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| Code | **IE 102** |
| Name | **Exploring Profession** |
| Hour per week | 5 (3 + 2) |
| Credit | 4 |
| ECTS | 5 |
| Level/Year | Undergraduate / 1 |
| Semester | Spring |
| Type | Compulsory |
| Prerequisites |  |
| Content | This course is designed to promote the development of professional passion among students and provide early-on/hands-on experience through lectures, field trips, case studies, and projects. Students will have a big picture view of the engineering profession and its practical requirements. Students will learn about the various aspects of the engineering profession and acquire both technical skills and non-technical skills, in areas such as communication, teamwork, and engineering ethics. The course also supports students entering the complex social system of the university in their efforts to succeed in engineering through personal and professional development, including understanding themselves as integrated physiological, social, and psychological entities who are able to formulate strategies and employ available university resources to support their academic and personal development. |

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| Code | **IE197** |
| Name | **Summer Training I** |
| Hour per week |  |
| Credit |  |
| ECTS | 0 (for 2nd year) / 4 (for 4th year) |
| Level/Year | Undergraduate / 2 and 4 |
| Semester | Fall / Fall |
| Type | Compulsory |
| Prerequisites |  |
| Content | This is the first of three courses designed for internship programs that industrial engineering students are to attend during their education. The students who have attended a summer internship program for the first time register for the course. The students are assessed considering internship report, presentations, and the internship program coordinator’s evaluation during the semester. The students get their credits for the course in the fourth year. To enroll in the course, a student must complete at least 6-week (30-workday) program. The students will have first-hand experience to learn the business environment, relationships in the business environment, the business culture, and business processes. For detailed procedures, refer to the department’s web page. |

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| Code | **IE201** |
| Name | **Developing Entrepreneurial Skills** |
| Hour per week | 3 (3+0) |
| Credit | 3 |
| ECTS | 4 |
| Level/Year | Undergraduate |
| Semester | Fall |
| Type | Compulsory |
| Prerequisites |  |
| Content | The course is designed to equip the students with the tools and skills that they need to go from a business idea to an established business. The students will then take that knowledge and apply it to the development, implementation and evaluation of a self-directed project with a topic of their choice in groups. At the end of the course, a competition will be held for the projects. An ‘Entrepreneurship Certificate’ of KOSGEB will be delivered to successful students. |

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| Code | **IE212** |
| Name | **Deterministic Optimization** |
| Hour per week | 4 (4+0) |
| Credit | 4 |
| ECTS | 7 |
| Level/Year | Undergraduate / 2 |
| Semester | Spring |
| Type | Compulsory |
| Prerequisites | IE213 |
| Content | The objective of this course is to equip the students with the capability of developing and coding algorithms to solve different types of models including linear, network, integer, and non-linear programming models. In this regard, the solution techniques and algorithms for different types of problems, e.g., simplex, dual simplex, network simplex, branch-and-bound algorithms and decomposition techniques, are introduced. Modeling and solving real-world problems is also emphasized in this course. Homework and project assignments will enhance students’ modeling and problem solving abilities in practice. |

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| Code | **IE213** |
| Name | **Mathematical Modeling** |
| Hour per week | 5(3 + 2) |
| Credit | 4 |
| ECTS | 7 |
| Level/Year | Undergraduate / 2 |
| Semester | Fall |
| Type | Compulsory |
| Prerequisites |  |
| Content | The course intends to teach the students the process of mathematical modeling. Specifically, the objective is to equip the students with the capability of abstracting a real-world system/problem conceptually, formulating and building mathematical models that are appropriate for the system/problem, coding and solving a mathematical model by using available off-the-shelf software e.g. GAMS, CPLEX, EXCEL SOLVER, EXPRESS, GUROBI and interpreting the solutions obtained from the models in terms of real-world system. The emphasis is placed on modeling and solving the problems rather than teaching the algorithms used to solve the models. |

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| Code | **IE 221** |
| Name | **Probability** |
| Hour per week | 3 + 0 (Theory + Practice) |
| Credit | 3 |
| ECTS | 6 |
| Level/Year | Undergraduate / 2 |
| Semester | Fall |
| Type | Compulsory |
| Prerequisites |  |
| Content | This is a first course on the subject and is designed to cover the fundamentals of probability theory. The course provides short history of probability and statistics; axiomatic definition of probability; probability spaces; random variables and vectors; probability distributions; continuous/discrete/joint distributions, distribution functions, density functions, standard distributions; mean value, variance and high-order moments; independence and conditional probability; common, marginal and conditional distributions. |

