MINING AND POWER ENGINEERING

II Level – MSc (3 semesters, 90 ECTS)

Entry requirements
BSc or BEng.
Each application is assessed individually on its merits. If in doubt, please contact the Admission Officer.
English: TOEFL - 550 points or
IELTS - 6 points

Mode of study
Full time

Duration; start date

Deadline for application

Language of instruction
English

Tuition fee for non EU /EFTA students
4000 EUR per year + 200 EUR application fee

Programme coordinators:
Leszek Jurdziak, PhD, DSc

Contact
Admission Officer
admission@pwr.wroc.pl
www.pwr.wroc.pl

PROGRAMME

3 SEMESTERS	*MSc*
Entry requirements: ***Bachelor of Science or*** ***Bachelor of Engineering*** ***(180 ECTS)***	*Completed:* ***Diploma thesis,*** ***Final Exam***

Possible extension: ***Studies of the III level (PhD)***	*Graduate Profile:* *The graduate will possess knowledge of design and operation of mining and power generation complexes. They will be prepared to perform the engineering tasks like feasibility studies concerning estimation of mineral energy resources and their applicability to power generation; computer aided design of the complex and its elements; technical design; construction supervision of mines and power plants; the power generation complex commissioning and maintenance. The Mining and Power Engineering studies graduate will find employment in lignite and coal mines, in particular infrastructurally joined up with thermal power plants, in power generation and distribution companies, related design offices, service providers and modern industry.*

Structure of the programme (credits)

ECTS	Semester 1	Semester 2	Semester 3
1			
2			
3			PE
4			
5			
6			
7	PE	PE	
8			
9			
10			ME
11			
12			
13			
14			
15			
16			EM
17			DS
18			
19			
20			
21			
22			
23	ME	ME	MT
24			
25			
26			
27			
28			
29	EM	EM	
30			FE

ME –	Mining Engineering courses
PE –	Power Engineering courses
EM –	Economic and Managerial courses
DS –	Diploma Seminar
MT –	Master Thesis
FE –	Final Exam

PLAN OF STUDIES

1st YEAR, SEMESTER 1

Obligatory courses:

No.	Code	Subject/Module	Contact hours/week					CHS	TSW	ECTS	Form of Assesment
			L	T	lab	p	s				
1	ESN0061	CAD/CATIA			3			45	90	3	T
2	ESN0201	Quantum physics	2					30	60	2	T
3	ESN0401	Electrical machines and devices	2		1			45	90	3	T
4	ESN0872	Heat transfer	1	1	1			45	90	3	T
5	ESN1041	Combustion and fuels	2	1	1			60	120	4	E
6	GGG100908	Geomechanics	2		1			45	90	3	E
7	GEG100905	Geology of energy resource deposits	2	1	1			60	120	4	T
8	GGG100933	Statistics in Engineering and Geology	2		2			60	90	3	E
9	GGG100928	Basic concepts of financial management	1		1			30	60	2	T
10	GGG100921	Satellite positioning and applications	1		1			30	60	2	T
11	ESN0521	Metrology and engines testing			1			15	30	2	T
TOTAL			14	3	14	0	0	465	900	30	

1st YEAR, SEMESTER 2

Obligatory courses:

No.	Code	Subject/Module	Contact hours/week					CHS	TSW	ECTS	Form of Assesment
			L	T	lab	p	s				
1	ESN0411	Power energy machines and devices	3	3				90	180	6	E
2	GGG100915	Fuel processing	2		2			60	120	4	T
3	GGG100913	Surface and underground mining technology	2		1			45	90	3	T
4	GGG100910	Mining machinery systems	2		1		1	60	120	4	E
5	GGG100917	Methods of computer assisted mine design	1		3			60	90	3	T
6	GGG100935	Economics in mining and power industry	2			1		45	90	3	T
7	GGG100923	Maintenance management systems and failure analysis	2		2			60	120	4	E
8	ESN0551	Mathematical simulation of power engineering processes	2		1			45	90	3	T
9	GGG100932	Practical training	4 weeks								T
TOTAL			16	3	10	1	1	465	900	30	

2nd YEAR, SEMESTER 3

Obligatory courses:

No.	Code	Subject/Module	Contact hours/week					CHS	TSW	ECTS	Form of Assesment
			L	T	lab	p	s				
1	ESN0021	Energy power processes automation	2		1			45	90	3	E
2	ESN1111	Energy process engineering	2		1			45	90	3	E
3	GGG	Integrated analysis of deformations of rock mass and structures	2		1	1		60	90	3	E
4	GGG100925	Environmental management	2	1	1			60	90	3	T
5	GGG100919	Methods of computer assisted mine design II	1		1			30	60	2	T
6	GGG	Market Risk of Mining and Energy Company	1			1		30	60	2	T
7	GGG100930	Diploma seminar					2	30	30	1	T
8	GGG100931D	Master thesis							300	13	T
TOTAL			10	1	5	2	2	300	810	30	

L	T	lab	p	s

L – Lecture T – Tutorials, **l** – laboratory, **p** – project, **s** – seminar,

CHS	TSW

CHS – Contact Hours (organized), **TSW** – Total Student Workload (h), **E** – Exam, **T** – Test, **CW** – Course Work

Description of the courses

1st Semester

CODE ESN 0061 CAD/CATIA

Language: English **Course:** Basic/**Advanced**
Year (I), semester (1) **Level:** II **Obligatory**/Optional
Prerequisites: Technical drawing **Teaching: Traditional**/Distance L.
Lecturer: Prof. Marek Gawliński, Janusz Skrzypacz Ph.D.

	Lecture	Tutorials	Laboratory	Project	Seminar
Hours / sem. (h)			45		
Exam / Course work/T:			T		
ECTS			3		
Workload (h)			90		

Outcome: the course is designed to provide skills in creating drawings by means of AutoCAD/CATIA program with 3D drawing

Content: communication with the program; the way the different data can be fed into the program; prototype drawing; methods of creating and modifying graphic entities; hatching; dimensioning; plotting; creating entity libraries; creating and manipulating text objects; plotting (sheet layouts, plot styles), creating and managing part libraries; 3D modelling (creating, editing, rendering and plotting).

