HOCHSCHULE PFORZHEIM

Module Handbook

Bachelor Program

RESOURCE EFFICIENCY MANAGEMENT

Translation from German Version from

August 2017

Table of Contents

List of Abbreviations

CR	Credits according to ECTS-System
PLH	Examination based on essay
PLK	Examination based on written exam
PLL	Examination based on laboratory work
PLM	Examination based on oral exam
PLP	Examination based on project work
PLR	Examination based on presentation
PLT	Examination based on written thesis
PVL-BVP	Prerequisite examination for bachelor interim overall exam
PVL-BP	Prerequisite examination for final bachelor graduation
PVL-PLT	Prerequisite examination for registration for bachelor thesis
SWS	Contact hours per week
UPL	Non-graded examination (pass/fail only)
WPF	Elective

Alignment Matrix for learning outcomes according to official state requirements

Module	Enlargement of Knowledge	Consolida-tion of Knowledge	Instrumental Competence	Systemic Competence	Communicative Competencies
BREM1110	X	X			
BREM2200	X	X			
BREM2400	X	X			
BREM2300		X	X		X
BREM2500		X	X	X	X
BREM2600		X	X		X
LAW3200	X	X			
BREM3000		X	X		
BREM3110	X	X	X	X	
BREM4000		X	X	X	X

BREM1110 – Technologies 1

Technologies 1	
ID	BREM1110
Study Semester	2
Level	Beginner
Credits	5
Contact hours per week	4
Frequency	Only summer semester
Associated Lectures	Production Engineering (2 SWS/2 Credits) Physics (2 SWS/3 Credits)
Prerequisites	none
Assessment Methods	PLM/PLK – 90 min
Requirements for granting of credits	Passing the assessments.
Significance for the Final Grade	none
Planned Group Size	Max. 50 students
Language	German
Module Duration	1 semester
Module Coordinator	Prof. Dr. Claus Lang-Koetz
Lecturer(s)	Prof. Dr. Nikolaus Thißen (Production Engineering) Prof. Dr. Hendrik Lambrecht (Physics) Prof. Dr. Claus Lang-Koetz (Production Engineering) Prof. Dr. Mario Schmidt (Physics)
Subject Area	Resource Efficiency Management
Applicability in other programs	none
Pedagogical Approach	Lecture with exercises
Objectives	<u>Production Engineering</u> The students... • know selected basic techniques and tools of production engineering and their delineation from each other; • understand the procedures and differences of important processes of production engineering; • are familiar with the theoretical and practical aspects of selected processes of production engineering and can transfer knowledge into practice; • are able to apply estimating balances of mass and energy flows to simple production processes. <u>Physics</u> The students… • know the central terms and principles of the physical fields of mechanics, thermodynamics, electrical science and inorganic chemistry. • are familiar with the concept of energy or energy conservation and understand the most important principles of the transformation between different forms of energy. • know how matter is built up and know the fundamental concepts of (chemical)

	metabolism. • can apply this knowledge to practical questions concerning environment and technology. The module primarily serves the purpose of knowledge enlargement and -consolidation.
Content	<u>Production Engineering</u>: • Introduction and overview of production engineering • Original molds from liquid state (casting): casting production with lost shape and permanent shape. Casting defects and their avoidance • Forming: Solid forming, sheet metal forming • Cutting processes: cutting with a geometrically defined and undefined cutting edge, cutting by ablation <u>Physics:</u> • Introduction, basics • Mechanics • Thermodynamics • Electromagnetism • Construction of matter
Relation to other Modules	The module is the basis for all further study program modules.
Workload	In addition to 4 x 15 = 60 SWS contact hours, students are expected to spend 90 hours on preparation and follow-up, independent literature studies, preparation of exercises and preparation for the exam.
Literature	<u>Production Engineering:</u> • Ilschner, B.; Singer, R. F.: Werkstoffwissenschaften und Fertigungstechnik, Springer. • Witt, G.: Taschenbuch der Fertigungstechnik, Fachbuchverlag Leipzig. • König, W.;, Klocke, F.: Fertigungsverfahren 1-5: Urformtechnik, Gießen, Sintern, Rapid Prototyping: Bd 5; Springer. • Doege, E.; Behrens, B.-A.: Handbuch Umformtechnik, Springer. • Grote, K.-H.; Feldhusen, J.: Dubbel, Taschenbuch für den Maschinenbau; Springer. <u>Physics:</u> • Harten, U.: Physik. Eine Einführung für Naturwissenschaftler und Ingenieure. Springer, Heidelberg u.a. (E-book!) • Leute, U.: Physik und ihre Anwendungen in Technik und Umwelt. Hanser Verlag, München. • Vinke, A.; Marbach, G.; Vinke, J.: Chemie für Ingenieure. Oldenbourg Verlag, München, Wien. <u>Consolidation:</u> • Povh, B.: Anschauliche Physik für Naturwissenschaftler. Springer, Heidelberg. • Tipler, P. A.; G. Mosca: Physik für Wissenschaftler und Ingenieure. Spektrum, Heidelberg.

