systems, real-time operating systems, multi-processing systems. General characteristics and components of UNIX and DOS, user interface, utilities, editors and Word Processors, file management services. Language processors, assemblers, compilers, interpreters. Programming languages, Data structures, basic operations and flow control. Source code, object code, libraries, executable program. Application: statements of Fortran, editing and execution of simple numerical algorithm programs. A two-semester course offered by both Nuclear and Fluids Departments. There is one exam that follows course completion.

Interactions of ionizing radiations with matter (02.04.2254.07.02.02)

Sources of radiation (α- β- γ- and neutron sources), interaction of α- and β-particles, photons, neutrons and fission fragments with matter, Introduction to Monte-Carlo computer codes for the simulation of interaction of radiation with matter. Safe use of radioactive sources, Radiation damage. Laboratory Training.

Radiation Protection and Dosimetry (02.04.2076.08.02.02)

Dosimetry Principles and units. Exposure. Dose. Internal and external irradiation. Exposure and Dose calculation. Dosimetry and portable instruments. Radiation Protection Principles. Radiobiological Effects. Dose limits. Legislation. Gamma-radiation and neutron shielding calculations. Shielding heating. Safe use of radioactive sources.

Industrial Applications of Nuclear Engineering (02.04.2255.07.02.02)

Measurement of thickness, density, humidity and flow rate using Nuclear Engineering methods. Nuclear level gauges. Leakage detection. Control of industrial processes using Nuclear Engineering methods. Radiography. Erosion and corrosion measurements. Radidating. Fire detection. Nuclear batteries. Industrial applications of small linear and/or cicular accelerators. Sterilization. Food conservation. Raditracers. Biotechnological applications. Radioactive pollution at the scrap metal cycle. Laboratory exercise.

Nuclear Power Reactor Set-up and Operation (02.04.2001.08.01.02)

Nuclear Power Reactor (NPR) types. NPR components and set-up. Criticality and geometry calculations of Nuclear Reactors. NPR heat transfer calculations. Site selection. Nuclear

accidents. Fourth Generation Nuclear Power Reactors.

Thermal-Hydraulic Analysis of Nuclear Power Plants (02.04.2262.09.02.02)

Nuclear (fission and fusion) power plants core cooling during steady state operation. Thermodynamic cycles and energy production. Thermodynamic and thermal-hydraulic analysis of nuclear (fission and fusion) power plants. Pressurizers, pumps, steam generators and turbines of nuclear power plants. Cooling systems of nuclear (fission and fusion) power plants. Transient phenomena, loss-of-coolant accidents. Emergency systems. Nuclear power plant safety. Laboratory training.

Biomedical Engineering - Medical Imaging & Radiotherapy (02.04.2263.08.02.02)

X-ray machines: operation and uses, radiographic units, Radiographic Image, films, intensifiers. Tomography principles, tomographers. Medical accelerators: principles, characteristics, types, and uses. Radiopharmaceuticals production and use. Whole-body counter. Gamma camera. Scanners. Imaging techniques: SPECT and PET. Radiotherapy. Cobalt Units, Brachytherapy, Radiation Protection.

Radioenvironmental Analysis and Protection (02.04.2275.09.02.02)

Natural radioactivity, artificial radioactivity and technologically enhanced natural radioactivity. Radioactive contamination from the operation of Nuclear Power Plants and of non-nuclear installations. Enhancement of natural radioactivity due to Industrial processes (TENORM). Radioactive contamination due to the use of radioactive materials. Radioactive effluents. Dispersion and kinetics of natural and artificial radionuclides in the environment and in the ecosystem. Special radioenvironmental measuring techniques. Methodology of Radioenvironmental surveys for the detection of radioactive contamination and relevant dosimetric calculations. High natural radiation areas. Statistical analysis and mapping of radioenvironmental measurements. Radon in the living environment. Radioactive aerosols measurements. Laboratory training.

Nuclear Measurement Systems (02.04.2287.08.02.02)

Nuclear radiation detectors. Radiation measurement statistics and detection limits. Gas detectors. Scintillation detectors. Semiconductor detectors. Neutron detectors. Radon measurement instrumentation. Portable Instruments for radiation detection. Radionuclide determination techniques: α-spectrometry, γ-spectrometry. Total-α and total-β measurements. Liquid scintillation. Radiochemical methods. Radon concentration measurement techniques and radon exhalation measurements. Nuclear related techniques for trace elements determination: Instrumental Neutron Activation Analysis (INAA). X-ray fluorescence (XRF). Laboratory Exercises.