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| Code | **IE 222** |
| Name | **Statistics** |
| Hour per week | 4 + 0 (Theory + Practice) |
| Credit | 4 |
| ECTS | 7 |
| Level/Year | Undergraduate / 2 |
| Semester | Spring |
| Type | Compulsory |
| Prerequisites | IE221 |
| Content | This course is designed to introduce quantitative analysis of uncertainty on top of IE 221-Probability. The focus is on broad treatment of applications of statistics, concentrating on techniques used in industry and science. Topics include descriptive statistics, parameter estimation, confidence intervals, hypothesis testing, analysis of variance, and regression. |

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| Code | **IE 242** |
| Name | **Business Process Analysis and Design** |
| Hour per week | 3 (3 + 0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate / 2 |
| Semester | Spring |
| Type | Compulsory |
| Prerequisites |  |
| Content | This course provides an introduction to key concepts and approaches to business process management, design, analysis such as incremental improvement, process automation, and process redesign. The main focus of this course is both understanding and designing business processes. Fundamental concepts that can be used to systematically analyze any business process will be covered. Students will learn how to identify, document, model, assess, and improve core business processes. Students will be introduced to process design principles by using sophisticated analytical techniques to design and manage efficient and effective operations and processes. Students will learn how to analyze and improve business processes in different contexts, and using different process improvement tools. They will learn tools from simple process-mapping to computer-based process-modeling using Signavio and Microsoft Office Visio. |

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| Code | **IE297** |
| Name | **Summer Training II** |
| Hour per week |  |
| Credit |  |
| ECTS | 0 (for 3rd year) / 5 (for 4th year) |
| Level/Year | Undergraduate / 3 and 4 |
| Semester | Fall and Spring |
| Type | Compulsory |
| Prerequisites | IE197 |
| Content | This is the second of three courses designed for internship programs that industrial engineering students are to attend during their education. The students who have attended a summer internship program for the second time register for the course. The students are assessed considering internship report, presentations, and the internship program coordinator’s evaluation during the semester. The students get their credits for the course in the spring semester of the fourth year. To enroll in the course, a student must complete at least 8-week (40-workday) program. The students will have first-hand experience to learn the business environment, relationships in the business environment, the business culture, and business processes. For detailed procedures, refer to the department’s web page. |

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| Code | **IE325** |
| Name | **System Simulation** |
| Hour per week | 5 (3 + 2) |
| Credit | 4 |
| ECTS | 7 |
| Level/Year | Undergraduate / 3 |
| Semester | Fall |
| Type | Compulsory |
| Prerequisites | IE221, IE222 |
| Content | This is an introductory course in computer simulation, which covers the use of simulation as a decision-making, comparison, or estimation tool. The emphasis is on basic concepts and methods in developing discrete-event simulation models for stochastic and dynamic systems and on how to analyze and interpret the results of simulation experiments. The students will also learn how to use ARENA simulation software. |

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| Code | **IE326** |
| Name | **Business Analytics** |
| Hour per week | 3 (3+0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate / 3 |
| Semester | Spring |
| Type | Compulsory |
| Prerequisites | IE221, IE222 |
| Content | INFORMS (The Institute for Operations Research and the Management Sciences) define business analytics as the scientific process of transforming data into insight for making better decisions. This course introduces essential analytic methods in descriptive, predictive and prescriptive business analytics, and can be thought of as a confluence of statistics, operations research, data mining, and machine learning. Related topics such as big data, data warehousing, OLAP, and Hadoop/MapReduce will also be introduced. |

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| Code | **IE 335** |
| Name | **Stochastic Models** |
| Hour per week | 3 + 0 (Theory + Practice) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate / 3 |
| Semester | Fall |
| Type | Compulsory |
| Prerequisites | IE 221 |
| Content | This course provides a comprehensive knowledge about Markov chains in discrete and continuous cases, the Poisson processes and exponential distribution, and queuing theory. The course requires basic knowledge in probability theory and linear algebra including conditional expectation and matrix. Students are expected to use and understand basic mathematical notations; select and apply an appropriate mathematical model for certain elementary probabilistic problems; and do basic hand calculations with accuracy. |