	Most recent edition, unless otherwise stated.
Keywords	Production Engineering, Physics
Last edited	August 2017

BREM2200 – Technologies 2

Technologies 2	
ID	BREM2200
Study Semester	3
Level	Advanced
Credits	6
Contact hours per week	4
Frequency	Only winter semester
Associated Lectures	Process Technologies (2 SWS/3 Credits) Energy Technologies (2 SWS/3 Credits)
Prerequisites	Min. 35 credits from interim grade
Assessment Methods	PLK – 180 min
Requirements for granting of credits	Passing the written exam.
Significance for the Final Grade	The module contributes to the final bachelor grade.
Planned Group Size	Max. 50 students
Language	German
Module Duration	1 semester
Module Coordinator	Prof. Dr. Nikolaus Thißen
Lecturer(s)	Prof. Dr. Nikolaus Thißen (Process Technologies) Prof. Dr. Claus Lang-Koetz (Process Technologies) Prof. Dr. Ingela Tietze (Energy Technologies) Prof. Dr. Hendrik Lambrecht (Energy Technologies)
Subject Area	Resource Efficiency Management
Applicability in other programs	none
Pedagogical Approach	Lecture with exercises
Objectives	<u>Process Technologies</u> The students... • know selected unit operations of process technologies; • are familiar with the structures of process technology systems and master their basic design; • are familiar with the theoretical and practical aspects of selected process techniques and can transfer their knowledge into practice; • are able to construct simple models of process technology processes and to conduct corresponding simple simulations. <u>Energy Technologies</u> The students... • know the thermodynamic foundations of energy conversion and corresponding terms; • are familiar with the relevant technical systems for energy conversion and energy supply (both from the conventional and regenerative energy carriers); • can independently conduct basic calculations for the technical design and assessment of

	energy conversion systems; • can compare energy conversion technologies from different angles (technical, economic and ecological); • understand the relationship between energy technology and energy economics regarding different energy conversion technologies and • are familiar with concepts at the interface between energy technology and energy economy such as contracting and energy management.
Content	<u>Process Technologies</u> • Introduction and overview of process technologies • Process engineering systems • Foundations of balances and transport mechanisms • Application of physical balances • Ratio variables ("concentration measures"), process parameters • Energy balances in thermodynamic settings; • Introduction to selected unit operations of thermal, chemical and mechanical process technologies <u>Energy Technologies</u> • Thermodynamic foundations • Heat recovery, heat exchanger • Steam generator • Steam power plants • Gas turbine power stations, combined cycle power plants • Renewable energy • Decentralized energy systems, cogeneration • Chill supply and compressed air • Cost structures • Energy efficiency, contracting, energy management
Relation to other modules	The module is based on "BREM1110: Technology 1". The module is the basis for the module "BREM2500: Applied Resource Efficiency" and "BREM2600: Production"
Workload	In addition to 4 x 15 = 60 SWS contact hours, students are expected to spend 120 hours on preparation and follow-up, independent literature studies, preparation of exercises and preparation for the exam.
Literature	<u>Process Technologies</u> • Schwister, K.; et. al.: Taschenbuch der Verfahrenstechnik, Fachbuchverlag Leipzig im Carl Hanser Verlag, 2000. • Gruhn, G.; et. al.: Systemverfahrenstechnik 1, Modellierung und Simulation verfahrenstechnischer Systeme, VEB, 1976 • Baehr, H. D.; Kabelac, S.: Thermodynamik, Grundlagen und technische Anwendungen, 15. Auflage, Springer, 2012. • Kraume,M.: Transportvorgänge in der Verfahrenstechnik, Grundlagen und apparative Umsetzungen, 2. Auflage,

	Springer, 2012. • K.-H. Grote, J. Feldhusen, Dubbel, Taschenbuch für den Maschinenbau, 23. Auflage, Springer, 2011. <u>Energy Technologies</u> • Panos, K.: Praxisbuch Energiewirtschaft, Energieumwandlung, -transport und -beschaffung im liberalisierten Markt, Springer, 2013. • Zahoransky, R.: Energietechnik. Systeme zur Energieumwandlung, Springer, 2015 • Kaltschmitt, M.; Streicher,W.; Wiese, A.: Erneuerbare Energien: Systemtechnik, Wirtschaftlichkeit, Umweltaspekte, Springer, 2014 • Strauß, A.: Kraftwerkstechnik: zur Nutzung fossiler, nuklearer und regenerativer Energiequellen, Springer, 2012 • Hahne, E.: Technische Thermodynamik: Einführung und Anwendung, Oldenbourg, 2010
Keywords	Process Technologies, Energy Technologies
Last edited	August 2017