Literature:

1. Any handbook or manuals for Auto CAD /CATIA 2006/2008 application

CODE ESN 0201 QUANTUM PHYSICS

Language: English **Course:** Basic/**Advanced**
Year (I), semester (1) **Level:** II **Obligatory**/Optional
Prerequisites: Basic physics and mathematics **Teaching: Traditional**/Distance L.
Lecturer: Dorota Nowak-Woźny Ph.D.

	Lecture	Tutorials	Laboratory	Project	Seminar
Hours / sem. (h)	30				
Exam / Course work/T:	T				
ECTS	2				
Workload (h)	60				

Outcome: the interpretation of the nature phenomenon and processes, the knowledge needed to effectively apply the phenomenon and processes

Content: introduction to the basic problems of the quantum physics, especially taking quantum-mechanical method of thinking into consideration

Literature:

1. E.H.Wichmann, *Quantum Physics*, McGraw-Hill Book Company, New York 1971
2. D.J.Griffiths, *Introduction to quantum mechanics*, 2005
3. P.T.Mathews, *Introduction to quantum mechanics*, Mc Graw Hill Higher Education 1974

CODE ESN 0401 ELECTRICAL MACHINES AND DEVICES

Language: English **Course: Basic/**Advanced
Year (I), semester (1) **Level:** II Obligatory/**Optional**
Prerequisites: Basic electrical engineering **Teaching: Traditional/**Distance L.
Lecturer: Prof. Bogdan Miedziński

	Lecture	Tutorials	Laboratory	Project	Seminar
Hours / sem. (h)	30		15		
Exam / Course work/T:	E		T		
ECTS	2		1		
Workload (h)	60		30		

Outcome: knowledge of the principles of action, constructions and exploitation of basic electric machines and devices.

Content: Phenomena occurring at construction of machines and devices. Structure, principles of operation and characteristics of D.C. machine. One-phase transformer, equivalent scheme, states of work. Regulating, measuring and three-phase transformers. A.C. machines - inductive and synchronous – principles of operation, structure, characteristics. Starting, regulation of speed and braking of motors. Synchronization of generators. Electric drive, converters, selection of motors. Transmission and distribution of electric energy. Electrical power supply system. Sources, transmission and distribution networks, substations, distribution boards. Supplying of industrial plant. Wires and cables, breakers, illumination. Environmental influences. Safety in electrical power engineering. Protection from electric shock. Quality of electric energy. Regulation of voltage, power and frequency. Relays, automatic protection and Automatic Switching Reserve. Systems steering and automatic regulation. Market of electric energy. Energy law, tariffs of electric energy.

Literature:

1. Chapman Stephen J. *Electric machinery fundamentals*, McGraw-Hill, New York, 1991.

CODE ESN 0872 HEAT TRANSFER

Language: English **Course: Basic/**Advanced
Year (I), semester (1) **Level:** II **Obligatory/**Optional
Prerequisites: Thermodynamics **Teaching: Traditional/**Distance L.
Lecturer: Prof. Zbigniew Gnutek z zespołem (w tym Sławomir Pietrowicz Ph.D.)

	Lecture	Tutorials	Laboratory	Project	Seminar
Hours / sem. (h)	15	15	15		
Exam / Course work/T:	T	T	T		
ECTS	1	1	1		
Workload (h)	30	30	30		

Outcome: Subject area of the course enables one to understand physical side of heat transport processes as well as to acquire the following abilities: calculations of heat fluxes, temperature profiles in different geometry bodies, calculations of heat transfer coefficients for different kinds of convection (without change of phase, condensation, boiling), calculation of heat fluxes for thermal radiation. It also provides skills in thermal calculations of heat exchangers and their designing.

Content: Basics laws of heat transfer. Steady conduction and heat penetration (plane barrier, tube, spherical, bars, fins and fin areas). The basic theory of heat exchanger-recuperators. The partition and the typical heat transfer causes (forced convection, natural convection without phase changing and with phase changing). Thermal radiation (basic laws, the heat transfer for special causes). Selected problems of conduction (conduction with internal heat sources, unsteady heat conduction).

Literature:

2. Frank Incropera, Dawid de Witt, Fundamental of Heat and Mass Transfer
3. AG. Blokh, Heat transfer in steam boiler furnaces, Springer-Verlag, 1988.
4. G.F.Hewitt (Editor), JeffreyHewitt, Heat Exchanger Design Handbook, (Volume 1-3), Begell House;Ringbound edition (March 1, 1998).

CODE ESN 1042 COMBUSTION AND FUELS

Language: English **Course:** Basic/**Advanced**
Year (I), semester (1) **Level:** II **Obligatory/**Optional
Prerequisites: **Teaching: Traditional/**Distance L.
Lecturer: Prof. Włodzimierz Kordylewski

	Lecture	Tutorials	Laboratory	Project	Seminar
Hours / sem. (h)	30	15	15		
Exam / Course work/T:	E	T	T		
ECTS	2	1	1		
Workload (h)	60	30	30		

Outcome: Students should acquire qualifications-skills in selection of fuels for burners and furnaces, and calculations of consumption of fuels and combustion air. They gain competence in maintenance of fuel installations in heat generating plants, power plants and industrial plants.

Content: The course comprises combustion stoichiometry, thermodynamics and chemical kinetics of combustion, properties of fossil fuels, biomass and wastes combined with reserves, total resources and consumption of fossil fuels. The mechanism of gas combustion is combined with combustion aerodynamics and flame structures. Dispersion of liquid fuels and their mechanisms of burning with related burners are considered. Burning of coal, firing and co-firing of biomass with coal, including related burners and furnaces, are described. Mechanisms of major pollutant generation in combustion systems and low-NO_x combustion systems are shown. The principles of fluidised combustion and burning in boiler furnaces are presented. Measurement methods in combustion complete the lecture.