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| Code | **IE345** |
| Name | **Financial and Managerial Accounting** |
| Hour per week | 3 (3+0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate / 3 |
| Semester | Fall |
| Type | Compulsory |
| Prerequisites |  |
| Content | This course is an introduction to accounting which covers the financial reporting process, accounting information system and the use of accounting data for decision making and control. Understanding the financial statements of an organization, especially the Income Statement and the Balance Sheet and analyzing the financial performance of companies and making managerial decisions using accounting information are a crucial part of the course. |

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| Code | **IE 346** |
| Name | **Engineering Economics and Cost Analysis** |
| Hour per week | 3 (3 + 0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate / 3 |
| Semester | Spring |
| Type | Compulsory |
| Prerequisites |  |
| Content | The objective of the course is to provide the student with an understanding of the principles, basic concepts, and methodology of the study of economics and engineering economic analysis. These principles and techniques can be used in feasibility studies, decision making during design, and equipment selection and replacement analysis. Students learn to apply standard time-value equivalence formulas to convert cash flows from different time points into comparable quantities and according to the risk that will arise in spite of the desired rate of return, the ability to set up a most appropriate portfolio of simple assets develops. |

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| Code | **IE 348** |
| Name | **Marketing Engineering** |
| Hour per week | 3 (3 + 0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate / 3 |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites | IE213, IE212, IE221, IE222 |
| Content | This course explores the development of international marketing programs from the determination of objectives and methods of organization through the execution of research, advertising, distribution, and production activities. Students examine the international similarities and differences in marketing functions as related to the cultural, economic, political, social, and physical dimensions of the environment. Students consider the changes in marketing systems and the adoption of marketing philosophies and practices to fill conditions in different countries. |

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| Code | **IE374** |
| Name | **Supply Chain Management** |
| Hour per week | 3 (3 + 0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate / 3 |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites | IE221, IE222, IE212, IE213 |
| Content | Introduction to concepts and terminology of logistics and supply chain management, examination of components of logistics and supply chain systems, analysis of interactions and trade-offs among these components, logistics network configuration, risk pooling and multi-echelon inventory systems, value of information in supply chains, coordination of the supply chain using contracts and other mechanisms, distribution strategies for the supply chain and product design for supply chain efficiency. |

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| Code | **IE 375** |
| Name | **Production and Service Systems Management I** |
| Hour per week | 4 + 0 (Theory + Practice) |
| Credit | 4 |
| ECTS | 6 |
| Level/Year | Undergraduate / 3 |
| Semester | Fall |
| Type | Compulsory |
| Prerequisites |  |
| Content | This course provides analytical skills and managerial insights necessary to analyze a firm's operations decisions and practices. The intent is to strengthen the student's management skills by applying the technical and theoretical IE and OR materials provide throughout the curriculum to both production and service delivery systems. On completion of the course, students become familiar with the fundamental concepts of facility location and layout and learn quantitative methods, basic tools and methodologies used to solve the related problems. This course also provides demand-forecasting models using time series methods. |

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| Code | **IE 376** |
| Name | **Production and Service Systems Management II** |
| Hour per week | 4 + 0 (Theory + Practice) |
| Credit | 4 |
| ECTS | 6 |
| Level/Year | Undergraduate / 3 |
| Semester | Spring |
| Type | Compulsory |
| Prerequisites | IE 375 |
| Content | This course, as a continuation of IE375, provides analytical skills and managerial insights necessary to analyze a firm's operations decisions and practices. The intent is to strengthen the student's management skills by applying the technical and theoretical IE and OR material provide throughout the curriculum to both production and service delivery systems. On completion of this course, students become familiar with the fundamental concepts of scheduling and sequencing of the jobs, project management, supply chain management and also learn quantitative methods, basic tools and methodologies used to solve the related problems. |

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| Code | **IE 380** |
| Name | **Quality Control and Assurance** |
| Hour per week | 3 (3 + 0) |
| Credit | 3 |
| ECTS | 4 |
| Level/Year | Undergraduate / 3 |
| Semester | Spring |
| Type | Compulsory |
| Prerequisites | IE 221, IE222 |
| Content | This course teaches the quality principles and related concepts that the student can use for quality evaluation and quality improvement in business environment, explains what quality is and the methods to improve quality through design and control, explores the principles and techniques used to evaluate both continuous and attribute data and enhances skills in computer software that are used in quality assurance activities and data analysis. |