BREM2400 – Industrial Ecology

Industrial Ecology	
ID	BREM2400
Study Semester	3
Level	Advanced
Credits	6
Contact hours per week	4
Frequency	Only winter semester
Associated Lectures	Environment and Sustainability (2 SWS/3 Credits) Resource Efficiency and CSR (2 SWS/3 Credits)
Prerequisites	Min. 35 credits from interim grade
Assessment Methods	PLR/PLK – 90 min
Requirements for granting of credits	Passing the assessments.
Significance for the Final Grade	The module contributes to the final bachelor grade.
Planned group size	Max. 50 students
Language	German
Module Duration	1 semester
Module Coordinator	Prof. Dr. Hendrik Lambrecht
Lecturer(s)	Prof. Dr. Hendrik Lambrecht Prof. Dr. Tobias Viere Prof. Dr. Claus Lang-Koetz Prof. Dr. Mario Schmidt
Subject Area	Resource Efficiency Management
Applicability in other programs	none
Pedagogical Approach	Lecture (incl. exercises)
Objectives	<u>Environment and Sustainability</u> The students… • have an overview of the history as well as the social and economic significance of environmental and sustainability issues; • are aware of the most important environmental problems ("impact categories") and the relevant parameters / indicators by which environmental problems can be assessed quantitatively; • know the most important concepts and terms of the sustainability debate (strong vs. weak sustainability, efficiency-, sufficiency- and consistency-strategy, etc.); • understand anthropogenic activities and economic activities as an energetic and material metabolism; • know the guiding principles of Industrial Ecology (recycling economy, dematerialization, detoxification) and the central analysis paradigm of industrial metabolism; • know the basic principles of material flow analysis as the most important tool for industrial ecology / material flow

	management; • have the prerequisite to understand advanced environmental analysis methods (in particular LCA). <u>Resource efficiency and CSR</u> The students… • understand the importance of environmental and sustainability issues at company level; • know historical developments and current concepts for the integration of environmental and sustainability issues in companies (environmental and sustainability management, corporate social responsibility, environmental management systems, etc.); • understand the link between company success and environmental- and sustainability performance. Furthermore they learn… • how corporate approaches to Industrial Ecology (material flow- and input / output analysis) can be implemented at company level; • how, on the basis of energy- and material flow analyzes, ecological, environmental and economic, esp. material flow cost-based, assessments can be conducted. The module primarily serves the purpose of knowledge-enlargement and -consolidation.
Content	<u>Environment and Sustainability</u> • Climate change • Presentation of other environmental problem areas, i. a. biodiversity, raw materials / resources, acidification, land use, etc.; • Foundations of sustainability • Introduction to Industrial Ecology (Material Flow Analysis, Input / Output) <u>Resource efficiency and CSR</u> • Introduction to Sustainability Management / CSR • Environmental management systems, especially ISO 14001 and EMAS • Ecological efficiency and resource efficiency • Foundations of material flow cost accounting • Introduction to Life Cycle Thinking Methods
Relation to other modules	The module is based on "BREM1110: Technology 1". The module is the basis for the module "BREM2500: Applied Resource Efficiency"
Workload	In addition to 4 x 15 = 60 SWS contact hours, students are expected to spend 120 hours on preparation and follow-up, independent literature studies, preparation of exercises and preparation for the exam.
Literature	<u>Environment and Sustainability</u> • IPCC (2014): Climate Change 2014:

	Synthesis Report. Genf. • WMO (2010): Scientific Assessment of Ozone Depletion: 2010. Genf. • Gradel, T. E.; Allenby, B.R. (2010). Industrial Ecology and Sustainable Enginieering. Upper Saddle River, Pearson. • Heinrichs, Harald; Michelsen, Gerd (Hrsg.) (2014): Nachhaltigkeitswissenschaften. Berlin, Heidelberg: Springer Spektrum. • Ayres, R. U.; Ayres, L. W. (Hrsg). (2002). A Handbook of Industrial Ecology. Northampton, Edward Elgar. • Brunner, Paul H.; Rechberger, Helmut (2004): Practical Handbook of Material Flow Analysis. Boca Raton: CRC Press. • Enquete-Kommission “Schutz des Menschen und der Umwelt” des Deutschen Bundestages (Hrsg.) (1994): Die Industriegesellschaft gestalten – Perspektiven für einen nachhaltigen Umgang mit Stoff- und Materialströmen. Bonn, Economica Verlag. <u>Resource efficiency and CSR</u> • Baumast, A.; Pape, J. (2013): Betriebliches Nachhaltigkeitsmanagement, UTB • Klöpffer, W., Grahl, B. (2009): Ökobilanz (LCA). Wiley-VCH. • ISO 14001:2015 • ISO 14051:2011 • UBA/BMU (2007): Nachhaltigkeitsmanagement in Unternehmen; UBA/BMU
Keywords	Sustainability Management, CSR, Industrial Ecology, Material Flow Analysis
Last edited	August 2017

BREM2300 – Energy Economics

Energy Economics	
ID	BREM2300
Study Semester	4
Level	Advanced
Credits	5
Contact hours per week	4
Frequency	Only summer semester
Associated Lectures	Energy Markets (2 SWS/3 Credits) Industrial Energy Management (2 SWS/2 Credits)
Prerequisites	Min. 47 credits from interim grade
Assessment Methods	PLR+PLH/PLK – 90 min
Requirements for granting of credits	Passing all assessments.
Significance for the Final Grade	The module contributes to the final bachelor grade.
Planned group size	Max. 50 students
Language	German
Module Duration	1 semester
Module Coordinator	Prof. Dr. Ingela Tietze
Lecturer(s)	Prof. Dr. Ingela Tietze Prof. Dr. Hendrik Lambrecht N.N.
Subject Area	Resource Efficiency Management
Applicability in other programs	none
Pedagogical Approach	Seminar and lecture
Objectives	<u>Energy Markets</u> The students… • are aware of the importance of energy carriers at different levels; • become acquainted with different energy carriers and their characteristics and can assess them on this basis; • understand the energy markets and their interactions; • know the price formation mechanisms and the determinants on different markets and can derive recommendations for action from it; • are aware of current energy policy contexts. <u>Industrial Energy Management</u> The students… • know the concept of energy management systems according to DIN EN ISO 50.001 and can explain strengths and weaknesses; • can assess energy demands, by determining relevant indicators; • are able to identify typical energy saving potentials and develop solutions for their exploitation;