Literature:

1. Beer J.M. Chigier N.A., *Combustion aerodynamics*, Applied Science Publishers LTD., London 1972.
2. Griffiths J.F., Barnard J. A., *Flame and combustion*, Blackie Academic & Profesionals, London 1995.
3. Lefebvre A.H., *Gas turbine combustion*, Hemisphere Publishing Corporation, New York 1983.
4. Tilman D.A., *The combustion of solid fuels and wastes*, Academic Press, INC, San Diego, 1991.
5. Smoot L.D., *Fundamentals of coal combustion*, Elsevier, Amsterdam 1993.
6. Lawn C.J., *Principles o f combustion engineering for boilers,* Academic Press, London 1987.

CODE GGG100908 GEOMECHANICS

Language: English **Course:** Basic/**Advanced**
Year (I), semester (1) **Level:** II **Obligatory/**Optional
Prerequisites: **Teaching: Traditional/**Distance L.
Lecturer: Witold Pytel, DEng, DSc; Jerzy Bauer, DEng

	Lecture	Tutorials	Laboratory	Project	Seminar
Hours / sem. (h)	30		15		
Exam / Course work/T:	E		T		
ECTS	2		1		
Workload (h)	60		30		

Outcome: Fundamental understanding of rock mechanics, ability to judge whether rock slopes and underground constructions are stable and ability to give recommendations how to stabilise an unstable construction.

Content: Rock mass properties-constitutive laws for elastic, plastic and viscous materials; strength theories; generalized Hoek-Brown criterion. Post-failure behaviour. Rock mass classification: engineering rock mass classification, Terzaghi's approach, RQD, RSR; geomechanics classification RMR; Rock Tunnelling Quality Index Q; Mine Roof Rating MRR etc. In-situ stresses – the world stress map; in-situ stress measurement. In-situ and induced stresses. Methods for stress analysis: Finite element method; Finite difference method; Boundary element method; Distinct element method. Practical examples of two-dimensional and three-dimensional static models–using PHASE and NE/NASTRAN programs. Rock mass discontinuities and their strength–shear strength and Barton's estimates. Field estimates of joint roughness coefficient JRC, instantaneous cohesion and friction. Slope stability problems and rockfall hazard–soil mechanics methods. Limit equilibrium models; analysis of rockfall hazard. Roof supports in rock engineering–roof strata behaviour (theories and numerical examples); support loading pressure; methods for support selection. Surface subsidence due to underground mining-theories and methods of assessment. Structure resistance against earthquake and mining related motion – modelling of structures; analysis using response spectra method; time history analysis using mode superposition method; numerical examples.

Literature:

1. Pariseau W. G., Design Analysis in Rock Mechanics. Taylor & Francis, Inc., 2006
2. Goodman R.E., Introduction to Rock Mechanics, 2nd Edition, Wiley, 1989.
3. Franklin J.A. , Dusseault M.B., Rock Engineering, McGraw Hill, 1989.

CODE GEG100905 GEOLOGY OF ENERGY RESOURCE DEPOSITS

Language: English **Course:** Basic/**Advanced**
Year (I), semester (1) **Level:** II **Obligatory**/Optional
Prerequisites: **Teaching: Traditional**/Distance L.
Lecturer: Tadeusz Przylibski DSc, Stanisław Ślusarczyk PhD, Paweł Zagożdżon PhD

	Lecture	Tutorials	Laboratory	Project	Seminar
Hours / sem. (h)	30	15	15		
Exam / Course work/T:	T	T	T		
ECTS	2	1	1		
Workload (h)	60	30	30		

Outcome: Students get the competence to solve specific problems regarding the characterization, exploration, operation processes and protection of geogenic resources of energy.

Content: Energy resource deposits' origin and formation processes. Properties of geogenic energy resources on Earth. Fossil fuels: lignite, hard coal, oil and gas formation processes, classification, composition and energy productivity. Worldwide fossil fuel deposits. Nuclear energy sources: deposit formation processes, characteristics of natural chains of radioactive decay, fission and fusion nuclear reactions. Worldwide deposits of uranium. Geothermal energy: heat production and transfer, regions of production. Geothermal energy prone areas on Earth. Other geogenic energy sources – wind and water. Exploration, operation processes and protection of geogenic resources of energy.

Literature:

1. Merrit R., *Coal exploration, mine planning and development*, Elsevier, Amsterdam 1986.
2. Buryakovsky L., Eremenko N.A., Gorfunkel M.V., Chilingarian G.V., *Geology and geochemistry of oil and gas*, Elsevier, Amsterdam 2005.
3. DiPippo R., *Geothermal power plants*, Amsterdam 2007
4. www.usgs.gov, www.nasa.gov, www.pgi.gov.pl,

CODE GGG100933 STATISTICS IN ENGINEERING AND GEOLOGY

Language: English **Course:** Basic/**Advanced**
Year (I), semester (1) **Level:** II **Obligatory**/Optional
Prerequisites: **Teaching: Traditional**/Distance L.
Lecturer: Krzysztof Hołodnik, DEng

	Lecture	Tutorials	Laboratory	Project	Seminar
Hours / sem. (h)	30		30		
Exam / Course work/T:	E		T		
ECTS	2		1		
Workload (h)	60		30		

Outcome: Having completed this course, a student should understand the statistical analysis of the geological field data and geostatistical modelling of the spatial parameter variability. The student should also be familiar with the parameter variability identification, with the initial cut-off grade analysis and evaluation of volume, tonnage and weighted average of the parameter in the indicated area of the deposit based on the geostatistical analysis.

Content: The random variable and the probability distribution. Parameters of the probability distribution (mean, variance, skewness, kurtosis, etc.). Basic distributions (discrete, exponential, normal, log-normal, beta, etc.). The dependency of the random variables. Covariance and correlation. Estimators of the mean, variance, etc. Testing of the statistical hypothesis (parametric and nonparametric tests). The regionalized variable and the geostatistical model of the variability. Trend surface analysis and anisotropy analysis. Methods of the estimation of the regionalized variable (kriging, inverse power of distance and "nearest neighbour"). Verification of the estimation procedure (cross-validation). CAD laboratory with the use of Datamine and Microsoft Excel software.

Literature:

1. Clark I. 2000. Practical geostatistics. Elsevier Applied Science, London and New York 1994 (1st ed.).
2. Davis J.C. 2002. Statistics and Data Analysis in Geology. J. Wiley and Sons, New York 1973 (1st ed.).
3. Webster R., Oliver M.A. 2000. Geostatistics for Environmental Scientists. John Wiley & Sons.