6.6. Subjects offered by Fluids Department

Fluid Mechanics I (02.05.2110.01.02)

Historical review, achievements – Physics and Chemistry of fluids – Continuum Mechanics – Kinematics – Basic laws in integral and differential form: balance of mass, moment, moment of momentum, energy (1^{st} and 2^{nd} law) – Constitutive relations – Newtonian and non-Newtonian fluids – Applications, simplifications: equations of Euler and Bernoulli – Equations of Navier-Stokes – Analytic solutions of Navier-Stokes equations (laminar flow in pipes) – Irrotational flow of incompressible fluids – Superposition of simple potential flow fields - Similarity laws – Flow stability – Turbulent flows – The concept of boundary layer – Laminar boundary layer of flat plate (theory of Blasius) – Turbulent flow in pipes – Forces on moving bodies – Moving frames of reference – Discontinuities – One dimensional isentropic flow of compressible fluid and Laval nozzle.

Fluid Mechanics II (02.05.2016.07.01.02)

Laminar and turbulent boundary layers. Stability and transition to turbulence. Applications of turbulent flows in jets and wakes of bodies. Boundary layer control. Flow separation phenomenon. Low Reynolds number flows with applications on hydrodynamic lubrication. Buoyant flows. Natural convection flows. Flow in open channels.

Hydraulic Turbomachines (02.05.2131.06.02.02)

Introduction. Fundamental equations for incompressible and compressible fluids. Types and principle of operation of various turbomachines. Relative motion in the rotating blade, equations, triangles of velocities. Centrifugal pumps: basic equations, operation principles, efficiency and characteristic curves. The pumping installation. Cavitation in pumps. Geometric and kinematic similarity of hydraulic turbomachines. Non-dimensional parameters. Description of a typical hydroelectric power plant – types of hydraulic turbines. Efficiency, characteristic operation curves and cavitation in water turbines. Calculation of basic turbine dimensions. Project: Centrifugal pump selection. Laboratory training: Measurements and drawing of the characteristic curves of a centrifugal pump/turbine.

Thermal Turbomachines (02.05.2045.05.01.02)

Introduction to the morphology, operation and aerothermal analysis of thermal turbomachines. Types of thermal turbomachines, compressor, turbine, steam-turbine. Fundamental governing equations. One-dimensional flow in thermal turbomachines. Flow analysis in two-dimensional cascades. One-dimensional flow analysis in axial and radial compressors. One-dimensional flow analysis in axial and radial turbines. Single- and multi-stage turbomachines. Turbine and compressor similarity. Basic mechanical features. Experiment in the Lab: Experimental determination of a compressor characteristic curve. Project on turbomachinery computations.

Computational Fluid Dynamics (02.05.2111.08.01.02)

Numerical solution of flow fields. Methods of numerical solution of algebraic equations and systems of equations; solution of ordinary differential equations, Runge-Kutta methods. Classification of partial differential equations into elliptic, parabolic and hyperbolic type and corresponding methods of discretization into algebraic equations. The methodology of finite difference and finite volume in potential flow fields (Laplace equation), in frictionless fluid flows (Euler equations) and in viscous flow fields (Navier-Stokes equations). Examples. Mathematical methods of turbulent flows. The nature of turbulence and the cascade mechanism of turbulent energy, turbulent spectra. Laboratory exercises: 1. Numerical solution of a flow field having analytic solution; 2. Numerical solution of parabolic flow fields; 3. Numerical solution of elliptic flow fields; 4. Numerical solution of hyperbolic flow fields.

Aerodynamics of the Subsonic Airplane (02.05.2022.08.02.02)

Introduction to the aerodynamics of the subsonic airplane (dynamic lift and resistance). Simple calculations of lift and resistance. The unsteady subsonic three dimensional flow of an inviscid flow: a) Flow around the fuselage, b) Flow around the wing (lifting line theory, monoplane equation, calculation of aerodynamic coefficients, compressibility effects), c) Flow around the propeller (momentum theory, blade element theory, lifting line theory, design and performance of the airplane propeller). d) Flow around the airplane (panel theory). Static theory flight and stability. Modern numerical methods for aerodynamic problems and their applications.

Design of Hydraulic Turbomachines(02.05.2080.09.02.02)

Study and design of centrifugal pumps: configuration of centrifugal pumps, statement of the inverse of designing, selection of main characteristic parameters, selection of speed of rotation, of the number of blades, calculation of the impellers diameters, number of blade. Correlation between design parameters and efficiencies. Numerical methods for the division of the impeller to partial impellers, design of the mixed flow impeller for the conformal representation. Spiral casing, design and operation. Forces acting on the impeller. Static and dynamic calculation of the shaft. Calculation of the critical speed of rotation. Selection of the bearings. Study and design of axial flow pumps: theoretical analysis of the flow through rotation cascades. Selection of main design constants. Mechanical configuration and design of the parts of an axial pump. Assignments concerning the complete design of a centrifugal pump.

Experimental Fluid Mechanics (02.05.2189.07.02.02)

Basic characteristics of measuring instruments. Measurement errors. Signal digitization. Fourier analysis. Operation principles of various measuring techniques like Hot wire anemometry, Laser Doppler anemometry, Particle Image Velocimetry, Pitot and Pitot Static tubes, tubes of many holes, flow rate meters, viscometers, ultra sound, shear stress measurement, pressure measurement, flow visualization. In the context of this course, 6 exercises take place applying some of the above techniques.

