

**“ANKARA UNIVERSITY AND NATIONAL TECHNICAL UNIVERSITY OF UKRAINE
JOINT DEGREE MASTER PROGRAM WITH THESIS: NUCLEAR ENERGY COURSES AND COURSE CONTENTS”**

No	University	Semester	C/E	COURSES	Hours per week				ECTS
					Lecture	Practical	Laboratory	Total	
1	AU	1	C	Patenting and Intellectual Property	2	1		3	3
2	KPI	2	C	Decontamination, Repair, Assembling and Decommissioning of Nuclear Power Plants	1	1		2	3
3	KPI	2	C	Computer Aided Design Systems in Power Plants	1		1	2	3
4	KPI	2	C	Theory and Systems of Automatic Control of Nuclear Power Plants	2		1	3	2,5
5	KPI	2	C	Control and Regulation of Steam Turbine Facilities at Nuclear Power Plants	1	2		3	3
6	KPI	2	C	Analysis Methods of Risk and Reliability of Nuclear Power Plants	2		1	3	5
7	KPI	2	C	Operational Modes of Nuclear Power Plants	4		3	7	10
8	AU	1	C	Regulatory and legal support of the energy industry	2	1		3	2
9	KPI	2	C	Nuclear-Physical Methods of Reactor Nuclear Power Stations Diagnosis	3	1		4	5
10	AU	1	C	Emergency modes and safety of nuclear power plants	3	2	2	7	7,5
11	AU	1	C	Analysis and management of accidents at nuclear power plants	2	1	1	4	6
12	AU	1	C	Energy Markets and Fuel Cycle Economics	2	1		3	4
13	KPI	2	C	Computer modeling of thermohydraulic processes in the elements of power equipment	1		2	3	6
14	AU	1	C	Heat exchange and hydrodynamics in power equipment	6			6	7
15	KPI	2,3	E	Subjects on Sustainable Development Problems	1	1		2	2
16	KPI	2,3	E	Subjects on Startup Projects Development	1	2		3	3
17	KPI	2,3	E	Practical foreign language professional communication		6		6	4,5
18	KPI	2,3	E	Pedagogy Subjects	1	1		2	2
19	KPI	2,3	E	Educational disciplines on safety in nuclear energy	2	1		3	4
20	AU	1,4	E	Advanced Reactor Physics	3			3	7
21	AU	1,4	E	Nuclear Safety and Security	3			3	7
22	AU	1,4	E	Nuclear Fuel Cycle	3			3	7
23	AU	1,4	E	Radiation Protection and Shielding	3			3	7

24	AU	1,4	E	Radiological Engineering	3			3	7
25	AU	1,4	E	Numerical Techniques 1	2	1		3	7

C: Compulsory Course, E: Elective Course

KPI: Igor Sikorsky Kyiv Polytechnic Institute (KPI), AU : Ankara University

“COURSE CONTENTS”

PATENTING AND INTELLECTUAL PROPERTY - ECTS 3

The purpose of the discipline is:

- Use the methodology of creative activity, modern methods of solving creative tasks and principles of engineering psychology and design when creating new technology and new technologies, including informational;
- Use the legal acts and international treaties regulating the relations in the field of intellectual property;
- Perform patent and information research to determine the level of technology and forecast its development;
- To identify objects of intellectual property rights;
- To determine the rights and obligations of holders of security documents for objects of intellectual property rights;
- Use the provision for processing applications for various intellectual property objects;
- Use the methods of evaluation of intellectual property rights objects for their further commercialization, including for the sale of licenses and technology transfer.

DECONTAMINATION, REPAIR, ASSEMBLING AND DECOMMISSIONING OF NUCLEAR POWER PLANTS - ECTS 3

The purpose of the discipline is:

- The ability to use basic methods and means of radiation protection, to calculate biological protection against ionizing radiation;
- The ability to conduct analytical, research and project activities on the development of radiation protection programs for ionizing radiation, radiation control programs and other documentation;
- The ability to analyse sources of ionizing radiation at npps, to develop technical solutions for reducing the impact of ionizing radiation on personnel, population and the environment;
- The ability to use stationary, portable and individual radiation monitoring devices.