CODE GGG100928 BASIC CONCEPTS OF FINANCIAL MANAGEMENT

Language: English **Course:** Basic/**Advanced**
Year (I), semester (1) **Level:** II **Obligatory**/Optional
Prerequisites: Economics **Teaching: Traditional**/Distance L.
Lecturer: Gabriela Paszkowska, PhD

	Lecture	Tutorials	Laboratory	Project	Seminar
Hours / sem. (h)	15		15		
Exam / Course work/T:	T		T		
ECTS	1		1		
Workload (h)	30		30		

Outcome: Basic understanding of fundamental economic phenomena and factors influencing the energy and minerals market, basic skills in investment project evaluation, basic understanding of financial reports of corporations.

Content: Stock and commodity market used by mining and power industries. Costs in economics and in accounting; relevant cost, incremental cost, marginal cost, alternative cost. Variable and fixed costs; break even point; Cost-volume-profit analysis. Basics of financial accounting. Income statement and cash flow statement. Financial ratioanalysis. The concept of time value of money. Basics of capital budgeting. Ex-

amples of mineral project evaluation. The concept of risk and return; risk analysis in project evaluation; the concept and methods of hedging.

Literature:

1. Brealey, Richard A. and Mayers, Stewart C., Principles of Corporate Finance, McGraw-Hill Series in Finance, McGraw-Hill, Inc. New York., 1991.
2. Jonson H.: Making Capital Budgeting Decisions: Maximizing the Value of the Firm. Financial Times/Prentice Hall, London, 1999.
3. Kolb B.A., DeMong R.F.: Priciples of Financial Management, Business Publications, Inc., Plano, Texas 1988.

CODE GGG100921 SATELLITE POSITIONING AND APPLICATIONS

Language: English **Course:** Basic/**Advanced**
Year (I), semester (1) **Level:** II **Obligatory**/Optional
Prerequisites: **Teaching: Traditional**/Distance L.
Lecturer: Jan Blachowski, PhD

	Lecture	Tutorials	Laboratory	Project	Seminar
Hours / sem. (h)	15		15		
Exam / Course work/T:	T		T		
ECTS	1		1		
Workload (h)	30		30		

Outcome: Knowledge and understanding of satellite positioning and navigation of objects. Ability to use satellite positioning for various applications

Content: Description of satellite positioning systems. General theory of satellite positioning. Introduction to coordinate systems. Methods and techniques of satellite positioning for various applications. Examples of satellite positioning applications. During laboratory classes: introduction to handheld GPS receivers and their main functions, planning GPS measurements, performing and comparison of single-point positioning and relative positioning techniques, basic processing of GPS measurements, transformation of geodetic coordinates (B, L, h) to Cartesian coordinates (X, Y, h) and reverse calculation.

Literature:

1. Grewal M. S., Weill L. R., Andrews A. P., 2007: Global Positioning Systems, Inertial Navigation, and Integration, John Wiley & Sons, Hoboken;
2. Hofmann-Wellenhof B., Lichtenegger H., Collins J., 2001: Global Positioning System: Theory and Practice, Springer-Verlag KG,Wien;
3. Kaplan E., Hegarty Ch., 1996: Understanding GPS: Principles and Applications, Second Edition, Artech House Telecommunications Library
4. Lecture and laboratory handouts

CODE ESN 0521 METROLOGY AND ENGINES TESTING

Language: English **Course:** Basic/**Advanced**
Year (I), semester (1) **Level:** II **Obligatory**/Optional
Prerequisites: Basic thermodynamics, fluid mechanics and electrical engineering. **Teaching: Traditional**/Distance L.
Lecturer: Karolina Madera-Bielawska Ph.D., Wojciech Zacharczuk Ph.D.

	Lecture	Tutorials	Laboratory	Project	Seminar
Hours / sem. (h)			15		
Exam / Course work/T:			T		
ECTS			1		
Workload (h)			30		

Outcome: Students should posses the ability to measure and balance engines and power engineering equipment.

Content: Measurements of main thermodynamic parameters (pressure, temperature, humidity, gas chemical compositions), velocity and flow rate, calorimetry of solid and gas fuels, granulometric analysis of solid fuels and control of boiler water quality. Measurements of parameters of a steam boiler, gas boiler, impeller pump, fan, piston air compressor, steam turbine and coal mill.

Literature:

1. Laboratory test statements

2nd Semester

CODE ESN 0411 POWER ENERGY MACHINES AND DEVICES

Language: English **Course:** Basic/**Advanced**
Year (I), semester (2) **Level:** II **Obligatory**/Optional
Prerequisites: Basic mechanics. Basic Thermodynamics. **Teaching: Traditional**/Distance L.
Lecturer: Prof. Halina Kruczek, Janusz Skrzypacz Ph.D.

	Lecture	Tutorials	Laboratory	Project	Seminar
Hours / sem. (h)	45	45			
Exam / Course work/T:	E	T			
ECTS	3	3			
Workload (h)	90	90			

Outcome: introduction to theory, principles of operation and basic constructions of thermal fluid-flow turbomachinery, design of boilers for large-scale application and methods of performing heat exchange calculations.

Content: Classification of rotodynamic compressing machines. Basic thermodynamic equations for compressing processes. Energy conversion at axial and radial compressor stages. Working medium flow through a rotor. Flow losses in a blade system, efficiency. Theoretical and true fans characteristics. Principles of fan choice and collaboration between compression machines and receiving installation or other machines. Thermodynamic calculations of compression process with cooling. Calculations of characteristics for conventional work conditions, choice of a driving motor. Control systems for fans and compressors. Problems connected with multistage turbins. Thermal and flow issues (flow kinematics and the most important indexes) and the basic construction components (turbine cylinders, rotors, rotor and stator blade systems, external and internal seals, bearings, safety control systems. Basics for impulse and reaction stage. Trends of the present day steam and gas turbines are discussed. Various design aspects and classification of boilers and furnaces, fuels for large-scale application and their preparation. Descrip-

tion of heat exchange in large-scale boilers and practical calculation procedures. Special-design boilers and modern measure-control systems.