Aerodynamics of Compressible Fluid (02.05.2211.07.02.02)

Discontinuities in Aerodynamics – Laws of vorticity for compressible flows – Linear and nonlinear theories of two-dimensional flow field – Prandtl-Mayer flow – Oblique shock waves – Mach lines – One dimensional unsteady, compressible flow – Theory of thin bodies in compressible flow (supersonic flow) – Linear theory of wings in compressible flow – Viscous compressible flows (laminar-turbulent) – Transonic flows – Real gas flows, heat addition in compressible flows – Non-equilibrium gas flows – Gas kinetics – Computational methods in high speed Aerodynamics – Introduction to supersonic airplane Aerodynamics.

Principles of Jet Propulsion (02.05.2202.08.02.02)

Thrust generation, equations for thrust calculation, factors influencing thrust. Comparative presentation of different jet-engine layouts. Description of the main pars of a jet engine. Cycle analysis and performance calculations. Parametric design studies. Inlets, design principles, subsonic, supersonic. Exhaust nozzles, operational principles, convergent, convergent divergent. Mixers. Layout and operational principles of compressors, burners and turbines. Blade Cooling. Component matching for equilibrium operation. Cycle analysis and performance calculations for different operating conditions, reduced performance parameters. On-aircraft engine operation for different flight conditions.

Design of Thermal Turbomachines(02.05.2100.08.02.02)

Basic principles of compressor and turbine design. Selection of rotational speed and annulus

dimensions. Determination of number of stages. Flow angle calculation across blade height (quasi-three-dimensional flow). Radial equilibrium equation. Comparison of different radial distributions of peripheral velocity. Investigation of compressibility effects. Blade profile selection using cascade experimental data. Blade design. Calculation of efficiency using empirical loss equations and experimental data. Calculation of performance maps. Laboratory exercise: measuring the flow field inside an axial compressor stage. Computational project: design of an axial compressor or turbine.

Hydrodynamic Installations (02.05.2194.08.02.02)

Non study hydraulic phenomena. Theory of rigid column of water and examples. The theory of water hammer. Wave velocity. Method of characteristics and analysis of transient hydraulic phenomena with the graphical method and the numerical method. Application for the analysis of more complicated installations and boundary conditions. Analysis of the transient phenomena to pumping installations and methods for the attenuation of the overpressure: pressure vessels, special non-return valves, etc. transients in hydroelectric power plants, equation of turbine controller. Analysis and calculation of surge tank. Pumping stations: piping, configuration and lay-out of a pumping station, measurement and control instruments, valves, methods for the variation of the flow rate. Operation of pumping station: temperature rise, noise, forces. Starting process. Piping network. Assignments concerning the analysis of hydraulic transient to a simple pipeline by the graphical and the numerical methods.

Wind Energy (02.05.2178.08.01.02)

Introduction to Renewable Energy Sources. Meteorological elements of wind. Wind energy potential. Types and subsystems of wind turbines. Aerodynamic design of horizontal and vertical axis wind turbines. Static and dynamic loading of wind turbines. Electrical motors for wind turbines and their cooperation with the grid. Site selection of wind turbine installations. Analysis of aerodynamic performance and optimized design of wind farms. Practical elements for wind turbine selection. Applications. Economics of wind turbines.

Aeroelasticity and Aeracoustics (02.05.2218.09.02.02)

Mathematical formulation of acoustic and dynamic physical problems: Analytic methods, Asymptotic methods, Numerical methods. Aerodynamics: Green functions and integral equations, Boundary element methods, vortex methods, Applications to the steady and unsteady flow simulations of airfoils and wings. Dynamics: Beam theory, Variational methods and the Finite element method, Multi-body dynamic analysis, Applications to aircraft configurations including helicopters. Aeroelasticity: Coupling principles, Eigenvalue analysis, Linear stability and application to flutter problems. Acoustics: the wave equation and its solution using Green's functions, Noise characteristics, Noise measurements and Noise assessment, Linear aeracoustics (Lighthill's theory), Application to rotor acoustics. Broadband noise characteristics and similarity theory, application to noise estimation. Wave propagation: Formulation of the problem, Ray theory approximation, Application to noise propagation in the atmosphere.

Gas and Steam Turbine Operation (02.05.2216.09.02.02)

Gas Turbines: Types and layout of gas turbines. Cycle analysis, performance parameters. Features of compressors and turbines. Blade cooling. Combustion, combustion chambers. Component matching, off-design operation, control. Performance simulation. Gas turbine systems. Steam turbine: Steam cycles and stem turbine. Stage analysis, types, operation. Performance parameters, losses, efficiency. Operation under varying loads, control. Performance simulation. Wet steam turbine features. Principles of fault diagnosis and condition monitoring. Performance diagnostics. Vibration diagnostics.

