Diploma of Graduate Studies:

Applications of Automatic Control of Mechanical Power Systems

This a special credit hours system Diploma under the supervision of ACC lab.(Registration is at ACC lab at Mech. Eng.Dept.

The Mandatory Courses: (18 credit hours)

Code	Course Title	Credit Hours	Prerequisite
MEP 560	Instrumentations for Measurements, Tests and Control in Mechanical Power Systems – 1st Term in the diploma	**3**	
MEP 561	Automatic Control – Theory and Applications in Mechanical Power Systems – 1st Term in the diploma	**3**	
MEP 562	Using Hydraulic Circuits in Mechanical Power Systems – 1st Term in the diploma	**3**	
MEP 563	Using Virtual Labs for Analysis of Automatic Control Systems - 2nd Term in the diploma	**3**	
MEP 564	Using PLC and IT in Automatic Control Systems - 2nd Term in the diploma	**3**	**MEP 560**
MEP 599	Project**- in last Term of the diploma	**3**	

**** Special applied course (with no final term exam), all grades are based on the In-term works.**

The Elective Courses: (student selects 12 credit hours from the list as per the courses offered by the department in each term- subject to availability):

Code	Course Title	Credit Hours	Prerequisite*
MEP 565	Using Pneumatic Circuits in Automatic Control Systems	**3**	
MEP 566	Advanced Applications of Hydraulic Circuits in Automatic Control Systems	**3**	**MEP 562**
MEP 567	Advanced Applications of PLC in Automatic Control Systems	**3**	**MEP 564**
MEP 568	Advanced Applications of Pneumatic Circuits in Automatic Control Systems	**3**	**MEP 565**
MEP 569	Applications of Virtual Labs for Control of Steam Power Plants	**3**	
MEP 570	Applications of Virtual Labs for Control of Refrigeration & Freezing Plants	**3**	
MEP 571	Applications of Virtual Labs for Control of Central Air-Conditioning Systems	**3**	
MEP 572	Applications of Virtual Labs for Control of Industrial Diesel Plants	**3**	
MEP 573	Applications of Virtual Labs for Study and Analysis of Performance of Internal Combustion Engines	**3**	
MEP 574	Applications of Virtual Labs for Control of Pumping Plants and Tanks Filling	**3**	
MEP 575	Applications of Virtual Labs for Control of Solar Energy Heating Plants	**3**	
MEP 576	Applications of Virtual Labs for Control of Central Water Heating Plants	**3**	
MEP 577	Applications of Virtual Labs for Control of Gas Turbines Plants	**3**	
MEP 578	Applications of Industrial Valves: Types, Design, Construction, Installing, and Maintenance	**3**	
MEP 579	Applications of Industrial Pipe lines: Types, Design, Construction, Installing, and Maintenance	**3**	
MEP 580	Selected Topics in Pipe lines, Pumps, and Turbines	**3**	*
MEP 581	Selected Topics in Control Systems of Pipe lines, Pumps, and Turbines	**3**	*
MEP 582	Selected Topics in Refrigeration and Air-Conditioning Engineering	**3**	*
MEP 583	Selected Topics in Control of Refrigeration and Air-Conditioning Systems.	**3**	*
MEP 584	Selected Topics in Combustion Systems and Internal Combustion Engines.	**3**	*
MEP 585	Selected Topics in Control of Combustion Systems & Internal Combustion Engines.	**3**	*
MEP 586	Selected Topics in Power Plants and Steam Engineering	**3**	*
MEP 587	Selected Topics in Control Systems in Power Plants and Steam Engineering	**3**	*

MEP 588	Fluid Dynamics and Applications		
MEP 589	Theory of Turbo Machines		
MEP 590	Heat and Mass Transfer		

* Before each term, the department announces the contents and subjects covered in each selected topics course which is available for registration for that term.

Diploma of Graduate Studies: **Applications of Automatic Control of Mechanical Power Systems**

Courses Contents

MEP 560 - Instrumentations for Measurements, Tests and Control in Mechanical Power Systems:

Basic definitions – Concept of Calibration, static and dynamic response – Importance of accuracy, error-propagation and uncertainty analysis in experimental measurements – Methods of statistical analysis and graphical presentation of experimental results – Practical applications of measurement devices, electrical instruments, and signal conditioning devices – Using of Personal Computers in data accusation, processing and analysis during and after experimental measurements. Measurements of pressure, temperature, flow rate, fluid velocity, force. Control of Pressure, temperature, and flow rate.