Literature:

1. AG. Blokh, *Heat transfer in steam boiler furnaces*, Springer-Verlag, 1988.
2. Boyce, Meherwan P., *Gas turbine engineering handbook* / Meherwan P. Boyce. - 3rd ed. – Boston [etc.] : Gulf Professional Publishing, Cop., 2006, 936 s.
3. Sanders, William P., *Turbine steam path*. Vol. 3, Mechanical design and manufacture / William P. Sanders. - Tulsa, OK : PennWell Corporation, Cop., 2004, 1030 s.
4. Wilson, David Gordon, *The design of high-efficiency turbomachinery and gas turbines* / David Gordon Wilson, Theodosios Korakianitis. - 2 ed. - Upper Saddle River: Prentice Hall, 1998, 593 s.
5. Lejzerovic, Aleksandr S., *Large power steam turbines: Design and operation*. [Design] / Aleksandr, S. Lejzerovic. - Tulsa: PennWell Books, 1997
6. O'Neill, Peter A., *Industrial compressors: Theory and equipment* / Peter A. O'Neill. - Oxford: Butterworth - Heinemann, 1993, 591 s.
7. Val S. Lobanoff, Robert R. Ross: *Centrifugal pumps Design and Application*
8. Bachus Larry, Custodio Angel: *Know and Understand Centrifugal Pumps*
9. Krassik Igor, Messina Joseph, Cooper Paul : *Pump Handbook*

CODE GGG100915 FUEL PROCESSING

Language: English **Course:** Basic/**Advanced**
Year (I), semester (2) **Level:** II **Obligatory**/Optional
Prerequisites: **Teaching: Traditional**/Distance L.
Lecturer: Prof. Jan Drzymała, Prof. Halina Kruczek, Prof. Maciej Chorow**ski**

	Lecture	Tutorials	Laboratory	Project	Seminar
Hours / sem. (h)	30		30		
Exam / Course work/T:	T		T		
ECTS	2		2		
Workload (h)	60		60		

Outcome: Basic knowledge of fuel processing technology and understanding of utilised physical and chemical phenomena

Content: Coal petrology and structure, coal preparation (gravity separation, flotation, oil agglomeration, special methods of coal processing). Coal desulfurization, coal comminution, drying, grinding and transport of coal mixtures to burners. Coal preparation system for fluidized bed reactors (+ sorbent). Biomass processing, gasification of solid fuels, liquefied natural gas (LNG).

Laboratory content: coal properties (moisture, ash, sulfur, and other components) gravity separation, coal flotation, oil agglomeration, Linde-Hampsona metod of gas liquefaction, biomass properties.

Literature:

1. Stach et al., *Textbook of coal Petrology*, Berlin, Gebruder Borntraeger, 1982.
2. Osborn D.G., *Coal Preparation Technology*, Graham and Trotman, 1988
3. Laskowski, J., *Coal flotation and fine coal utilization*, Elsevier 2001

CODE GGG100913	SURFACE AND UNDERGROUND MINING TECHNOLOGY				
Language: English				**Course:** Basic/**Advanced**	
Year (I), semester (2)	**Level:** II			**Obligatory**/Optional	
Prerequisites:				**Teaching: Traditional**/Distance L.	
Lecturer: Prof. Monika Hardygóra, Prof. Jan Butra, Witold Kawalec, DEng, Anna Gogolewska, DEng					
	Lecture	**Tutorials**	**Laboratory**	**Project**	**Seminar**
Hours / sem. (h)	30		15		
Exam / Course work/T:	E		T		
ECTS	2		1		
Workload (h)	60		30		

Outcome: Participants who successfully complete this course will be able to perform the following: discuss the roles of exploration, feasibility studies, mine planning, mining methods, information systems, development, ground control, explosives, roof support, production and delivery systems, ventilation, backfill, drainage, natural hazards, and mine layout design in the development and operation of a coal underground mine; discuss the planning, design, operation and monitoring of lignite surface mine dumps (overburden piles);evaluate underground and surface mining methods in the context of variable coal and lignite deposit conditions and constraints; perform a selection of the equipment and machines for different underground and surface mining methods; apply the knowledge gained to the management of groundwater and surface water at underground mines and open pits; apply the knowledge gained to the feasibility, planning and production stages of a coal underground and lignite surface mining operation.

Content: The lecture provides a comprehensive introduction and reference for students who require a solid grounding in selection, design and development of mining methods and equipment for lignite surface mines and coal underground mines. Principal course topics are listed below. Introductions to mining methods, equipment, and basic requirements for coal underground mining. Layout and design of underground coal mine development and equipment requirements. Layout and design of underground coal mine development and equipment requirements. Opening-up of a coal deposit by means of mine workings. Development workings. Underground mining methods for coal winning like longwall, shortwall, sublevel caving, block caving, sublevel stoping. Drilling-and-blasting technique. Mechanized extraction. Roof support. Mine working support. Mine backfilling. Loading and hauling of excavated material. Underground transport systems (horizontal and vertical). Ventilation systems. Drainage systems. Natural hazards such as methane explosion, dust explosion, coal self-ignition, gas and rock outbursts, tremors, rock-bursts and climatic conditions. Protective methods. Introductions to mining methods, equipment and basic requirements for lignite surface mining. Layout and design of surface lignite mine development and equipment requirements. Opening-up of a lignite deposit. Overburden stripping and dumping. Dumps. Dump slopes and their stability. Surface mining systems (bench, block etc.). Mechanized lignite excavation. Machinery used in surface mining (excavators, spreaders, draglines etc.). Development workings. Loading and hauling of excavated material. Transport systems (vertical and horizontal). Drainage systems. Natural hazards such as tremors. Industrial safety in underground and surface mines.

The laboratory tasks include analysis and making a digital 3D quality model of a deposit. It also includes elements of underground mine designing using the digital quality model of a deposit and technological assumptions to design a development working and coal face, and elements of surface mine designing using the digital quality model of a deposit and technological assumptions to design a final open-cut working, an overburden haulage incline out of the pit and an overburden dump. Making the time plan for a mine output. The DATAMINE software is used.