	• know common approaches to in-plant energy supply and can interpret and assess these approaches economically and technically; • understand the requirements for operational energy procurement and can develop and assess suitable models based on demand characteristics; • are familiar with the principles of energy- and electricity taxes and reimbursement; • understand the challenges for companies posed by European emissions trading The module primarily serves the purpose of knowledge-enlargement and -consolidation.
Content	<u>Energy Markets</u> • Introduction (basic terms and definitions, importance of energy, energy as a production factor, resource economics) • Oil market (value chain, world market, price mechanisms) • Gas industry (value chain, supra-regional markets, price mechanisms) • Coal market (value chain, world market, price mechanisms, subsidization in Germany) • Organization of the German gas market • Organization of the German electricity market • Energy policy (including promotion of renewable energies) • German “energy transition” <u>Industrial Energy Management</u> • Introduction (basic terms and definitions, load curves, energy management and its components) • Energy management according to DIN EN ISO 50001 • Energy demand and energy saving • Technical and economic design of self-supply systems (conventional, cogeneration, renewable energies), contracting • Electricity and gas procurement (full supply contracts) • Tranche models, portfolio management • Energy- and electricity tax • Emissions trading (management strategies for emission rights, trade)
Relation to other Modules	
Workload	In addition to 4 x 15 = 60 SWS attendance hours, students are expected to spend 90 hours on preparation and follow-up, independent literature studies, preparation of exercises and preparation for the exam.
Literature	<u>Energy Markets</u> • Panos, K.: Praxisbuch Energiewirtschaft, Energieumwandlung, -transport und -beschaffung im liberalisierten Markt, Springer, 2013 • Pfaffenberger, W.; Heuterkes, M.: Energiewirtschaft: Einführung In Theorie und Politik, De Gruyter Oldenbourg, 2012 • Erdmann, G.: Energieökonomik, Springer, 2008

	Industrial Energy Management • Panos, K.: Praxisbuch Energiewirtschaft, Energieumwandlung, -transport und -beschaffung im liberalisierten Markt, Springer, 2013 • DIN EN ISO 50.001 Energiemanagementsysteme – Anforderungen mit Anleitung zur Anwendung (ISO 50001:2011) • Geilhausen, M.; Bränzel, J.; Engelmann, E.; Schulze, O.: Energiemanagement: Für Fachkräfte, Beauftragte und Manager, Springer, 2015
Keywords	Energy Markets, Industrial Energy Management
Last edited	August 2017

BREM2500 – Applied Resource Efficiency

Applied Resource Efficiency	
ID	BREM2500
Study Semester	4
Level	Advanced
Credits	9
Contact hours per week	6
Frequency	Only summer semester
Associated Courses	Material Flow Assessments (2 SWS/3 Credits) CMM in Resource Efficiency Management (2 SWS/3 Credits) Environmental Technologies (2 SWS/3 Credits)
Prerequisites	Min. 47 credits from interim grade
Assessment Methods	PLL+PLR/PLH Environmental Technologies: PLK – 90 min
Requirements for granting of credits	Passing all assessments.
Significance for the Final Grade	The module contributes to the final bachelor grade.
Planned group size	Material Flow Assessments, max. 50 Environmental Technologies max. 50 CMM, max. 25
Language	German
Module Duration	1 semester
Module Coordinator	Prof. Dr. Hendrik Lambrecht
Lecturer(s)	Prof. Dr. Hendrik Lambrecht (Material Flow Ass.) Prof. Dr. Tobias Viere (CMM) Prof. Dr. Mario Schmidt Prof. Dr. Nikolaus Thißen (Environmental Tech.) Prof. Dr. Claus Lang-Koetz (Environmental Tech.)
Subject Area	Resource Efficiency Management, CMM in Environmental Sciences, Quantitative Methods
Applicability in other programs	none
Pedagogical Approach	Lecture, Computer-Exercises
	<u>Material Flow Assessments</u> The students… • have consolidated their knowledge of a selected analytical method (LCA, material flow cost accounting, energy- and material flow analysis) by applying it to given or self-chosen problems; • learn how to document own research results according to scientific standards (reproducible, comprehensible). <u>Computer-assisted Management Methods (CMM) in Resource Efficiency</u> The students… • know essential analytical methods, their foundations and fields of application; • can apply these methods of analysis to