MEP 561 - Automatic Control – Theory and Applications in Mechanical Power Systems:

Types of Control Systems – Mechanical components, pneumatic, hydraulic, electric systems – Modeling – Transfer function – Closed loop system – Instantaneous response – Stability and equilibrium tests – Design of control systems – Applications of control systems in turbo-machines, heat transfer equipments and in combustion systems.

MEP 562 - Using Hydraulic Circuits in Mechanical Power Systems:

Definition of Hydraulics- Hydrostatics (Pressure, Transportation & Magnification of Force & Moment)- Hydrodynamics (Continuity eqn., Bernoulli's eqn., Energy eqn., types of fluid flow)- Methods of Power transportation- Basic Components of Hydraulic Systems-Types of Positive Displacement Pumps (Gear, Vane, and piston pumps)- Types of Hydraulic Actuators (Cylinders, Engines, Semi-rotating Engines)- Pressure Valves – Directional Control Valves – Flow Control Valves- Non-return Valves – Conditioning of Hydraulic Oils (filters, Heat Exchangers, Tanks)- Oil Piping – Auxiliaries (Accumulators, Manifolds, Flow Meters, Pressure Gauges, Switches)- Hydraulic Symbols – Reading Hydraulic Schematics – Basic Hydraulic Circuits (Direction Control, Speed Control, Two-cylinders Control, Pumps Curves, Step-displacement diagram, Numbering of Hydraulic Elements).

MEP 563 - Using Virtual Labs for Analysis of Automatic Control Systems:

Definition of Virtual Labs(V.L.), Relation with PC and IT applications – Function of V. L. in Automatic Control Systems of Mechanical Power Engineering- Requirements of on line interactive Control- Systematic Basic Components and general format for Automatic Control V.L.- Main Menus of V.L. program-Setting Basic Control Elements- Showing Flow directions on Synoptic diagram- Elements of Main Control Board- Sensors and Gauges Board- Operation, Control and Alarms Board- Changing Operation Parameters- Diagnostics and Trouble Shooting- Data Recording-File Saving-Operator Reports- Charts of Heat Balance and System thermal Results- Evaluation and Calibration of V.L. Program- Case Study: Management and Operation of Automatic Control System of Industrial Steam Boiler- The simulation includes many critical control alarms, input/output signals, operation and instrumentation parameter-boards, diagnostic tools, error-report filling, help/trouble-shooting menus and Thermal Balance Calculations and Plotting tools.

MEP 564 - Using PLC and IT in Automatic Control Systems:

What is a PLC- Identifying Details, functions, Applications of PLC Units- Introduction for Basic Electric Components in Automatic Control Circuits (Sensors, transducers, keys, Relays, Contactors)-Types of PLCs-Types of Analog and Digital Signals-Pneumatic Logical Elements- Types of Memories:
ROM, RAM,EPROM, EEPROM…- PLC Programming - Ladder Diagram- Function Chart- Statement List-Setting Inputs and Outputs- Timers and Counters Programming- Expanding of PLCs.

MEP 565 - Using Pneumatic Circuits in Automatic Control Systems:
Design and Analysis of Automatic Systems (Objective/Method)- Advantages and Disadvantages of Pneumatic Systems- Methods of Preparation of Compressed Air-Calculations of air piping system using operation Parameters (length, Pressure, flow rate, Pressure-drop)- Air Pressure Ratings-Types of Actuators (Cylinders, Engines, Semi-rotating Engines)- Direct Control of Single and Double Acting Cylinder- Pressure Control Valves – Directional Control Valves – Flow Control Valves- Non-return Valves –Auxiliaries (Accumulators, Manifolds, Flow Meters, Pressure Gauges & Switches)- Symbols –Reading & Analysis of Pneumatic Circuits Schematics.

MEP 566 - Advanced Applications of Hydraulic Circuits in Automatic Control Systems:
Course Objective is to show correct method of operation of Hydraulic Systems to get their best Performance and extended operation life- Construction of Integrated Hydraulic Circuits (that include various elements studied before) to perform pre-specified functions- Applied Examples- Sealing Methods (simple and dynamic sealing)- Setting up Hydraulic Systems (1^{st} run tests, Initial required precautions, examination and starting up various elements)- Methods of operation and Maintenance: Connecting various Components- Investigation of Pump and motor status-Identifying air bleeding points in the Hydraulic System- No load Operation and Loading procedure – Adjusting Pressure & Flow Control Valves- Protective Maintenance- Trouble Shooting and Faults finding and fixing- Auxiliaries of Hydraulic Circuits(Accumulators, Manifolds, Flow Meters, Pressure Gauges & Switches).