Engine Operation (02.05.2217.09.01.02)

Aircraft mission analysis, relation with the basic aircraft and engine characteristics for the

realization of a specific mission. Optimal design solution aircraft/engine for specific mission. Analysis for various engine operating conditions and their relation to specific aircraft flight conditions. Thrust and power excess for engine acceleration and engine condition during acceleration. Basic concepts and types of engine auxiliary systems.

Computational Methods in Turbomachinary(02.05.2185.09.02.02)

Boundary layer and viscous flow theory. Incompressible and compressible viscous layers in compressor and turbine bladings. Differential and integral methods for viscous flow modeling in turbomachines. Viscous-inviscid interaction methods in turbomachinery. Turbulence and transition modeling in turbomachines. Secondary flows and relevant computational methods. Tip clearance flows in turbomachines and their modeling. Advanced case studies.

Biofluid-Mechanics and Biomedical Engineering (02.05.2231.09.01.02)

Biofluid-Mechanics. Elements of Anatomy and Physiology of the circulatory system – Blood rheology _ Structure and mechanical properties of the blood vessel wall – Wave propagation in arteries – Pulsating blood flow in arteries – The circulatory system, regulation, modeling – The heart as a pump – Microcirculation – Fluid mechanics of thrombogenesis and atherogenesis – Measurement in circulatory system. – Urodynamics - Bio-fluid Mechanics of respiration, of hearing and smelling – Diagnostics and Bio-fluid Mechanics. *Devices and equipment of Biomedical Fluid mechanics.* Respiratory ventilators – Haemodialysers (artificial kidney) – Peristaltic and infusion pumps – Biomedical measurements (stethoscopes, pressure recording, flowmeters, ultrasonics) - Cardiac artificial valves, artificial grafts, replacements, biocompatibility. Artificial organs – Assist devices – Extracorporeal equipment – Devices and equipment of urodynamics – Lithotripters – Suction and drainage technology.

Introduction to Aircraft Design and its Subsystems (02.05.2197.07.01.02, 02.06.2197.07.01.02)

This is an introductory course aiming at setting the basis for the subsequent courses related to the dimensioning of an aircraft, its propulsion system and the structural design. It is divided in three parts corresponding to the design of the airframe, the propulsion system and the structural design. Following a conceptual presentation based on simple and basic physical principles the aircraft operation is explained. Then through a historical review of the evolution of aircrafts, the trends in designing are explained using statistical information. Using statistical data the dimensioning of the airframe and the propulsion requirements are set within the framework of standards and regulations. The second part concerns the propulsion system for both propeller equipped and modern jet powered aircrafts. In both cases the basic dimensioning is obtained based on statistical data. The course is concluded with an account on materials and structural design of aircraft components. Principles of static and dynamic analysis are given as well as an introduction to crashworthiness. The aim of this part is to set the framework regarding the special requirements aircraft manufacturing set on the material characteristics and their assessment compared to on land applications.

Operating Systems and Programming Languages (02.04.2241.01.01.02*, 02.05.2241.01.01.02, 02.04.2241.02.01.02, 02.05.2241.02.01.02)

The software of digital computers. The role and structure of operating systems. Categories of operating systems, real-time operating systems, multi-processing systems. General characteristics and components of UNIX and DOS, user interface, utilities, editors and Word Processors, file management services. Language processors, assemblers, compilers, interpreters. Programming languages, Data structures, basic operations and flow control. Source code, object code, libraries, executable program. Application: statements of Fortran, editing and execution of simple numerical algorithm programs. A two-semester course offered by both Nuclear and Fluids Departments. There is one exam that follows course completion.

Introduction into Mechanical Engineering (02.05.26.01.01.02)

Educational background and the skills of an Engineer. Learning methods. Presentation of the program of studies and of the laboratories of the School. Typical examples of the activity of the laboratories. Basic Mechanical Engineering equipment and installations from ancient to modern times. The mechanical engineering approach to problem solving (analysis-synthesis with the use of principles of Physics- Mathematical and experimental simulation and principles of economy). Lessons from successful and failed engineering constructions. The innovative thinking and the innovator engineer. Principles of successful oral and written communication. Principles of professional conduct and code of ethics.

Numerical Analysis (02.05.2148.03.01.02)

Systems of linear equations: Direct (Gauss elimination, factorization) and iterative (Jacobi, Gauss-Seidel, SOR) solution methods. Eigenproblems and the power method. Interpolation and polynomial regression: Taylor, Lagrange, Newton and Hermite polynomials. Spline interpolation. Nonlinear equations: bisection, regula-falsi, fixed-point iterative methods, Newton-Raphson, the secant and Schroder methods. The Newton's method for systems of nonlinear equations. Numerical differentiation and integration. Approximation of derivatives. Simple rules for numerical integration. Gaussian quadrature. Integration of improper integrals. Differential equations. The Initial-value problem, Numerical errors. One-step methods (Taylor, Runge-Kutta). Multistep methods (Adams, prediction-correction). Regression theory. Least-squares regression (polynomial, exponential). Least-squares with orthogonal polynomials. Boundary-value problems. Partial derivatives approximation. The linear shooting method. Finite difference methods. Finite elements, the Galerkin method.