COMPUTER AIDED DESIGN SYSTEMS IN POWER PLANTS - ECTS 3

The purpose of the discipline is:

- The ability, based on the analysis of calculations of temperature, velocity and pressure distribution, to be developed using CAD;
- To develop optimal designs and operational modes of heat-exchange equipment;

- Determine the thermo-stress condition of nodes and equipment parts.

SUBJECTS ON SUSTAINABLE DEVELOPMENT PROBLEMS - ECTS 2

The purpose of the discipline is:

- determine the level of sustainable development of territorial production systems according to the relevant indicators;
- to develop a system of support for the adoption of technical and organizational and managerial decisions aimed at increasing the level of sustainable development of territorial production systems.

SUBJECTS ON START-UP PROJECTS DEVELOPMENT - ECTS 3

The purpose of the discipline is:

- providing students with a system of theoretical knowledge and applied skills for the start-up and organization of the start-up;
- To form students' competencies, sufficient for the implementation of complex tasks for creating an innovative business start-up format and managing the development of a newly created enterprise.

PRACTICAL FOREIGN LANGUAGE PROFESSIONAL COMMUNICATION - ECTS 4,5

The purpose of the discipline is:

- to have persistent skills of the generation of speech in English, taking into account its phonetic organization, preservation of the pace, norms, uses and style of speech;
- to use the grammatical and lexical resources of the English language;
- to adequately perceive, understand, appreciate, reproduce and produce oral or written discourse;
- use the national-cultural component of the language for communication purposes;
- to determine the essence of language as a social phenomenon, its connection with the thinking, culture and social development of the people, functional properties of the language and its linguistic and ethnographic features;
- to identify and use different strategies for intercultural contact with representatives of other cultures, to make competent and reasoned decisions that are directly related to the intermediary's function in intercultural communication;
- to compare native and foreign cultures, to carry out research work;
- It is logical to arrange the necessary operations for the successful and effective communicative and translation activities.

PEDAGOGY SUBJECTS - ECTS 2

The educational discipline aims at preparing graduate students for future pedagogical activities at higher educational institutions of different levels on the positions of assistants and teachers.

After mastering the discipline, a graduate of a magistracy must be able to:

- Implementation of educational programs and curricula in accordance with the state standards of higher education;
- Analysis and selection of effective methodological teaching methods;

- Development and conducting of all kinds of classes and control measures at a higher educational establishment;
- Education and intellectual development of the personality of those who study;
- Self-assimilation of pedagogical literature;
- Critical evaluation of the conducted classes.

THEORY AND SYSTEMS OF AUTOMATIC CONTROL OF NUCLEAR POWER PLANTS - ECTS 2,5

The purpose of the discipline is:

- To develop the ability of students to define the main provisions of the theory of automatic control and the principles of building automated control systems of nuclear power plants,
- To evaluate industrial schemes of automation of automatic control systems for power units and their auxiliary equipment.

CONTROL AND REGULATION OF STEAM TURBINE FACILITIES AT NUCLEAR POWER PLANTS - ECTS 3

The purpose of the discipline is:

- Ability to apply new modern methods and programs for calculating, designing and optimizing equipment of the atomic energy complex
- Ability to develop technical tasks for the design and manufacture of equipment for the atomic energy complex and to evaluate the technical and economic efficiency of the work.

ANALYSIS METHODS OF RISK AND RELIABILITY OF NUCLEAR POWER PLANTS - ECTS 5

The purpose of the discipline is:

- To create the ability of students to apply the methodology of probabilistic analysis of NPP safety in order to assess compliance with the safety criteria and increase the safety level of the NPP.

OPERATIONAL MODES OF NUCLEAR POWER PLANTS - ECTS 10

The purpose of the discipline is:

- on nuclear fuel production;
- on issues of "movement" of nuclear fuel from its production up to its disposal;
- To master the questions of formation of fuel loading, knowledge of methods and methods of conducting neutron-physical calculations of active zones of power reactors.

REGULATORY AND LEGAL SUPPORT OF THE ENERGY INDUSTRY - ECTS 2

NUCLEAR - PHYSICAL METHODS OF REACTOR NUCLEAR POWER STATIONS DIAGNOSIS - ECTS 5

The purpose of the discipline is;

- To create the ability of students to apply the basic methods and technical means of controlling the nuclear-physical parameters of nuclear

installations;

- To solve practical scientific and technological tasks in the field of nuclear energy.