MEP 567 - Advanced Applications of PLC in Automatic Control Systems:
Applications and Practical Examples for using PLC units in Automatic Control of Mechanical Power Systems-Various Examples and Applications for the Ladder Diagrams, Function Charts, and Statement Lists-Applications on PC using PLC simulation and Computer Programs.

MEP 568 - Advanced Applications of Pneumatic Circuits in Automatic Control Systems:
Advanced Applications on PC for Industrial Pneumatic Circuits including Virtual Labs and Interactive Simulations for Different Circuits (Q cycle, L cycle, U cycle, & the 3-cylinders cycle).These pneumatic automation cycles, are largely used in the industry (e.g., for automatic feeding of work pieces). The 4-circuits layouts are carried out with cascade & mechanical stroke end techniques. It is possible to run only single manually controlled sequence, to use every time you want to repeat cycle, or can run automatically until the deposit depletion (i.e., end of all 5-work pieces to be fed).The literal sequence has been divided in 2 or more groups, so that, the energy transmission, to the air distribution lines, is carried out by means of bi-stable 5/2 valves, driven by signals of impulsive kind (i.e., cam or mechanical actuation type). When the plant is started the air flow are visible and you can follow any selected cycle both on the pneumatic circuit and also be seen on the "stroke-pitch diagram" that characterizes the sequence. The button Exit closes the entire program and thus returns you to Windows.

MEP 569 - Applications of Virtual Labs for Control of Steam Power Plants:
Interactive Automatic Control System for Steam-Turbine & Rankin Cycle Power Generation Plant:
This is an interactive computer-based training course that includes an investigation, a virtual computer simulation and flow visualization. The course is designed to give the participant a broad based understanding of the most important concepts of practical automatic control and real thermo-fluid processes existing in multi-stage industrial Steam-Turbine & Rankine Cycle Power Generation Plant of maximum electric output of 30 MWatt. Pressure and temperature gauges show various values at all critical points of the plant.The steam-turbine unit include one high-pressure part and two low-pressure parts. Steam may be extracted or not-extracted from those 3 parts for 3-feed water heat exchangers and also for a deaerating unit. The plant also includes: an industrial 120 ton/hr at 120 bar water-tube boiler (of virtLab-1) and a water-cooled vacuum condenser with 6000 m^3/hr condenser cooling-water pump and many flow control valves. The simulation includes all previous boiler controls of VirtLab-1. Additional control systems/boards are included for steam turbine and electric-alternator unit and for the vacuum condenser and the cooling-water pump. The simulation includes many critical control alarms, input/output signals, operation and instrumentation parameter-boards, diagnostic tools, error-report filling, help/trouble-shooting and Thermal Balance Calculations and Plotting tools.

MEP 570 - Applications of Virtual Labs for Control of Refrigeration and Freezing Plants:

Interactive Automatic Control for Industrial Refrigeration and Freezing Plant:

This is an interactive computer-based training course that includes an investigation, virtual computer simulation and flow visualization. The course is designed to give the participant a broad based understanding of the most important concepts of practical automatic control and real thermo-fluid processes existing in industrial R22 compression refrigeration plant used for both freezing and cold storage of frozen products. Pressure and temperature gauges show various values at all critical points of the plant. The plant uses a 6 m^3/hr water-cooled condenser with adjustable inlet water-temperature. The reciprocating compressor runs at 1450 rpm and has a 377 cm^3 displacement volume. The plant has a freezing thermal load of 5 kW and a refrigeration thermal load of 3 kW with two adjustable thermostats for controlling refrigeration and freezing cells for different adjusted ambient temperature. On-line, and updated real R22 h-s diagram is plotted to show every point of the cycle. The h-s plotting is stored on a PDF file for further analysis. The simulation includes many flow or pressure control valves, many critical control alarms, input/output signals, operation &instrumentation parameter-boards, diagnostic tools, error-report filling, help/trouble-shooting and Thermal Balance Calculations and plotting tools.

