Mechanical Engineering

Five-year M.Sc. studies
School of Mechanical Engineering
National Technical University of Athens

Athens, September 8, 2010

Semester 1:

- Mathematics Ia (52h lectures and exercises)
- Mathematics Ib (65h lectures and exercises)
- Physics I (65h lectures and exercises)
- Mechanical Engineering Drawing I (52h lectures and exercises + 4h laboratory)
- Introduction to Computer Science (52h lectures)
- Mechanics I (78h lectures and exercises)
- Introduction into Mechanical Engineering (39h lectures)
- Operating Systems (26h lectures)

Semester 2:

- Mathematics IIa (65h lectures and exercises)
- Mathematics IIb (52h lectures and exercises)
- Physics II (65 lectures and exercises)
- Mechanics II (78h lectures and exercises)
- Mechanical Engineering Drawing II (65h lectures and exercises+6h laboratory)
- Programming Languages (26h lectures and exercises)
- Engineering Materials (52h lectures and exercises)
- Introduction to Electric Circuits and Systems (52h lectures and exercises)

Semester 3:

- Mathematics IIIa (52h lectures and exercises)
- Numerical Analysis (52h lectures and exercises)
- Mechanics III (78h lectures and exercises+16h laboratory)
- Machine Elements I (78h lectures and exercises)
- Electromechanical Power Conversion Systems (52h lectures)
- Introduction to Mechanical Workshop Technology (52h lectures)
- Engineering Economics (52h lectures)

Semester 4:

- Heat Transfer I (78h lectures and exercises)
- Thermodynamics I (78h lectures and exercises)
- Fluid Mechanics I (78h lectures and exercises)
- Machine Elements II (78h lectures and exercises)
- Mechanisms and Introduction to Machine Design (52h lectures)
- Industrial Electronics (52h lectures)

Semester 5:

- Mechanical Measurements (78h lectures and exercises+6h laboratory)
- Production/Operations Management and Business Administration I (65h lectures)
- Manufacturing Processes I (52h lectures)
- Industrial Fluid Mechanics (52h lectures)
- Steam Generators I (78h lectures)
- Thermal Turbomachines (52h lectures)
- Machine Dynamics I (52h lectures)

Semester 6:

- Hydraulic Turbomachines I (65h lectures)
- Internal Combustion Engines I (78h lectures and exercises)
- Environmental Technology (39h lectures)
- Manufacturing Processes II (52h lectures)
- Operational Research I (52h lectures)
- Analysis of Mechanical Structures I (52h lectures)
- Introduction to Automatic Control Systems (78h lectures)

Semester 7, Energy Engineering Cycle:

I. Core Courses

- Thermodynamics II (52h lectures)
- Internal Combustion Engines II (52h lectures)
- Fluid Mechanics II (52h lectures)
- Hydroelectric Power (52h lectures)
- **Physical Principles of Nuclear Power Reactor Plants (Nuclear Engineering I) (52h lectures)**

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.

II. Elective Courses

Students should also choose two from the following courses:

- Heat Transfer II (52h lectures)
- Thermodynamics Software (52h lectures)
- Transport Phenomena (52h lectures)
- Experimental Fluid Mechanics (52h lectures)
- New and Renewable Energy Sources (52h lectures)
- Optimization Methods in Aerodynamics (52h lectures)
- **Interactions of Ionizing Radiations with Matter (52h lectures + laboratory)**

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.

- **Industrial Applications of Nuclear Engineering (52h lectures)**

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. Radio-dating. Fire detection. Nuclear batteries. Industrial applications of small linear and/or circular accelerators. Sterilization. Food conservation. Radiotracers. Biotechnological applications. Radioactive pollution at the scrap metal cycle. Laboratory exercise.

Semester 8, Energy Engineering Cycle:

I. Core Courses

- Refrigeration I (52h lectures)
- Combustion Theory, Combustion Systems (52h lectures)
- Computational Fluid Dynamics (52h lectures)
- Wind Energy (52h lectures)
- **Nuclear Power Reactor Set-up and Operation (52h lectures)**

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.

II. Elective Courses

Students should also choose two from the following courses:

- Steam Generators II (52h lectures)
- Computational Methods for Transport Phenomena (52h lectures)
- Principles of Jet Propulsion (52h lectures)
- Gas Exchange and Supercharging of Internal Combustion Engines (52h lectures)
- Hydrodynamic Installations (52h lectures)
- Thermal Turbomachines II (52h lectures)
- Computational Project (52h lectures)
- **Radiation Protection and Dosimetry (52h lectures)**

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.

- **Biomedical Engineering – Medical Imaging & Radiotherapy (52h lectures)**

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.

- **Nuclear Measuring Systems (36h lectures + 16h laboratory exercise)**

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.

Semester 9, Energy Engineering Cycle:

I. Core Courses

- Equipment and Systems of Thermal Processing (52h lectures)
- Pollution Abatement Technology for Thermal Plants (52h lectures)
- Air-Conditioning (52h lectures)
- Solar Energy (52h lectures)
- Gas and Steam Turbine Operation (52h lectures)

II. Elective Courses

Students should also choose two from the following courses:

- Combustion/Pollution of Internal Combustion Engines (52h lectures)
- Refrigeration II (52h lectures)
- Combustion/Pollution of Aircraft Engines (52h lectures)
- Thermal Energy in Buildings (52h lectures)
- Hydraulic Turbomachines II (52h lectures)
- Viscous Flows in Turbomachines (52h lectures)
- Aeroelasticity and Aeracoustics (52h lectures)
- Bio-Fluid Mechanics and Biomedical Engineering (52h lectures)

- **Thermal-Hydraulic Analysis of Nuclear Power Plants (52h lectures + 4h laboratory)**

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

- **Radioenvironmental Analysis and Protection (52h lectures + project)**

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.