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| Code | **IE391** |
| Name | **Industry Applications I** |
| Hour per week | 3 (3 + 0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate / 3 |
| Semester | Fall |
| Type | Elective |
| Prerequisites | IE221, IE213, IE212, IE222 |
| Content | This is the first course of a series of four courses designed to improve university-industry collaboration and to enable the students to gain experience in solving real problems of organizations. The students are expected to conduct research to solve a real-world problem in groups under the supervision of the instructor and in collaboration with the experts from the industry. In this context, the students survey papers related to the problem, visit the organization to analyze the problem and collect data, construct conceptual and analytical models to solve the problem, develop solution methodologies for the proposed models, and apply the models to the problem. |

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| Code | **IE392** |
| Name | **Industry Applications II** |
| Hour per week | 3 (3 + 0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate / 3 |
| Semester | Spring |
| Type | Elective |
| Prerequisites | IE221, IE213, IE212, IE222, IE325 |
| Content | This is the second course of a series of four courses designed to improve university-industry collaboration and to enable the students to gain experience in solving real problems of organizations. The students are expected to conduct research to solve a real-world problem in groups under the supervision of the instructor and in collaboration with the experts from the industry. In this context, the students survey papers related to the problem, visit the organization to analyze the problem and collect data, construct conceptual and analytical models to solve the problem, develop solution methodologies for the proposed models, and apply the models to the problem. |

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| Code | **IE393** |
| Name | **Industry Applications III** |
| Hour per week | 3 (3 + 0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate / 4 |
| Semester | Fall |
| Type | Elective |
| Prerequisites | IE221, IE213, IE212, IE222, IE325 |
| Content | This is the third course of a series of four courses designed to improve university-industry collaboration and to enable the students to gain experience in solving real problems of organizations. The students are expected to conduct research to solve a real-world problem in groups under the supervision of the instructor and in collaboration with the experts from the industry. In this context, the students review papers related to the problem, visit the organization to analyze the problem and collect data, construct conceptual and analytical models to solve the problem, develop solution methodologies for the proposed models, and apply the models to the problem. |

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| Code | **IE394** |
| Name | **Industry Applications IV** |
| Hour per week | 3 (3 + 0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate / 4 |
| Semester | Spring |
| Type | Elective |
| Prerequisites | IE221, IE213, IE212, IE222, IE325 |
| Content | This is the fourth course of a series of four courses designed to improve university-industry collaboration and to enable the students to gain experience in solving real problems of organizations. The students are expected to conduct research to solve a real-world problem in groups under the supervision of the instructor and in collaboration with the experts from the industry. In this context, the students survey papers related to the problem, visit the organization to analyze the problem and collect data, construct conceptual and analytical models to solve the problem, develop solution methodologies for the proposed models, and apply the models to the problem. |

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| Code | **IE395** |
| Name | **Decision and Risk Analysis** |
| Hour per week | 3 (3+0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate / 3 |
| Semester | Fall |
| Type | Compulsory |
| Prerequisites | IE221, IE222, IE212, IE213 |
| Content | The course is mainly divided into three parts, general introduction to decision analysis, multi-criteria decision analysis, and multi-objective optimization. In the first part, the merits of a structured rational decision-making process are emphasized. In the second part, the structuring of decision elements (values, objectives, alternatives, measures, tradeoffs, and uncertainty), multi-attribute utility theory (MAUT), analytic hierarchy process (AHP), and decision tree under certainty/uncertainty are introduced. In the third part, multi-objective optimization and goal programming are discussed. |

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| Code | **IE397** |
| Name | **Summer Training III** |
| Hour per week |  |
| Credit |  |
| ECTS | 0 (for 4th year Fall Semester) / 6 (for 4th year Spring Semester) |
| Level/Year | Undergraduate / 4 |
| Semester | Fall or Spring |
| Type | Compulsory |
| Prerequisites | IE297 |
| Content | This is the last of three courses designed for internship programs that industrial engineering students are to attend during their education. The students who have attended a summer internship program for the third time register for the course. The students are assessed considering internship report, presentations, and the internship program coordinator’s evaluation during the semester. The students get their credits for the course in the spring semester of the fourth year. To enroll in the course, a student must complete at least 8-week (40-workday) program. The students will have first-hand experience to learn the business environment, relationships in the business environment, the business culture, and business processes. For detailed procedures, refer to the department’s web page. |