MEP 571 - Applications of Virtual Labs for Control of Central Air-Conditioning Systems:

Interactive Automatic Control System for an Industrial Air-conditioning plant:

This is an interactive computer-based training course that includes an investigation, a virtual computer simulation and flow visualization. The course is designed to give the participant a broad based understanding of the most important concepts of practical automatic control & real thermo-fluid processes existing in an industrial plant used to air-condition a building to some pre-specified dry-bulb temperature and relative humidity. Air-locks are used to have different adjustable ratios of recycled air brought back to the building mixed with some renewal air. The plant includes 4 centrifugal pumps for the 4 battery cells for heating, cooling, humidification, and after-heating. Each pump has its on/off control board. Each battery cell has a control board that includes a pump flow rate-meter and both inlet and outlet cell temperature (except the humidification cell). The plant has an on/off air fans or ventilators control board and air locks control board. On-line, real psychometric diagram is plotted showing all performed processes. The diagram shows a point for Renewal air, point for Recycled air taken from inside the environment, a point for the mixture of Renewal and Recycled air, points for the air outlet from the various A/C plant batteries, and last point for the air going to the environment-building. The simulation includes many flow control valves and temperature read-out gauges. , many critical control alarms, input/output signals, operation and instrumentation parameter-boards, diagnostic tools, error-report filling, help/trouble-shooting and Thermal Balance Calculations and Plotting tools.

MEP 572 - Applications of Virtual Labs for Control of Industrial Diesel Plants:

Interactive Automatic Control System for Industrial 6-cylinder, turbo-charger, 4 stroke Diesel engine drive with thermal balance calculations:

This is an interactive computer-based training course that includes an investigation, a virtual computer simulation and flow visualization. The course is designed to give the participant a broad based understanding of the most important concepts of practical automatic control and real thermo-fluid processes existing in Industrial 6-cylinder, turbo-charger, 4-stroke Diesel engine drive. The engine follows the actual indicated compression ignition Diesel Cycle diagram. The thermal balance of this mechanical Power system is also performed and presented for each working engine condition. The engine utilizes the hot-exhaust gases to drive a compressor turbo-charger unit to pre-charge and increase the pressure of fresh air into the cycle. This unit has an air-cooler and two sea water pumps. The 6-cylinders are jacket-water cooled using a fresh water tank and two-fresh water pumps. Fuel is pumped to the injectors using two-fuel pumps.The lube oil unit is driven by two lube oil pumps & a lube oil cooler through one of the two sea-water heat exchangers. The second sea-water heat exchanger is used to cool the fresh water used in the engine cooling circuit. Automatic control system includes both of the engine conductions section and auxiliary management section. The simulation includes many critical control alarms, input/output signals, operation and instrumentation parameter-boards, diagnostic page tools, error-report filling, help/trouble-shooting menus and Thermal Balance Calculations and Plotting tools.

MEP 573 - Applications of Virtual Labs for Study and Analysis of Performance of Internal Combustion Engines

Interactive Automatic Control System for an Industrial 6-cylinder, turbo-charger, Diesel engine with a hydraulic brake unit: This is interactive computer-based training course that includes investigation, a virtual computer simulation& flow visualization. The course is designed to give the participant a broad based understanding of the most important concepts of practical automatic control and real thermo-fluid processes existing in Industrial 6-cylinder, turbo-charger, and 4-stroke Diesel engine drive. The engine follows the actual indicated compression ignition Diesel Cycle diagram. The thermal balance of this mechanical Power system is also performed and presented for each working engine condition. This extension lab investigates all performance characteristics of the internal combustion engine of VirtLab-8 as a system with two degrees of freedom: during normal operation its output work is altered in two ways: (1) by changing its rpm for a fixed load on the engine shaft; (2) by changing position of hand-lever or accelerator to keep same rpm for variable load on the engine shaft. The engine characteristics are obtained at full torque load, power and fuel specific consumption. The engine is mounted on a bench and connected to a dynamometrical brake. All proper operation conditions are adjusted through the control boards. The simulation includes many critical control alarms, input/output signals, operation and instrumentation parameter-boards, diagnostic page tools, error-report filling, help/trouble-shooting menus and Thermal Balance Calculations and Plotting tools.