EMERGENCY MODES AND SAFETY OF NUCLEAR POWER PLANTS - ECTS 7,5

The purpose of the discipline is;

- Know and understand the principles and criteria of safety and NPP, as well as apply them in practice;
- Know the purpose, composition, characteristics, locking and operating modes, as well as setting the operating system security;
- Ability to apply the basic laws of atomic physics and heat-mass in the analysis of design accidents;
- Ownership of the principles of management of the power unit in the event of accidents and the ability to apply instructions on the elimination of accidents;
- To be guided by modern approaches and methods of safety assessment of the NPP;
- Understanding of the whole complex of physical and chemical processes and their interactions in severe accidents, as well as their impacts on the mechanisms of the failure of the hermetic unit of the power unit;
- Know the basics and procedures of the plan of emergency response on the site of the NPP;
- Understand the principles, methods and procedures for managing accidents at NPPs.

ANALYSIS AND MANAGEMENT OF ACCIDENTS AT NUCLEAR POWER PLANTS - ECTS 6

The purpose of the discipline is;

- Understanding of the philosophy of nuclear safety and the ability to implement it in practice;
- Ability to analyse emergency processes and offer emergency management measures:

ENERGY MARKETS AND FUEL CYCLE ECONOMICS - ECTS 4

COMPUTER MODELLING OF THERMOHYDRAULIC PROCESSES IN THE ELEMENTS OF POWER EQUIPMENT - ECTS 6

The purpose of the discipline is;

- The ability, based on the analysis of the calculations of the distribution of temperatures; velocities and pressure, to be developed using CAD;
- To develop optimal constructions and operational modes of heat-exchange equipment;
- Determine the thermal stresses of nodes and equipment parts.

HEAT EXCHANGE AND HYDRODYNAMICS IN POWER EQUIPMENT - ECTS 7

The purpose of the discipline is;

- Ability to analyze thermohydraulic processes in steam generating channels and perform calculations of power equipment;
- The ability to determine and analyze the heat-hydraulic parameters of two-phase flows in the steam generating channels of the power equipment using the methods of calculations of the circuit of natural circulation and rectangular elements of power plants according to

geometrical characteristics and thermal load.

EDUCATIONAL DISCIPLINES ON SAFETY IN NUCLEAR ENERGY - ECTS 4

- This course, primarily about safety and the role of humans in this case.
- The structure of the nuclear industry in Ukraine and the initial information about the nuclear power plant, popularly explained the work of the main process equipment NPP.
- Described nuclear energy in the world, provides information on all nuclear reactors in the world, nuclear safety Ukraine presented in comparison with nuclear world.
- It is shown that a fundamental principle of security management at present is creating a culture of safety. The role of human factor in ensuring safety are the methods of analysis and consideration of the human factor.
- Training is seen as essential to the security culture and the psychology of security - both scientific field, providing staff training.
- It is considered safety culture assessment and possible ways of measuring the development of safety culture and stage of development, methods of assessment and self-assessment of safety culture.
- It is considered the stability of power under normal operating conditions and in accidents, are indicators of sustainability and the use of the power unit and methods of their calculation.

NUCLEAR SAFETY AND SECURITY – ECTS 7

- Fundamental principles in Nuclear Security;
- Development of International Legal Framework for Nuclear Security;
- Overview of the International Instruments in implementing Nuclear Security;
- Nuclear Security: Legally Binding International Instruments and Non Binding Instruments;
- Convention on the Physical Protection of Nuclear Material and its 2005 Amendment, UN Security Council Resolutions, The Code of Conduct on the Safety and Security of Radioactive Sources;
- Security aspects of different types of nuclear installations;
- Nuclear Instrumentation Methods and Measuring Devices for nuclear and other radioactive material measurements;
- Laboratory hands-on experiments for radioactive and nuclear material categorization;
- Threat assessment, Threat analysis and Design Basis Threat;
- Self Assessment in Nuclear or Radiological Security case exercises;
- Nuclear forensics supporting to nuclear security.
- Probabilistic safety analysis for nuclear components and entegrated systems
- Response to nuclear incidents or accidents, emergency cases,emergency preparednes, planning and implementation

ADVANCED REACTOR PHYSICS- ECTS 7

- Introduction to Nuclear Energy;

- Neutron Interaction with Matter;
- Nuclear Fission, Chain Reaction;
- Neutron Elastic Scattering;
- Neutron Slowing Down;
- Neutron Transport Equation;
- One-Group Diffusion Equation, Elementary Solutions to Diffusion Equation, Multi-Group Diffusion Equation;
- Finite Difference /Monte Carlo Methods;
- Reactor Kinetics/ Dynamics.