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| Code | **IE412** |
| Name | **Network Optimization** |
| Hour per week | 3(3+0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate / 4 |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites | IE 213, IE 212 |
| Content | The course will provide an integrated view of the theory, algorithms, and the applications of key network optimization problems in telecommunication, logistics, social and computer networks. Network optimization problems including the shortest path problem, the maximum flow problem, the minimum cost flow problem, assignment and travelling salesperson problems will be presented. Moreover the course also concentrates on solution methodologies such as network simplex algorithm, Lagrange relaxation, column generation and other decomposition methods. |

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| Code | **IE414** |
| Name | **Advanced Linear Programming** |
| Hour per week | 3 (3 + 0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate/4 |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites | IE212, IE213, MATH203 |
| Content | Study of further concepts, theories, and algorithms than basic linear programming. The course begins by quickly refreshing the students’ minds about the simplex method, duality theory and sensitivity analysis. We then deal with advanced sensitivity analysis, variants of simplex method such as the dual simplex, revised simplex, simplex method with bounds, transportation simplex and network simplex algorithms. Further topics include sparse matrix techniques, basis factorization and update, interior point methods such as Karmarkar’s projective algorithms, or the ellipsoidal method, barrier methods, Dantzig-Wolfe decomposition, and delayed column generation. |

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| Code | **IE415** |
| Name | **Discrete Optimization** |
| Hour per week | 3 (3 + 0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate/4 |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites | IE 212, IE 213, or the consent of the instructor |
| Content | Study of concepts, theories, and algorithms of integer and combinatorial optimization. Topics include modeling, comparison of alternative formulations, computational complexity, polyhedral theory, valid inequalities, cutting-plane algorithms, enumerative algorithms such as dynamic programming, branch-and-bound, branch-and-cut, heuristic algorithms and techniques to handle large problems such as Benders’ decomposition and delayed column generation (and branch-and-price). Applications include graphs, networks, transportation, and scheduling. |

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| Code | **IE416** |
| Name | **Nonlinear Programming** |
| Hour per week | 3 (3 + 0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate/4 |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites | IE212, IE213 |
| Content | A study of concepts algorithms and applications of constrained and unconstrained nonlinear programs. The topics include the fundamentals and the theoretical aspects such as convex sets and functions, necessary and sufficient optimality conditions, constraint qualifications, duality theory, Lagrange multipliers, and basic iterative methods such as Newton and Gauss-Newton methods, and gradient projections. The emphasis is on some selected applications from engineering, natural sciences, and statistics. |

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| Code | **IE417** |
| Name | **Heuristic Methods in Optimization** |
| Hour per week | 3 (3 + 0) |
| Credit | 3 |
| ECTS | 6 |
| Level/Year | Undergraduate/4 |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites | IE 213, IE 212 |
| Content | Heuristics are methods that seek a fine, but not necessarily optimal solution in a reasonable amount of time. This course will survey a wide range of heuristic methods (greedy heuristics, improvement heuristics constructive heuristics, metaheuristics: simulated annealing, tabu search, genetic algorithms, ant colony optimization), emphasizing their generic characteristics and limitations, and the types of problems to which they are best adapted. |

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| Code | **IE418** |
| Name | **Discrete Mathematics** |
| Hour per week | 3 (3 + 0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate/4 |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites |  |
| Content | A course designed to prepare students for a background in abstraction, notation, and critical thinking for the mathematics most directly related to optimization and computer science. Topics include logic, relations, functions, basic set theory, countability and counting arguments, mathematical induction, combinatorics, discrete probability, recursion, sequence and recurrence, elementary number theory, graph theory, and mathematical proof techniques. |

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| Code | **IE422** |
| Name | **Advanced Simulation** |
| Hour per week | 3 (3 + 0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate/4 |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites | IE325 |
| Content | This course continues the material presented in IE 325 and focuses on the analysis of the statistical nature of simulation. Modelling complex systems, verification, interpreting output and approaches for minimizing model run time are discussed. Probability distributions are examined for appropriateness and data fitting. Determining run length with appropriateness and confidence intervals are used to describe the output. |