Industrial Fluid Mechanics (02.05.2021.05.02.02)

Formulation of conservation laws. Airfoil theory. Linear cascades. Blowers – characteristic operation curves. Blowers in serial and parallel operation. Flow in pipes and fittings. Fanno and Rayleigh lines. Pipeline design. Blowers in pipelines. Flow in pipe networks – calculation methods. Networks of liquids (e.g. water supply, fire-networks) and gases (incompressible-compressible, natural gas). Natural gas installations. Unsteady flow in pipelines – Water hammer. Cavitation in pipe fittings. Fluid mechanics in industrial processes. New technologies: liquid jets, micro-fluid mechanics, casting of thermoplastics, water-jet cutting, hydrodynamic lubrication. External flows: Air – structure interaction (flow around buildings, automobiles, antennas – oscillation of bodies, aerodynamic noise, natural ventilation). Ventilation in road tunnels.

Environmental Technology (02.05.2187.06.02.02)

Current environmental problems , causes and sources of pollution. Air pollution (emission limits and concentrations, law, effects on health, primary and secondary pollutants, meteorology, atmospheric dispersion). Indoor air quality (concentration levels, ventilation). Noise, Thermal pollution, Water pollution. Air pollution control equipment. Equipment and methods for measuring air pollutant concentrations.

Optimization Methods in Aerodynamics (02.05.2253.07.02.02)

Inverse design and optimization problems in aerodynamics. Objectives in design problems. Shape optimization problems with inviscid and viscous flow considerations. Numerical optimization: mathematical background, optimization without or with constraints, single- and multi-variate optimization, single- and multi-objective optimization, iterative optimization methods (sequel to methods known from the Numerical Analysis course), existence and uniqueness of the optimal solution, advantages and limits of numerical optimization methods. Applications. Stochastic optimization methods based on evolutionary algorithms and artificial intelligence. Advantages and disadvantages. Applications.

New and Renewable Energy Sources (RES) (02.05.2252.07.02.02)

Introduction: RES and the energy problem - Historical evolution of energy technologies – The present situation: energy sources and energy consumption (worldwide, in Europe, in Greece) – Towards a sustainable energy future- The development of RES in Europe and in the world – RES in Greece – Short and long term perspectives of RES (worldwide, in Europe, in Greece). The potential of RES- Methods of analysis and estimation: wind potential – solar radiation – biomass – hydroelectric potential – geothermal resources – ocean waves/ ocean currents. Technologies - applications – systems of RES: Wind turbines- Passive solar systems – Bioclimatic architecture – Active solar thermal systems – Photovoltaic systems – Bioenergy – Small hydro – Marine energy systems – Geothermal energy– Hydrogen – Fuel cells. Techno-economic analysis of RES systems: Energy costs (conventional, environmental, external) – Environmental impacts and their economic evaluation - Avoided costs of conventional fuels – Analysis of investments and their application in energy systems – Management of energy systems including RES.

Hydroelectric Power (02.05.2251.07.01.02)

The developments of the hydroelectric potential in Europe and in Greece: perspectives and actual status. Advantages and disadvantages of the hydroelectric energy. Basic differences between large and small hydroelectric power plants. Arrangement of small hydropower plants. Basic elements of hydrology: the water resources, evaluation and measurement of steamflows, hydrologic cycle, hydrologic models and hydrologic basin. Flow duration curves. Extreme values of flow rate (flood estimation). Civil engineering works: dams, weirs, spillways, still basin, energy dissipators, intake structures, open channels, penstock, etc. Optimization of the piping diameter. Electromechanical equipment: hydraulic turbines, selection, operating characteristics, of electrical generators, efficiencies. Automatic control and regulation. Power house lay-out. Environmental impacts. Economic analysis, design optimization. Project concerning the selection and lay out of a small hydroelectric power plant with given flow rate measurements of a period of 10 years.

Gas Turbine Diagnostics (02.05.2280.09.02.02)

The need and importance for gas turbine engine condition monitoring. Relation to on-condition maintenance. Measured quantities and methods, data collection for monitoring. , Systems and methods for condition assessment and fault diagnosis. Gas path analysis: direct methods, estimation methods, linear, non-linear. Trending. Use of fast response measurements (sound, vibration). Elements of life assessment methods. Data evaluation, artificial intelligence methods. Jet engine testing, parameter corrections. The use of computers for monitoring methods support.

6.7. Subjects offered by Manufacturing Technology Department

Engineering Drawing I and Laboratory (02.06.2012.01.01.02)

Laboratories: 1. Workshop technology (Bench and drilling operations). 2. Engineering metrology, tolerances/fits. 3. Instrumentation, measurement systems, sensors, jigs, fixtures.