Literature:

1. Antia H.E., Mohamed A.M.O., 1998: Geoenvironmental Engineering. Elsevier.
2. Bise C. J., 2003: Mining Engineering Analysis. SME

3. Blyth F.G.H., 1984: Geology for Engineers. Elsevier.
4. International Mining Journal. Team Publishing Ltd, Berkhamsted, Hertfordshire. England

CODE GGG100910 MINING MACHINERY SYSTEMS

Language: English **Course:** Basic/**Advanced**
Year (I), semester (2) **Level:** II **Obligatory/**Optional
Prerequisites: **Teaching: Traditional/**Distance L.
Lecturer: Prof. Monika Hardygora, DEng, DSc; Prof. WalterBartelmus, DEng, DSc; Radosław Zimroz, DEng; Ryszard Błażej, DEng

	Lecture	Tutorials	Laboratory	Project	Seminar
Hours / sem. (h)	30		15		15
Exam / Course work/T:	E		T		T
ECTS	2		1		1
Workload (h)	60		30		30

Outcome: Knowledge of design parameters and selection criteria of different machines and machinery systems used in the mining industry.

Content: Design parameters and selection criteria of surface and underground mining and material handling equipment. Continuous, cyclical and mixed machinery systems used in surface and underground mines, power plants and coal preparation plants. In seminar classes the students will present and discuss the design, analyse functions and applications of different machines.

Literature:

1. Golosinski T.S., Boehm F.G.: Continuous Surface Mining. Trans Tech Publications, Edmonton 1987
2. Walker S.C.: Mine Winding and Transport. Elsvier, Amsterdam, 1988
3. Swinderman R.T., Goldbeck L.J., Marti A.D.: Foundations 3. The Practical Resource for Total Dust & Material Control. Martin Engineering, Neponset/Illinois, 2002
4. Mining machinery manufacturers' catalogues and publications
5. Current issues of specialized journals: "Mining Magazine", "International Mining", "Coal Equipment Buyer", "Engineering and Mining Journal"

CODE GGG100935 ECONOMICS IN MINING AND POWER INDUSTRY

Language: English **Course:** Basic/**Advanced**
Year (I), semester (2) **Level:** II **Obligatory/**Optional
Prerequisites: **Teaching: Traditional/**Distance L.
Lecturer: Leszek Jurdziak, PhD, DSc

	Lecture	Tutorials	Laboratory	Project	Seminar
Hours / sem. (h)	30		15		
Exam / Course work/T:	T		T		
ECTS	2		1		
Workload (h)	60		30		

Outcome: Knowledge and understanding of energy and mining markets, economic analysis skills.

Content: The lecture and realized projects are designed to provide future decision makers in the power and mining industry with economic skills that will help them understand energy and mining markets and their structures (including perfect competition, natural and bilateral monopoly and oligopoly) and enable them to make better energy-related policy decisions. It will provide institutional, technological and historical information on oil, coal, gas and electricity markets alongside with price and production cost movements and knowledge of modern tools for their analyses (including transactional cost economics, contract and game theory, energy futures and real option techniques). Energy externalities and pollu-

tion is also discussed, including environmental management, scarcity and depletion of exhaustible resources and markets for emission allowances.

Literature:

2. Dahl C.A., International Energy Markets: Understanding Pricing, Policies and Profits, Pennwell Books, 2004.
3. Electricity Economics. Regulation and Deregulation. Geoffrey Rothwell, Tomas Gomez. Wiley Interscience, 2003.
4. Power System Economics: Designing Markets for Electricity by Steven Stoft, Wiley-IEEE Press, 2002.
5. Harris Ch., Electricity markets. Pricing, structures and Economics. John Wiley & Sons, Ltd, 2006.
6. Pepall L., Richards D.J., Norman G., Industrial Organization: Contemporary Theory & Practice. Thomson South-Western, 2005.
7. Makansi J., An Investor's Guide to the Electricity Economy. John Wiley & Sons, Ltd, 2002.

CODE GGG100917 METHODS OF COMPUTER ASSISTED MINE DESIGN I

Language: English **Course:** Basic/**Advanced**
Year (I), semester (2) **Level:** II **Obligatory/**Optional
Prerequisites: **Teaching: Traditional/**Distance L.
Lecturer: Witold Kawalec, DEng; Krzysztof Hołodnik, DEng

	Lecture	Tutorials	Laboratory	Project	Seminar
Hours / sem. (h)	15		45		
Exam / Course work/T:	T		T		
ECTS	1		2		
Workload (h)	30		60		

Outcome: Having completed this course students should know the algorithms of building the digital structural and quality orebody models, the techniques of the computer-aided mine design which allow them to take under consideration a digital quality orebody model and variants of mining constraints. The students should be familiar with CAD methods and tools covering the modelling techniques in an interactive 3-D graphics environment for the display and manipulation of drillholes, block models, wireframe models (Digital Terrain Models and solid) points and strings. The students should posses an ability to evaluate the designed excavations to predict volume, tonnage and quality parameters of the production, to generate views, sections and plans for the analysis or reporting purpose.

Content: Structural and quality orebody modelling (wireframe and block model). Elements of underground development design on the basis of a digital quality block model of a deposit. Design of underground development and mining drives. Elements of an open pit design on the basis of a digital quality model of a deposit. Solid model evaluation (wireframe against block model). Ultimate pit design based upon the formal criteria of mineability. Ultimate pit evaluation. Initial cut design with the detailed slopes, benches and access road design. External dump detailed design. Volume calculations. Short-term scheduling and blending for prepared mining blocks and a given mining period. CAD laboratory with the use of Datamine software.

Literature:

1. DATAMINE Studio Introductory Tutorial.
2. Hustrulid W., Kuchta M. 2006. Open Pit Mine Planning & Design, Taylor & Francis.
3. Tolwinski B., Golosinski T.S. 1995. Long term open pit scheduler, Mine Planning and Equipment Selection, Balkema, 1995.