Objectives	simple cases and come to decisions; • have learned to use the methods with IT support. <u>Environmental Technologies</u> The students… • know selected unit operations of Environmental Technologies; • understand individual process combinations of basic environmental technology operations; • are familiar with the structures of environmental systems and with their basic design; • are familiar with the theoretical and practical aspects of selected environmental techniques and can make a practical reference to these processes; • are able to construct simple models for environmental issues and processes and to conduct corresponding simple simulated calculations. The module primarily serves for the consolidation of knowledge as well as the acquisition of instrumental competence. The courses also contribute significantly to the acquisition of systemic and communicative competence.
Content	<u>Material Flow Assessments</u> New seminar topics given each semester • Energy and material flow analyzes (both at the economic and operational level) • LCA • Material Flow Cost Accounting <u>Computer-assisted Management Methods (CMM) in Resource Efficiency</u> In this course the focus is on the use of IT. In order to consolidate the knowledge gained from the two other courses of the module and to link it to the Lean topic area, practice-oriented tasks are solved with the support of common software, esp. Excel, Visio, e! Sankey and Umberto. <u>Environmental Technologies</u> • Introduction and overview of environmental technologies • Exhaust treatment • Development of gaseous emissions • Design and operation of selected processes for treatment of exhaust gases • Simple modeling for balancing of mass- and energy streams for concepts to solve environmental problems • Presentation of resource-efficient concepts to reduce and avoid emissions • Wastewater treatment • Development of waste water • The structure and function of selected waste water treatment methods • Treatment of special pollutants • Overview of industrial waste water treatment

Relation to other Modules	The module is based on "BREM2200: Technology 2" and on “BREM2400: Industrial Ecology”.
Workload	Material Flow Assessments: In addition to 2 x 15 SWS = 30 contact hours students are expected to spend 60 hours on preparation of the presentation/essay CMM: In addition to 2 x 15 SWS = 30 contact hours students are expected to spend 60 hours on preparation and follow-up. Environmental Technologies: In addition to 2 x 15 SWS = 30 contact hours students are expected to spend 60 hours on preparation and follow-up.
Literature	• DIN EN ISO 14044:2006 – Umweltmanagement – Ökobilanz – Anforderungen und Anleitungen. • European Commission JRC IES (2010): ILCD Handbook. General guide for Life Cycle Assessment – Detailed Guidance, EC JRC IES. • International Journal of Life Cycle Assessment. • Klöpffer, W.; Grahl, B. (2009): Ökobilanz (LCA), Wiley-VCA. • PAS 2050:2011 - Specification for the assessment of the life cycle greenhouse gas emissions of goods and services, BSI. • Schmidt, M.; Schorb, A. (1995): Stoffstromanalysen in Ökobilanzen und Öko-Audits. Springer. • WBCSD/WRI (2011): The Greenhouse Gas Protocol - A Corporate Accounting and Reporting Standard, Revised Edition, WBCSD/WRI. • BMU (2003): Leifaden Betriebliches Umweltkostenmanagement. • DIN EN ISO 14051:2011 – Umweltmanagement – Materialflusskostenrechnung – Grundlagen. • Herzig, C.; Viere, T., Schaltegger, S.; Burritt, R. L. (2012): Environmental Management Accounting: Case Studies in South-East Asian Companies, Routledge. • IFAC - International Federation of Accountants (2005): International Guidance Document on Environmental Management Accounting, IFAC. • Jasch, C. (2009): Environmental and Material Flow Cost Accounting: Principles and Procedures, Springer. • Schaltegger, S.; Burritt, R. L. (2000): Contemporary Environmental Accounting, Greenleaf.
Keywords	Modeling, IT-usage, energy- and material flow analysis, analysis methods
Last edited	August 2017

BREM2600 – Production

Production	
ID	BREM2600
Study Semester	4
Level	Advanced
Credits	5
Contact hours per week	4
Frequency	Only summer semester
Associated Lectures	Raw Materials and Resources (2 SWS/2 Credits) Lean Production (2 SWS/3 Credits)
Prerequisites	Min. 47 credits from interim grade
Assessment Methods	PLK (90 min)/PLM
Requirements for granting of credits	Passing the assessments.
Significance for the Final Grade	The module contributes to the final bachelor grade.
Planned group size	Max. 50 students
Language	German
Module Duration	1 semester
Module Coordinator	Prof. Dr. Claus Lang-Koetz
Lecturer(s)	Prof. Dr. Claus Lang-Koetz Prof. Dr. Mario Prof. Dr. Frank Bertagnolli
Subject Area	Resource Efficiency Management
Applicability in other programs	none
Pedagogical Approach	Lecture and, if applicable, simulation game (Lean Production)
Objectives	<u>Raw Materials and Resources</u> The students… • know the essential raw material groups and raw materials which are important for production and are currently being discussed with regard to the criticality of resources (e.g. copper, aluminum, rare earths, gold, tantalum, phosphorus); • know the origin, the market situation, shortages and the importance of the addressed raw materials for future technologies; • are familiar with the function of selected future technologies and their application in products; • learn concepts for assessing the scarcity of raw materials, e.g. criticality <u>Lean Production</u> The students… • know the history, approaches and connections of the Toyota production system as well as more holistic production systems; • know essential analytical methods (value stream analysis) and instruments from the