Engineering Materials (02.06.2105.02.01.02)

Materials classification. Structure and mechanical properties of metals. Industrial alloys (phase diagrams, binary and three-part alloys, ferrous and non-ferrous alloys). Heat treatments of metals and alloys (thermal and thermo-chemical processes, defects). Wear. Surface Engineering. Laboratory exercises: 1. Structure characterization of ferrous and non-ferrous alloys. 2. Heat treatment of steels.

Mechanical Engineering Drawing II (02.06.2147.02.01.02, 02.03.2147.03.01.02)

Laboratories: 1. Turning. 2. Milling. 3 Planning.

Introduction to Mechanical Workshop Technology (02.06.2200.03.01.02)

Introduction to manufacturing processes for mechanical engineering products. Manufacturing process types (forming, cutting, casting, powder processing and joining). Manufacturing systems based on product volume and variety: on-off, batch and repetitive manufacturing. Practical introduction to the main mechanical workshop processes: governing phenomena, suitable materials, equipment, methods, constraints and problems (defects): forming-bending-piercing sheet, turning-milling-drilling-grinding bulk material, powder metallurgy, electro-discharge machining, casting, welding, soldering, laser beam processing, coating, heat treating etc. Typical machine tools for material removal (lathes, milling and grinding machines) and sheet forming (presses, press brakes): structure, function, kinematics, metrology, jigs and fixtures. Cutting tools: basic geometry, types and materials. .Basic programming of CNC turning and machining centers (G-code). Surface quality and integrity, tolerances and fits. Principles of selecting and designing manufacturing processes: criteria (form, precision, quantity, time and cost) and alternative solutions. Process plans: case studies and optional assignments concerning manufacturing process design for particular product examples.
Laboratory exercises: 1. Workpiece manufacturing through basic CNC machine tool programming 2. Experimental metal casting.

Manufacturing Processes I (02.06.2156.05.01.02)

Overview of manufacturing processes. Fundamentals of Plasticity and applications on the manufacturing processes. Mechanics of forming processes / Formability. Bulk deformation processes (rolling, forging, extrusion, rod-, wire- and tube-drawing). Sheet-metal forming processes (bending, deep-drawing, stretch forming, bulge forming). Forming Limit Diagrams (FLDs). Friction / Lubrication. Residual stresses. Defects. Laboratory exercises: 1. Slab rolling. 2. Closed-die forging. 3. Extrusion. 4. Deep-drawing. 5. Bulge test.

Manufacturing Processes II (02.06.2093.06.01.02)

Overview of conventional (mechanical) material-removal processes Cutting with single-point and multipoint cutting tools of clearly defined geometry. Mechanics of chip formation. Cutting tools and tool wear. Machinability. Abrasive processes. Mechanics of grinding. Grinding wheels and grinding wheel wear. Finishing operations. Friction / Lubrication. Cutting fluids. Residual stresses. Laboratory exercises: 1. Metal cutting in turning: Mechanics of cutting. 2. Metal cutting in turning: Tool wear. 3. Metal cutting in milling. 4. Metal cutting in drilling. 5. Surface grinding.

Manufacturing Systems I (02.06.2222.08.02.02)

Types, structure and function of Manufacturing Systems. Equipment layout, product and work flows and information flow. Control levels. Cellular production, Group Technology, coding systems, Computer Aided Process Planning systems. Flexible Manufacturing Systems: flexibility types. Operations assignment and scheduling. Controller design based on Petri Nets. System Monitoring. Robotics Manufacturing Cells: industrial robot types, integration interfaces, on and off-line robot programming for machine tool tending and manufacturing processing. Analysis and Design of Manufacturing Systems using discrete event simulation. Computer Integrated Manufacturing: information integration, interfaces in Computer-Aided-X software systems, databases and local area communication networks. Optional assignments in four major topics of the syllabus.
Laboratory exercises: 1- Manufacturing System Simulation using dedicated discrete event software 2- Industrial robot programming for machine tool tending

Manufacturing Systems II (02.06.2277.09.01.02)

Problem solving in modern manufacturing systems using computational intelligence and other IT techniques. The students are introduced to advanced IT tools, such as: expert systems, artificial neural networks, evolutionary algorithms and fuzzy logic. Practical problem solving is emphasized through assigned coursework based on software development and use rather than in theoretical foundations of relevant tools and techniques. Standard topics dealt with are: Process Plan development. Definition and recognition of shape features connected to particular manufacturing process types (material removal, sheet forming). Process parameter selection. Path planning, tool selection and feed scheduling in high speed milling. Machining time and surface quality criteria in machining operations. Manufacturing process control using quantitative and qualitative models. Transition from process parameter selection to process control. Manufacturing cell control: operation dispatching criteria (lead time, resource utilisation etc.) Links to discrete event simulation. Manufacturing system design. Simplified process plans. Virtual Manufacturing Systems and their structure optimisation. Manufacturing system diagnostics. Sensor based individual manufacturing process monitoring. Discrete status change monitoring in manufacturing systems.