MEP 574 - Applications of Virtual Labs for Control of Pumping Plants and Tanks Filling:

Part I: Interactive Automatic Control System for an Industrial pumping plant with two Parallel or Series Centrifugal Pumps: This is an interactive computer-based training course that includes an investigation, a virtual computer simulation and flow visualization. The course is designed to give the participant a broad based understanding of the most important concepts of practical automatic control and real thermo-fluid processes existing in Industrial pumping station. The station includes two centrifugal pumps which may work separately or work as pairs in parallel or in series. The pumps are provided with separated controls and instrumentation. Each of the two pumps can be operated independently from the other pump. The simulation allows changing all the operation conditions of each pump including the rpm, the inlet suction head, and the output discharge. This allows investigation of the H-Q curves of the plant for all possible different flow conditions. Also the characteristic H-Q curve of each pump can be obtained at full load conditions. The simulation includes many critical control alarms, input/output signals, operation and instrumentation parameter-boards, diagnostic page tools, error-report filling, help/trouble-shooting menus and Thermal Balance Calculations and Plotting tools.

Part II: important concepts of practical automatic control and real fluid processes existing in filling different vertical tanks with liquids. The plant includes a venture-meter at output and flow control valve at inlet. The simulation allows adjusting flow/speed values, working data, and venture meter values. The tank filling time is calculated and the diagram of head-pressure is plotted, presented and updated instantaneously. The simulation includes many critical control alarms, input/output signals, operation and instrumentation parameter-boards, diagnostic page tools, error-report filling, help/trouble-shooting menus and Thermal Balance Calculations and Plotting tools.

MEP 575 - Applications of Virtual Labs for Control of Solar Energy Heating Plants:

Interactive Automatic Control System for an Industrial Solar Heating Plant with 2-Flat Plate collectors and auxiliary boiler: This is an interactive computer-based training course that includes an investigation, a virtual computer simulation and flow visualization. The course is designed to give the participant a broad based understanding of the most important concepts of practical automatic control and real thermo-fluid processes existing in an Industrial Solar Heating Plant with 2-Flat Plate collectors and an auxiliary boiler. The simulation includes many critical control alarms, input/output signals, operation and instrumentation parameter-boards, diagnostic tools, error-report filling, help/trouble-shooting menus and Thermal Balance Calculations and Plotting tools.

MEP 576 - Applications of Virtual Labs for Control of Central Water Heating Plants:

Interactive Automatic Control System for a civil heating plant for hot water distribution:

This is an interactive computer-based training course that includes an investigation, a virtual computer simulation and flow visualization. The course is designed to give the participant a broad based understanding of

the most important concepts of practical automatic control and real thermo-fluid processes existing in a civil heating plant for hot water distribution. The simulation includes many critical control alarms, input/output signals, operation and instrumentation parameter-boards, diagnostic tools, error-report filling, help/trouble-shooting menus and Thermal Balance Calculations and Plotting tools.

MEP 577 - Applications of Virtual Labs for Control of Gas Turbines Plants:

Interactive Automatic Control System for Gas Turbine Plants:

This is interactive computer-based training course that includes the following items: Engine Design- Operating Principles- Engine Case & Air inlet- Compressor Section- Diffuser & Combustion- Turbine & Exhaust- Ignition System- Bearing & Seals- Lubrication & Lube Oil- Lube Oil Pumps- Lube Oil Filters & Coolers- Lube Oil Instrumentation- Hydraulic Oil System- Trip Oil System- Fuel System – Fuel Gas Supply System- Fuel Gas Control System- Liquid Fuel System- Liquid Fuel system Operation- Pneumatic Starting System- Hydraulic Starting System- Diesel Starting System- Enclosures- Fire Detection- Gas Detection-Fire Extinguisher Systems- Principles of Power Generation- Generator Components- Generator Lube Oil- Generator Control- Principles of Compression- Compressor Components- Compressor Lube Oil- Compressor Control System.

MEP 578 - Applications of Industrial Valves: Types, Design, Construction, Installing, and Maintenance

Course Program &Contents: Introduction+ movie (all types of valves, basic functions, selection)- Fundamentals (hydraulic considerations, construction, Classes or ratings, materials, standards for valves, standards for different parts)- Fluid Flow in valves (calculation of pressure losses, design & sizing parameters, cavitations, fluid-tightness, solved example on sizing) - Operation of Manual Valves (types, selection, connections, operation) -Non-manual Valves: Check Valves (types, selection, design and installation factors, examples) + a movie- Control Valves: Pressure Relief Valves (direct acting, characteristics) –_Automatic & Electric Valves (spool types, single/multi-stage controls)- Problems of Valves & valve Maintenance (some movies)- Water Hammer -Special Types of valves (in Hydraulic or Pneumatics Circuits).