	field of lean production and can apply these methods to simple practice cases; • are aware of the management's impact on the productivity of a company as well as the goals for the executives arising from their responsibility; • become acquainted with corresponding management approaches. The module is primarily used for the consolidation of knowledge and the attainment of instrumental competence as well as communicative competences.
Content	<u>Raw Materials and Resources</u> The course gives an overview of raw material groups and selected individual raw materials which are of great importance for production and are currently being discussed with regard to the criticality of resources (for example copper, aluminum, rare earths, gold, tantalum, phosphorus). Concepts for assessing the scarcity are presented. For the respective raw materials, corresponding applications in technologies or products are presented. <u>Lean Production</u> • Waste • Flow • Quality • Tact Time • Standardization • Kaizen • Management & Culture • Pull • Supply Chain • Value Stream • Machinery • Flexible Manpower Systems • Administration • Perfection • Holistic Production Systems
Relation to other Modules	none
Workload	Raw Materials and Resources: In addition to 2 x 15 SWS = 30 contact hours students are expected to spend 30 hours on preparation and follow-up. Lean Production: In addition to 2 x 15 SWS = 30 contact hours students are expected to spend 60 hours on preparation and follow-up.
	<u>Raw Materials und Resources</u> • Achzet B., Reller A., Zepf V., University of Augsburg, Rennie C., BP, Ashfield M. and Simmons J., ON Communication (2011): Materials critical to the energy industry. An introduction. • Angerer, G. et al. (2009): Rohstoffe für Zukunftstechnologien, Einfluss des branchenspezifischen Rohstoffbedarfs in rohstoffintensiven Zukunftstechnologien auf die zukünftige Rohstoffnachfrage. BMWi/ ISI/ IZT

Literature	• EU (2014): REPORT ON CRITICAL RAW MATERIALS FOR THE EU. Report of the Ad hoc Working Group on defining critical raw materials <u>Lean Production</u> • Hans-Dieter Zollondz: Grundlagen Lean Management: Einführung in Geschichte, Begriffe, Systeme, Techniken sowie Gestaltungs- und Implementierungsansätze eines modernen Managementparadigmas. Oldenbourg • Taiichi Ohno: Das Toyota-Produktionssystem. Campus • James P. Womack, Daniel T. Jones: Lean Thinking: Ballast abwerfen, Unternehmensgewinn steigern. Campus • Mike Rother, John Shook: Sehen Lernen: Mit Wertstromdesign die Wertschöpfung erhöhen und Verschwendung beseitigen. Lean Management Institut • Takeda, Hitochi: Das Synchrone Produktionssystem. Franz Vahlen
Keywords	Lean Production, Raw Materials, Resources
Last edited	August 2017

LAW3200 – Legal Aspects of Environmental Protection

Legal Aspects of Environmental Protection	
ID	LAW3200
Study Semester	6
Level	Advanced
Credits	5
Lecture hours per week	4
Frequency	Each semester
Associated Lectures	Legal Aspects of Environmental Protection
Prerequisites	Min. 47 credits from interim grade
Assessment Methods	PLM/PLH/PLK - 60 min
Requirements for granting of credits	Passing the assessments.
Significance for the Final Grade	The module contributes to the final bachelor grade.
Planned group size	Max. 50 students
Language	German
Module Duration	1 semester
Module Coordinator	Prof. Dr. Tobias Brönneke
Lecturer(s)	Prof. Dr. Tobias Brönneke Dr. Rüdiger Herpich
Subject Area	Law /Resource Efficiency Management
Applicability in other programs	none
Pedagogical approach	Lecture with exercises
Objectives	The students… • recognize legal questions at the interface to economic and technical resource efficiency management; • have a first overview of the most important German and European environmental regulations; • can differentiate between what the law demands from a citizen / company (substantive provisions) and the tools it provides for the implementation of these requirements and how the authorities ensure compliance with the laws by these tools; • know practical in-plant aspects of environmental- and resource protection; • are able to interact with environmental law specialists and lawyers about the legal issues in the context of resource efficiency management and to contribute adequately to the proper solution of the issues. <u>Critical thinking and analytical skills</u> The students are able to apply analytical skills constructively and critically to problems. <u>Communication skills</u> The students are able to express complex issues in clear written form.

	The module serves primarily for enlargement and consolidation of knowledge.
Content	• Environmental law: introduction, objectives, principles and systematics, legal sources of environmental law • Instruments of environmental administration: approval of installations, incidental provisions and regulations, operating bans, discretion • Legal protection within environmental law • Emission control act • Recycling economy and waste legislation • Implementation of resource efficiency in an operational context • Material flow management in the context of resource efficiency, e.g. REACh, GHS/CLP, hazardous goods law, ProdHaftG, KrWG • Production and handling of hazardous substances / products • Implementation of regulations for resource efficiency and sustainability • Global industry standards, norms and managements systems in the field of quality / environmental protection / energy: ISO9001, 14001, 50001 (EMAS) and their relation to national, European and international law • Resource efficiency in practice: industrial promotion, examples for its implementation
Relation to other Modules	The module is based on LAW1010 (Recht I), LAW1200 (Recht II), BREM2400 (Industrial Ecology) and BREM2500 (Applied Resource Efficiency).
Workload	In addition to 4 x 15 = 60 SWS contact hours, students are expected to spend 90 hours on preparation and follow-up, independent literature studies, preparation of exercises and preparation for the exam.
Literature	Nomos Öffentliches Recht (Legislative Texts) as well as other legal texts printed as necessary work material. <u>Literature</u> • Erbguth/Schlacke: Umweltrecht, neueste Auflage • Oberrath: Öffentliches Recht oder • Detterbeck: Öffentliches Recht. - always latest edition – Scripts of the two sub-courses are provided on the e-learning platform
Keywords	Environmental Law
Last edited	August 2017