Advanced Materials (02.06.2235.09.01.02)

Mechanical behavior of materials (viscoplastic properties, failure criteria, creep, fatigue). Processing and properties of polymers. Processing and properties of composites (metal matrix and fiber reinforced composites). Processing of multilayered and coated materials. Processing of superplastic materials. Technology of aerospace materials. Processing and properties of advanced ceramics (superconductors and bioceramics). Inspection, selection and industrial applications of materials. Laboratory exercises: 1. Mechanics of composites: Macro- and microscopic phenomena. 2. Dynamic loading of sheet metal made of aluminum alloys: Formability and Surface Integrity.

Introduction to the Aircraft and its Subsystems (02.06.2197.07.01.02, 02.05.2197.07.01.02)

This is an introductory course aiming at setting the basis for the subsequent courses related to the dimensioning of an aircraft, its propulsion system and the structural design. It is divided in three parts corresponding to the design of the airframe, the propulsion system and the structural design. Following a conceptual presentation based on simple and basic physical principles the aircraft operation is explained. Then through a historical review of the evolution of aircrafts, the trends in designing are explained using statistical information. Using statistical data the dimensioning of the airframe and the propulsion requirements are set within the framework of standards and regulations. The second part concerns the propulsion system for both propeller equipped and modern jet powered aircrafts. In both cases the basic dimensioning is obtained based on statistical data. The course is concluded with an account on materials and structural design of aircraft components. Principles of static and dynamic analysis are given as well as an introduction to crashworthiness. The aim of this part is to set the framework regarding the special requirements aircraft manufacturing set on the material characteristics and their assessment compared to on land applications. Contributing Departments: Fluids / Manufacturing Technology.

Machine Tools (02.06.2035.07.01.02)

Machine tool types and kinematics. Technological evolution and impact to manufacturing. Machine tool

structure: body, spindles, motors, drives, sensors, position encoders, motion transmission. Fixtures and workholding elements. Computer numerical control of machine tools: structure and functionsof CNC systems. Methods and types of interpolation. Motion control. Adaptive control for manufacturing processes. Selection of CNC system main characteristics. CNC machine tool programming. Parametric programming. CAM systems. Machine tool dynamics: machining force variation. Frequency response function. Forced vibrations. Chattering. Stability regions. Experimental determination of machine tool dynamic characteristics. Machine tool metrology using lasers: positional CNC axis accuracy. Angular errors. Composite errors. Volumetric error. Error analysis/budgeting. Thermal errors. Use of metrological equipment.
Laboratory exercises: *1- Machine tool programming using a CAM system 2-Machine tool dynamic*

Welding- Casting (02.06.2258.07.02.02)

A. Welding: phenomena during welding of materials. Weldability. Conventional and non-conventional welding processes. Welding metallurgy (phase diagrams, heat affected zone). Welding defects. Destructive and non-destructive tests.
B. Casting: phenomena during material solidification. Castability. Casting methods using expendable and permanent moulds. Directional solidification. Feeding system design. Casting defects. Casting equipment. High pressure casting presses. Casting dies. Rapid casting model production.
Laboratory exercises : 1. Arc welding practice and metallography. 2. Casting practice and simulation using dedicated software.

Dynamic Straining (02.06.2259.07.02.02)

Basic principles. Elastic stress waves (propagation of one-dimensional longitudinal and transverse wave, generalized theory of elastic stress waves, reflection, spalling and scabbing, applications). Elasto-plastic stress waves (stress-strain diagram, one-dimensional longitudinal wave propagation, unloading waves). Shock waves (basic notions, propagation, detonation waves). Plastic impact strain (penetration into semi-infinite medium, penetration into plates, blanking, impact onto non-deformable targets, shear bands). Macro and micro-defects. Experimental diagnostic techniques for dynamic phenomena. Laboratory exercises: Detonation fracture of brittle materials. Impact penetration of projectile into semi-space. Impact punching of steel plate.

Non-Conventional Manufacturing Processes (02.06.2060.08.01.02)

Fundamentals of dynamic plasticity applied in bulk and porous materials. Non-conventional forming techniques of bulk material (ring-rolling, impact and rotary forging, hydrostatic extrusion). Non-conventional sheet-metal forming techniques (hydroforming, high energy rate forming, shot-peening, superplasticity, punching). Non-conventional material removal processes (machining/Grinding) (Abrasive jet machining, Explosive cutting, Ultra-sonic machining, Electro-discharge machining (EDM), electrochemical grinding (ECG), electrochemical machining (ECM), chemical cutting). Non-conventional welding techniques (explosive cladding/welding, laser welding). Powder compaction (powder metallurgy, dynamic powder compaction, elastic and plastic waves in porous materials) Defects Laboratories: 1. Open-die impact forging 2. Explosive sheet metal forming. 3. Electro-discharge machining (EDM). 4. Powder metallurgy: Static and dynamic compaction of metal powders.