CODE GGG100923	MAINTENANCE MANAGEMENT SYSTEMS AND FAILURE ANALYSIS

Language: English **Course:** Basic/**Advanced**
Year (I), semester (2) **Level:** II **Obligatory**/Optional
Prerequisites: Basic metallurgy, strength of materials, machine design. **Teaching: Traditional**/Distance L.
Lecturer: Bogumił Tomasz Dałkowski Ph.D., Prof. Marek Gawliński

	Lecture	Tutorials	Laboratory	Project	Seminar
Hours / sem. (h)	30		30		
Exam / Course work/T:	E		T		
ECTS	2		2		
Workload (h)	60		60		

Outcome: Knowledge of basic terms and mathematical reliability models and of fundamental methods of maintenance planning, scheduling and monitoring. Students should be able to carry out a failure analysis of both design and exploitation stage to improve the design and to give prevention directives.

Content: Basic terms: Reliability, Availability, Durability, Maintainability. Mathematical and statistical models of reliability. Maintenance Planning and Scheduling (Linear Programming, Queuing systems, Digital simulation, Critical Path Method, Project Management). The course comprises the fundamentals of failure analysis and the methods to prevent them. There will be discussed the types of failures and their potential consequences, algorithms of failure analysis based on examples taken from exploitation.

Literature:

1. Dieter G. E. Engineering Design: A Materials and Processing Approach, McGrawHill, New York 2000.
2. Budzinski K.G., Budzinski M. K., „Enginering Materials: properities and Selection", Prentice Hall, Upper Saddle River, New Jersey, 2005.
3. Boyer H. E., Metal Handbook No: 10, „ Failure Analysis and Prevention" American Society for metals, Ohio, 1975.

CODE ESN 0551	MATHEMATICAL SIMULATION OF POWER ENGINEERING PROCESSES

Language: English **Course:** Basic/**Advanced**
Year (I), semester (2) **Level:** II **Obligatory**/Optional
Prerequisites: Fluid mechanics and thermodynamics, heat transfer. **Teaching: Traditional**/Distance L.
Lecturer: Prof. Zbigniew Gnutek, Sławomir Pietrowicz Ph.D.

	Lecture	Tutorials	Laboratory	Project	Seminar
Hours / sem. (h)	30		15		
Exam / Course work/T:	T		T		
ECTS	2		1		
Workload (h)	60		30		

Outcome: Having completed this course students should be familiar with mathematical models of single/multiphase flows, heat transfer and combustion. They should understand a mathematical modelling process. Students will have skills in using commercial software to simulate simple flows and power plant processes. They will learn how to examine operating data from installation monitoring system.

Content: Mathematical models in Euler and Langrangian coordinates. Models in state coordinates. Computational fluid mechanics. Modelling of turbulent flows with combustion and heat transfer. Mathematical models of different components of thermal power plants. Thermal power plant simulation. Monitoring and data processing.

Literature:

1. H.K.Versteeg , W.Malalasekera, *An introduction to Computational Fluid Dynamics*, Longman Group Ltd., 1995
2. Flynn D. *Thermal Power Plant Simulation and Control*, The Institution of Electrical Engineers, London *2003*

3rd Semester

CODE ESN 0021 ENERGY POWER PROCESS AUTOMATION

Language: English **Course:** Basic/**Advanced**
Year (II), semester (3) **Level:** II **Obligatory/**Optional
Prerequisites: Basic mathematics and informatics. **Teaching: Traditional/**Distance L.
Lecturer: Janusz Lichota Ph.D.

	Lecture	Tutorials	Laboratory	Project	Seminar
Hours / sem. (h)	30		15		
Exam / Course work/T:	E		T		
ECTS	2		1		
Workload (h)	60		30		

Outcome: Basic knowledge of power plant control system design.

Content: The aim of the course is to enhance student knowledge of power plant control system technology. Power Plant Unit consists of many automation subsystems with strong links (MIMO control object). Computer simulation approach to modelling (using MATLAB software) allows one to show method of boiler control system arrangement. To control steam pressure and power generation two modes called "Boiler-following-turbine" or "Turbine -following- boiler" are used. The course includes basic knowledge of artificial neural networks, fuzzy systems and genetic algorithms, too. Those techniques are used to identify and control power plant systems.

Literature:

1. Flynn D. *Thermal Power Plant Simulation and Control*, The Institution of Electrical Engineers, London *2003*

CODE ESN 112 ENERGY PROCESS ENGINEERING

Language: English **Course:** Basic/**Advanced**
Year (II), semester (3) **Level:** II **Obligatory/**Optional
Prerequisites: Basic mathematics and informatics. **Teaching: Traditional/**Distance L.
Lecturer: Prof. H.Pawlak-Kruczek.

	Lecture	Tutorials	Laboratory	Project	Seminar
Hours / sem. (h)	30		15		
Exam / Course work/T:	E		T		
ECTS	2		1		
Workload (h)	60		30		

Outcome: Knowledge of energy technologies, their development trends and implementation problems.

Content: This lecture provides an overview of advanced use of solid fossil fuels, biomass and waste, as well as renewable energy technologies. Contemporary tendencies in use of new generation energy technologies are described. An overview of power stations with supercritical parameters is also given. The lecture also presents the "clean fuel" technologies, renewable energy technologies, modern fuel conversion technologies, fluidised bed techniques, combined-cycle (C-C), integrated gasification with combined cycle (IGCC). State-of-the art technologies and market development are presented, too.

Literature:

1. Flynn D. *Thermal Power Plant Simulation and Control*, The Institution of Electrical Engineers, London *2003*

CODE GGG101025	INTEGRATED ANALYSIS OF DEFORMATIONS OF ROCK MASS AND STRUCTURES

Language: English **Course:** Basic/**Advanced**
Year (II), semester (3) **Level:** II **Obligatory/**Optional
Prerequisites: **Teaching: Traditional/**Distance L.
Lecturer: Anna Chrzanowska, PhD, DSc, PEng

	Lecture	Tutorials	Laboratory	Project	Seminar
Hours / sem. (h)	30		15	15	
Exam / Course work/T:	E		T	T	
ECTS	2		1	1	
Workload (h)	60		15	30	

Outcome: Fundamental understanding of integrated analysis of deformations using the combination of monitoring and numerical modelling of deformations what is essential for studying the processes occurring in engineering structures and in rock mass at the construction and post-construction stages.