BREM3000 – Resources

Resources	
ID	BREM3000
Study Semester	6
Level	Academic
Credits	5
Contact hours per week	4
Frequency	Each semester
Associated Lectures	Markets and the Economics of Natural Resources
Prerequsites	Min. 47 credits from interim grade
Assessment Methods	PLK - 90 min
Requirements for granting of credits	Passing the written exam.
Significance for the Final Grade	The module contributes to the final bachelor grade.
Planned group size	Max. 50 students
Language	English
Module Duration	1 semester
Module Coordinator	Prof. Dr. Jürgen Antony
Lecturer(s)	Prof. Dr. Jürgen Antony
Subject Area	Economics
Applicability in other programs	none
Pedagogical Approach	Lecture with exercises
Objectives	The students… • know the most important raw material markets (including secondary raw materials and energy) and their functioning; • are able to track and estimate raw material prices on world markets; • know the basic principles of resource economics; • are familiar with resource policy options (operational, economic). The module serves primarily for the consolidation of knowledge as well as the acquisition of instrumental competence.
Content	Commodity Markets: Functionality of LMX, EEX, CME, MCX etc. Price trends and influencing factors within the raw material- and energy industry. Shifting effects (e.g. BTL). Forecasts. Public goods, Tragedy of the Commons, external effects, resource allocation, Coase Theorem, Pigou taxes, Hotelling Rule, Hartwick Rule, Jevons and Rebound effects, UGR Resource Policy: Operational risk management, policy options and actors
Relation to other Modules	none

Workload	In addition to 4 x 15 = 60 SWS contact hours, students are expected to spend 90 hours on preparation and follow-up, independent literature studies, work on case studies and exercise examples and preparation for the exam.
Additional Remarks	The module can also be completed by an equivalent performance in course of an international study semester. The module is offered exclusively in English as part of the International Study Program. The credits obtained are taken into account for the 18-credit requirement of the study program.
Literature	• Baker, R. P. (2010): The Trade Lifecycle: Behind the Scenes of the Trading Process (Wiley Finance) • Clark, E. et al. (2001): International Commodity Trading: Physical and Derivative Markets (Wiley Trade Series) • Conrad, J. (2011): Resource Economics. Cambridge University Press • OECD (2012): Sustainable Materials Management: Making Better Use of Resources, Paris • Perman, R. et al. (2011): Natural Resource and Environmental Economics, Pearson.
Keywords	Resource Economics, Resource Markets, Scarcity, Risk Management, Resource Policy, Sustainable Development, Non-renewable Resources
Last edited	August 2017

BREM3110 – Electives: Practical Applications

Electives: Practical Applications	
ID	BREM3110
Study Semester	6
Level	Academic
Credits	6
Contact hours per week	4
Frequency	Each semester
Associated Lectures	Project Management Organization (2 SWS/3Credits) Change Management in der Industrie (2 SWS/3 Credits) Methods of Quality Management (2 SWS/ 3 Credits) Independent Studies (4 SWS/6 Credits) Technology and Innovation Management (2 SWS/3 Credits) Seminar Lean Management (2 SWS/3 Credits) Mitarbeiterführung/Leadership (2 SWS/3 Credits)
Prerequsites	Min. 47 credits from interim grade
Assessment Methods	PLP/PLR/PLH/PLK - 60 min
Requirements for granting of credits	Passing 2 WPFs resp. 6 Credits. The individual components may be passed separately.
Significance for the Final Grade	The module contributes to the final bachelor grade.
Planned group size	Max. 50 students
Language	German / English
Module Duration	1 semester
Module Coordinator	Prof. Dr. Claus Lang-Koetz
Lecturer(s)	Prof. Dr. Claus Lang-Koetz Prof. Dr. Frank Bertagnolli Professors of various study programs.
Subject Area	Resource Efficiency Management
Applicability in other programs	Individual WPF are also available for other study programs
Pedagogical Approach	Lecture with exercises/seminar Independent Studies: project work
	The WPF module should provide students with the opportunity to concentrate on their individual focus within the study program. The objectives differ depending on the WPF: <u>Project Management Organization</u> The students are able to plan, structure, conduct, control and organize projects. They can guide and moderate small teams with common tools. <u>Change Management in Industry</u> The students know why changes take place, are necessary and normal. They know the course of a change and its concomitants as well as the background and can classify the topic of Change