Computational Methods in Manufacturing Processes (02.06.2264.08.02.02)

Large permanent deformation (material flow, yield criteria for isotropic and anisotropic materials. Plane plastic strain. Axi-symmetric plastic strain). Mechanics of manufacturing processes (basic notions of plane stress and strain and axi-symmetric strain. Residual stresses). Analytic method of friction hill (plane strain, axi-symmetric strain, applications in bulk metal forming processes). Analytic method of boundary loads (Theorems of upper and lower bounds, hodographs, upper bound applications in bulk and sheet metal forming processes and material removal processes). Analytic method of slip lines (theorems of stresses and velocities, , applications in manufacturing processes). Numerical methods (explicit and implicit codes, applications in bulk and sheet metal forming processes, and in metal removal processes). Experimental methods for load, pressure, temperature and flow of processed material. Laboratory exercise: 1. Forging in plane strain: analytical and

experimental determination of plastic zone. 2. Deep drawing of sheet metal: numerical simulation and experimental determination of process parameters.

Manufacturing and Mechanics of Composite Materials **(**02.06.2267.08.01.02)

A. Fabrication of composite materials: Classification and terminology. Matrix and fibre materials. Fabricating processes. Advantages and limitations of composites. Industrial applications.

B. Mechanical behaviour of composite materials:Elastic constants of an orthotropic lamina, stress-strain relations of anisotropic materials, failure criteria of orthotropic materials. Lamination theory for laminated composites (coding, stress-strain relations, equilibrium equations,combined stresses of composite plates and shells, failure criteria). Sandwich hybrid structures. Fatigue, impact, delamination. Environmental effects (temperature/fire/moisture) onthe degradation of composites. Experimental characterization of composite materials.

Crash Analysis of Structures (02.06.2207.08.01.02)

Fundamentals of Structural Plasticity. Theorems of Limit Analysis. Limit analysis of bar structures. Limit analysis of plates and shells. Residual strength of structures in the plastic domain. Strain-rate effects. Crashworthiness of thin-walled structures. Impact energy-absorbing systems. Design and construction of active and passive safety systems. Crash tests. Laboratory exercises: 1. Static collapse of thin-walled structures. 2. Dynamic collapse of thin-walled structures.

Tools and Dies (02.06.22.09.02.02)

Tools / dies. Materials selection. Design and analysis. Numerical simulation. Design elements / failure. Theoretical works: Press tooling (deep-drawing and punching tools). Forging dies. Extrusion tooling. Casting moulds.

Micro-Nanotechnology (02.06.2278.09.02.02)

Classification – General aspects. Ultra-precision machining of metals, polymers and ductile materials. Ultra-precision grinding of glasses and ceramics. Superfinishing processes. Micro/Nanotechnology techniques. Energy-beam micromachining. Photo-Lithography, X-ray Lithography. LIGA. Electron-beam micromachining. Ion-beam micromachining. Laser-beam micromachining. Micro-EDM. Scanning Tunneling Microscopy. Atomic Force Microscopy. Chemical micromachining. Other micro/nanoprocesses. Micro-punching. Micro-Injection molding.

Materials Protection and Surface Engineering (02.06.2259.07.02.02)

Surface properties and surface integrity.
Surface preparation and conditioning.
Wear/Corrosion/Oxidation/Fatigue (phenomenology, mechanism, analysis, protection processes).
Modification Surface Engineering Processes (mechanical, thermal and thermochemical processes).
Difussion in solid state.
Coating and Thin-Film Processes (techniques, testing and characterization of protective coatings).
Economics of surface engineering processes.
Waste treatment technologies applied to industrial metal coating processes.

Case studies of surface engineering processes related to the mechanical engineering sector.

Failure Analysis of Materials (02.06.2266.08.02.02)

Introduction(Terminology. Procedure of failure detection. Techniques for failure analysis. Main failure mechanisms. Failure root-causes).Elements of Fracture Mechanics (Elements of Plasticity. Brittle/ductile fractures. Residual stresses. Fractography).Time-dependent mechanical behaviour / Creep (Fracture mechanisms. Failure modes. Residual life – Equation of Larson-Miller).Cyclic loading/Fatigue (Fracture mechanisms. Failure modes (LCF, HCF). Macro- and micro-fractography of fracture surfaces. Damage accumulation law)Environmental degradation of materials/Corrosion (Corrosion types. Corrosion/fatigue interaction. Hydrogen embrittlement. “Liquid-metal” embrittlement (LME)).Wear/Friction (Wear mechanisms. Surface fatigue. Corrosive wear).Failure diagnosis techniques / Non-destructive testing (NDT)Quality management systems as tool of failure prevention (Quality management systems. Tools and techniques of continuous improvement (FMEA, PFMEA, FMECA, FMA)).Forensic Engineering. Failures in manufacturing processes (Defects).
Analysis of industrial failures (case studies).

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