RADIATION PROTECTION AND SHIELDING – ECTS 7

- Radiation protection philosophy, ALARA, ICRP 103 Report, Basic radiation safety standards, regulations;
- External and internal exposures;
- Rules for safe transportation of radioactive source and materials;
- Radiation field quantities, radiation sources;
- Radiation interactions with matter, general radiation transport equation;
- Radiation protection methods, radiation dose limits, measures for radiation workers;
- Shielding principles for different radiation;
- Shielding calculation methods for different medical imaging and radiotherapy rooms.

NUMERICAL TECHNIQUES 1 – ECTS 7

- Type Transformations, Input and Output Formats;
- Operators (number operators, and, or, xor) and pointer studies;
- Loops (if, else if, while, for studies);
- Importing and reading data from a file;
- Basic principles of Monte Carlo technique, basic sampling principle and inverse transformation method;
- Interaction of X-rays with matter, mean free path length and determining of the interaction;
- Types of interaction, Photoelectric phenomena Compton scattering, Rayleigh scattering;
- Coordinate Transformations, Cartesian and Global Coordinates;
- Determination of Coordinates of Photon in Matter Entry Point;
- Gauss distribution, standard deviations, error calculations;
- Energy Spectrum;
- Dose and Scatter Section Calculations;

- Mathematical Phantoms;
- The Mathematical Phantom of the Head.

NUCLEAR FUEL CYCLE – ECTS 7

- Introduction and review of the nuclear fuel cycle;
- Nuclear fuel resources, mining and milling;
- Conversion and enrichment;
- Reactor fuel design and fabrication;
- Reprocessing and recycling;
- High level waste management;
- Low level waste management and decommissioning of nuclear power plant.

RADIOLOGICAL ENGINEERING - ECTS 7

A fundamental understanding of

- Radiation interact, ions in matter, the biological effects of radiation;
- Internal and external dosimetry;
- Occupational and environmental radiation protection;
- Health physics instrumentation, regulations;
- Waste management;
- Risk assessment, radiation shielding.

“SCIENTIFIC PREPARATORY LECTURES” COURSES

Nº	Courses	ECTS Credits	Type of control	Course work	Classroom hours per week	Lectures	Practical lessons	Laboratory
<i>1 semester</i>								
1	Hydro-gas Dynamics	7,0	exam		5	3	1	1
2	Heat and Mass Exchange	7,0	exam		5	3	2	

3	Theory of Nuclear Reactors -1. Diffusion and neutron deceleration.	4,0	exam		3	2	1	
4	Theory of Nuclear Reactors -2. Course work	1,0		1				
5	Education disciplines on auxiliary equipment of NPP. Pumping and auxiliary equipment of NPP.	5,0	test		4	3	1	
6	Fundamentals of Security Management in Nuclear Energy.	2,0	test		2			
7	Ukrainian (Russian) professional language professional - 1.	2,0	test		2		2	
8	Foreign language of professional orientation - 1.	2,0	test		2		2	
Total per semester:		30,0	3/3	1	23	11	9	1
2 semester								
1	Heat exchange during phase transformations and radiation.	5,0	exam		4	2	2	
2	Nuclear Power Reactors.	4,0	exam		2,5	2	0,5	
3	Nuclear and Heat Power Plants.	3,0	test		3	2	1	
4	Technology of Coolant.	4,0	test		4	3		1
5	Theory of Nuclear Reactors -3. Critical dimensions of the reactor.	5,5	exam		4	2	2	
6	Training disciplines on kinetics and control of Nuclear Reactors. Non-stationary processes and control of Nuclear Steam Production Facilities (NSPF).	4,5	exam		3,5	2,5		1
7	Ukrainian (Russian) professional language professional - 1.	2,0	test		2		2	
8	Foreign language of professional orientation - 2. Foreign language professional communication. Business language	2,0	test		2		2	
Total per semester:		30,0	3/5		25	13,5	9,5	2
Total:		60,0	6/8	1				