Content: Principle of integrated analysis, deformation analysis based on system theory, Deformation analysis based on continuum mechanics, Approximate methods for solving continuum problems, Numerical methods, Finite Element Method (FEM), New monitoring geodetic techniques, Robotic Total Stations (RTS), Global Positioning System (GPS), Peudolites, InSAR, Grand Based Radar Interferometry, Geotechnical monitoring techniques, New geotechnical instrumentation (MEMS), Challenges of geodetic monitoring systems, Continuous and fully automated monitoring system ALERT-DDS, Fem analysis using Geostudio software, Problems in oil fields (Venezuela), McKenzie natural gas project, Monitoring of slope stability in open pit mines, Hydro-electric projects: Stability of large dams in Canada, USA, and China.

Literature:

1. Selected Journal Publications
2. Zienkiewicz, O. C. and R.L. Taylor, The Finite Element Method, McGraw Hill, 1991,
3. Chrzanowska, A. Integrated analysis of deformations, Lecture Notes, 2010

CODE GGG100925	ENVIRONMENTAL MANAGEMENT

Language: English **Course:** Basic/**Advanced**
Year (II), semester (3) **Level:** II **Obligatory/**Optional
Prerequisites: Ecology **Teaching: Traditional/**Distance L.
Lecturer: Prof. Jadwiga Więckowska, Maria Mazur Ph.D., Karolina Madera-Bielawska Ph. D.

	Lecture	Tutorials	Laboratory	Project	Seminar
Hours / sem. (h)	30	15	15		
Exam / Course work/T:	T	T	T		
ECTS	1	1	1		
Workload (h)	30	30	30		

Outcome: knowledge of legal state of the sphere of environmental economic advantage.

Content: The lecture introduces to the economic fundamentals of policy of protecting environment and natural resources. The first part of the lecture deals with engineering/legal potential to counteract the de-

structive impact of the civilisation on the ecosphere (long term actions – eco-development strategy, casual actions – identification of degradation sources, methods applicable in evaluating environment conditions and main directions to protect individual ecosphere components). Instruments of ecological policy and financing sources of pro-ecological undertakings resulting from the policy pursued within this field in EU (environment valuation, modelling of economic effects of ecological policy, systems of environment-related information). The environmental management systems conformable to EU and international Standards (EMAS and ISO14000) are presented.

Literature:

1. Folmer H., Gabel L., Opschoor H., *Principles of Environmental and Resource Economics*, Edward Elgar Publishing Ltd. Aldershot, 1995

CODE GGG100919 METHODS OF COMPUTER ASSISTED MINE DESIGN II

Language: English **Course:** Basic/**Advanced**
Year (II), semester (3) **Level:** II **Obligatory**/Optional
Prerequisites: **Teaching: Traditional**/Distance L.
Lecturer: Witold Kawalec, DEng, Krzysztof Hołodnik, DEng

	Lecture	Tutorials	Laboratory	Project	Seminar
Hours / sem. (h)	15		15		
Exam / Course work/T:	T		T		
ECTS	1		1		
Workload (h)	30		30		

Outcome: Having completed this course, students should be familiar with the long term mine scheduling and blending and open pit mine planning based upon pit optimisation methods.

Content: Economic block model of a deposit for various price formulas. Ultimate pit design using L-erchs'a-Grossmann' algorithm (on the basis of a digital quality block model of a deposit). Life-of-mine plan on the basis of generated pushbacks with optional targets and constraints. CAD laboratory with the use of Datamine and NPV Scheduler software.

Literature:

1. NPV Scheduler Help.
2. Lapworth A.D. 1996. Scheduling using optimisation and blending, Mining Magazine, February 1996.
3. Lerchs H., Grossmann I.F. 1965. Optimum Design and Open Pit Mines, Transactions, C.I.M. Vol. LXVIII,. 17-24.
4. Tolwinski B., Golosinski T.S. 1995. Long term open pit scheduler, Mine Planning and Equipment Selection, Balkema, 1995.

CODE EKG101028 MARKET RISK OF MINING AND ENERGY COMPANY

Language: English **Course:** Basic/**Advanced**
Year (II), semester (3) **Level:** II **Obligatory**/Optional
Prerequisites: **Teaching: Traditional**/Distance L.
Lecturer: Leszek Jurdziak, PhD, DSc

	Lecture	Tutorials	Laboratory	Project	Seminar
Hours / sem. (h)	15			15	
Exam / Course work/T:	T			T	
ECTS	1			1	
Workload (h)	30			30	

Outcome: Future engineering staff will be acquainted with functioning of mining and energy companies on competitive markets and with their hedging strategies regarding sale or purchase of commodities and energy on domestic or foreign markets.

Content: The operation of mines and power stations in a market economy requires signing up selling and purchasing contracts of raw materials and energy. More and more often transactions are taken on stock exchanges or competitive markets characterised by big price volatility. This exposes companies to market risk and threat of loss of liquidity. Companies having transactions in foreign currency (e.g. exporters) are additionally exposed to currency risk. After identification of market risk operation of commodity financial and energy markets as well as available derivative instruments are described. Various ways of risk evaluation and the applied protective strategies used to manage the risk are also presented.

Literature:

1. Chew D.Ch. Ed., Corporate Risk Management, Columbia Business School Publishing, 2008
2. Brown G.W., ChewD.H., "Corporate Risk. Strategies and Management". Risk Books 2005.
3. Culp Ch.L., Miller M.H. Eds, "Corporate hedging in theory and practice. Lessons from Metallgesellschaft". Risk Books 1999.
4. Weron R., Modeling and forecasting electricity loads and prices. John Wiley & Sons, Ltd, 2006.
5. Eydeland A., Wolyniec K., Energy and Power Risk Management. New Developments in Modeling, Pricing, and Hedging. John Wiley & Sons, Ltd, 2003.
6. Fusaro P.C., Energy risk Management. Hedging Strategies and Instruments for the International Energy Markets. McGraw-Hill 1998.