Objectives	Management into the context of their study program and the future field of work. The students are familiar with the most important starting points and obstacles within Change Management. They know management tools and methods for the successful planning and internal implementation of changes. They also reflect on the change context and further develop their personality. This process is actively supported by a learning diary in the course. Methods of quality management Students have basic knowledge of relevant methods of quality management, know the foundations of quality management systems with the relevant ISO standards, and know how to apply central analysis tools to simple problems. Independent Studies The students are able to conduct a project with a challenging topic independently and in a team, which, in addition to methodological demands, also requires social interaction, e.g. in the internal business system. Technology and Innovation Management Students will learn the foundations of technology and innovation management and their importance for companies. They learn how to use selected methods by means of simple practical problems. Seminar Lean Management The students are able to research, prepare and present a complex, practice-relevant topic independently. They can work up literature and systematize and incorporate practical experience. They know the basics and also some details from the area of Lean Management and realize the transfer into practice. Leadership / Leadership Students will get to know and understand the special aspects and tools of the management of employees. They are able to lead teams. The module serves primarily for the enlargement and consolidation of knowledge as well as the acquisition of instrumental competence. When choosing Independent Studies, in addition to instrumental competence, systemic competence is the focus.
Content	The contents of the courses are based on the current topics of the respective subjects and, in addition to the foundations, are intended to impart knowledge about instruments as well as their use through practical examples. The content for Independent Studies is currently being defined, in particular, in cooperation with externals (companies, etc.).
Relation to other Modules	The module is based on BREM2600 (Production).
Workload	In addition to 2 x 15 = 30 SWS contact hours, students are expected to spend 60 hours on preparation and follow-up, independent literature studies, work on case studies and exercise examples and preparation for the exam.

	In case of choosing “Independent Studies”: In addition to 2 x 15 = 30 SWS contact hours, students are expected to spend 150 hours on preparation and follow-up, independent literature studies, work on case studies and exercises and preparation for the exam.
Additional Remarks	The module or a single course of the module can also be completed by an equivalent performance in course of an international study semester. Acceptance is given to modules or courses related to the study program's main focus. English-language courses within the module are offered as part of the International Study Program. The credits obtained are taken into account for the 18-credit requirement of the study program.
Literature	Examples: <u>Project Management Organization</u> • Maylor (2010): Project Management. Prentice Hall • Buchanan et al. (2010): Organizational Behaviour. FT Prentice Hall <u>Change Management in der Industrie</u> • Regber und Zimmermann (2001): Change Management in der Produktion: Prozesse effizient verbessern im Team. Moderne Industrie. • John P. Kotter (2011): Leading Change (Deutsche Ausgabe). Vahlen. • Doppler et al. (2011): Unternehmenswandel gegen Widerstände: Change Management mit den Menschen. Campus. • Lauer (2010): Change Management: Grundlagen und Erfolgsfaktoren. Springer. <u>Methods of Quality Management</u> • Sower, Victor (2001): Essentials of Quality, Wiley • Seghezzi, H.D.; Fahrni, F.; Friedli, T. (2013): Integriertes Qualitätsmanagement, Hanser. <u>Technologie- und Innovationsmanagement</u> • Vahs, D.; Brem, A. (2013): Innovationsmanagement – Von der Idee zur erfolgreichen Vermarktung, 4. Auflage, Schäffer-Poeschel Verlag. • Spath, D. et al: Technologiemanagement. Grundlagen, Konzepte, Methoden, Fraunhofer Verlag.
Keywords	
Last edited	August 2017

BREM4000 – Seminar Resource Efficiency Management

Seminar Resource Efficiency Management	
ID	BREM4000
Study Semester	7
Level	academic
Credits	8
Contact hours per week	2
Frequency	Each semester
Associated Lectures	Seminar Resource Efficiency Management
Prerequsites	Completed interim grade
Assessment Methods	PLH/PLR/PLP
Requirements for granting of credits	Passing the assessments.
Significance for the Final Grade	The module contributes to the final bachelor grade.
Planned group size	Max. 30 students
Language	German
Module Duration	1 Semester
Module Coordinator	Prof. Dr. Claus Lang-Koetz
Lecturer(s)	Prof. Dr. Claus Lang-Koetz N.N.
Subject Area	Resource Efficiency Management
Applicability in other programs	none
Pedagogical Approach	Seminar
Objectives	The students… • can independently prepare and present a complex technical-economic topic related to resource efficiency; • can work up scientific literature and / or (if appropriate), practical experience can be systematized and integrated; • are familiar with the foundations and some details from the area of production organization and resource efficiency management; • can independently conduct analysis in the context of resource efficiency management and draw conclusions; • have all the prerequisites for the preparation of a bachelor thesis. The module serves primarily for the consolidation of knowledge and the acquisition of instrumental, systemic and communicative competence.
Content	The contents are currently defined.
Relation to other Modules	The module is based on BREM2600 (Production) and BREM3110 (Electives: Practical Applications)
Workload	In addition to 2 x 15 = 30 SWS contact hours, students are expected to spend 210 hours on preparation and follow-up, incl. literature studies

	as well as the preparation and presentation of a case study or a seminar paper.
Additional Remarks	The module is offered en bloc within the first 6 and 7 lecture weeks.
Literature	Depends on the contents.
Keywords	
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