MEP 579-Applications of Industrial Pipe lines: Types, Design, Construction, Installing, and Maintenance

Course Program &Contents: (1) *Introduction & Basic Concepts:* -Fundamental Aspects of Fluid Flow Piping Systems, Types and components of Piping Systems, Review of Hydraulic considerations, Major and Minor Losses in Piping Systems, Types of Pipe Fittings, Solved Examples. (2) *Piping System Design & Calculations*: Solved Practical Cases. (3)*Using Computer Software in the design of piping systems*. (4) *Types of Valves* (basic functions, selections: hydraulic considerations, construction, ratings, materials, Flow through valves, pressure losses, design facts / parameters - Manual Valves (types, selection, connections, operation) - Check Valves (types, selection, design and installation factors)-Reducing and Pressure Relief Valves (direct acting, characteristics) - Automatic Control Valves (spool types, single/multi-stage controls)- Valve Maintenance - Examples for automatic Valves & movies. (5) *Types of Flow Meters.*

MEP 580- Selected Topics in Pipe Lines, Pumps, and Turbines:

Special Course: Selected and Advanced Topics Covering Latest Scientific and the most Recent Technical Methods in Applications of Mechanical Power Engineering Regarding Pipe Lines, Pumps, and Turbines.

MEP 581- Selected Topics in Control Systems for Pipe Lines, Pumps, and Turbines:

Special Course: Selected and Advanced Topics in Automatic Control Covering Latest Scientific and the most Recent Technical Methods in Control Applications of Mechanical Power Engineering Regarding Pipe Lines, Pumps, and Turbines.

MEP 582- Selected Topics in Refrigeration and Air Conditioning Engineering:

Special Course: Selected and Advanced Topics Covering Latest Scientific and the most Recent Technical Methods in Applications of Mechanical Power Regarding Refrigeration and Air Conditioning Engineering.

MEP 583- Selected Topics in Control of Refrigeration and Air Conditioning Systems:

Special Course: Selected and Advanced Topics in Automatic Control Covering Latest Scientific and the most Recent Technical Methods in Control Applications of Mechanical Power Regarding Refrigeration and Air Conditioning Engineering.

MEP 584- Selected Topics in Combustion Systems and Internal Combustion Engines:
Special Course: Selected and Advanced Topics Covering Latest Scientific and most Recent Technical Methods in Applications of Mechanical Power Regarding Combustion Systems and Internal Combustion Engines.

MEP 585- Selected Topics in Control of Combustion Systems and Internal Combustion Engines:
Special Course: Selected and Advanced Topics in Automatic Control Covering Latest Scientific and most Recent Technical Methods in Control Applications of Mechanical Power Regarding Combustion Systems and Internal Combustion Engines.

MEP 586- Selected Topics in Power Plants and Steam Engineering:
Special Course: Selected and Advanced Topics Covering Latest Scientific and most Recent Technical Methods in Applications of Mechanical Power Regarding Power Plants and Steam Engineering.

MEP 587- Selected Topics in Control Systems for Power Plants and Steam Engineering:
Special Course: Selected and Advanced Topics in Automatic Control Covering Latest Scientific and the most Recent Technical Methods in Control Applications of Mechanical Power Regarding Power Plants and Steam Engineering.

MEP 588 - Fluid Dynamics and Applications:
The governing equations of fluid flow – 1-D incompressible and compressible flows with applications- 2-D flow: Newtonian fluids, Navier-Stokes equations, examples on flow in pipes. Viscous flow and theory of lubrication- Boundary Layer flow – Turbulent flow – Applications on flow of gases and liquids in pipelines.

MEP 589 - Theory of Turbo-machines:
The fundamentals, basic concepts and basic laws of turbo-machines – Similarity of turbo-machines – 1-D flow – 2-D flow through group of blades-cascade – 3-D flow in turbo-machines.

MEP 590 - Heat and Mass Transfer:
Heat transfer by conduction – Heat transfer by convection – Heat transfer by radiation – Heat transfer during conditions of Boiling and Condensation - Heat exchangers – Mass Transfer.

MEP 599 – Project:
Special applied course (with no final term exam), all grades are based on the In-term works.