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| Code | **IE425** |
| Name | **System Dynamics** |
| Hour per week | 3 (3 + 0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate/4 |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites | IE325 |
| Content | Introduction to systems thinking and system dynamics modelling applied to strategy, organizational change, and policy design. Students study application cases including business cycles, the use and reliability of forecasts, the design of supply chains, service quality management, project management and product development, the dynamics of infectious diseases. |

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| Code | **IE426** |
| Name | **Data Mining** |
| Hour per week | 3 (3 + 0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate/4 |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites | IE221, IE222, IE213, IE212 |
| Content | Introduction to basic data and data mining concepts. Data pre-processing; handling missing values, basic data transformations. Rule induction; decision trees, naive Bayesian probability and neural networks. Classification analysis; Rule-Based, Nearest-Neighbour and Bayesian Classifiers, Support Vector Machines. Association Analysis; Rule Generation. Cluster Analysis; Center-based, Hierarchical, Density-based, and Fuzzy Clustering. Cluster Validation, Anomaly Detection. |

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| Code | **IE432** |
| Name | **Stochastic Programming** |
| Hour per week | 3 + 0 (Theory + Practice) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate/4 |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites | IE 213, IE 221 |
| Content | This course is designed to teach optimization in the face of uncertainty. This course provides theory of stochastic programming, expected value of stochastic programming, applications of stochastic programming, two-stage stochastic linear programs, multi-stage stochastic linear programs, L-shaped algorithm, and stochastic decomposition. |

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| Code | **IE442** |
| Name | **Operations Analysis and Design** |
| Hour per week | 3 (3+0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate/4 |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites | IE242, IE375, IE376 |
| Content | Introduction to traditional industrial engineering. Concepts and functions in the design, improvement, and analysis of man - machine systems mainly in the context of a manufacturing environment. Design and improvement of manufacturing systems such as cost reduction, process efficiency, time study, work measurement, material handling systems, and layout design. |

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| Code | **IE446** |
| Name | **Supply Chain Economics** |
| Hour per week | 3 (3 + 0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate/4 |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites | IE374 |
| Content | This course brings an economics perspective to complex decision-making in the management of supply chains. Introduces models that handle both competition and cooperation and provide the resulting product flows and prices in the chains. After an introduction of the theoretical foundations, the course extends relationships between electric power supply chains and transportation networks through theoretical results and the solution of practical examples. Explores environmental supply chain and financial networks with intermediation, which are interpreted as supply chains and also solved as such. |

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| Code | **IE448** |
| Name | **International Marketing Tool: Turquality** |
| Hour per week | 3 (3 + 0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate/4 |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites | IE213, IE212, IE221, IE222 |
| Content | The aim of this course is to provide detailed information about Turquality, the first state-sponsored branding program of the world, designed to increase our country's exports by developing strong global brands. To do this, the research and advertising, distribution and production activities will be carried out and the aims and methods of the organization will be determined and researches on the development of international marketing programs will be done. Students will examine international similarities and differences in marketing functions in relation to the cultural, economic, political, social and physical dimensions of the environment. |

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| Code | **IE449** |
| Name | **Financial Engineering** |
| Hour per week | 3 (3 + 0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate/4 |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites | IE 335, IE 345, IE 346, or the consent of the instructor |
| Content | This course focuses on the application of financial principles and, in particular, derivatives in addressing financial problems. There will be a focus on the use of derivatives as risk-management and securities structuring instruments. The topics include investments and financial markets, term structure of interest rates, fixed-income securities, risky and risk-free assets, asset pricing models, pricing and hedging derivative securities such as forwards, futures, swaps, and options, mean-variance analysis of portfolios, and value at risk. |

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| Code | **IE454** |
| Name | **Sustainable Energy Systems** |
| Hour per week | 3 (3+0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate/4 |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites | IE212, IE325 |
| Content | This course assesses current and potential future energy systems, covering resources, extraction, conversion, and end-use technologies, with emphasis on meeting regional and global energy needs in the 21st century in a sustainable manner. We (maybe guest lecturers) will examine various renewable and conventional energy production technologies, energy end-use practices and alternatives, and consumption practices in different countries. Students will learn a quantitative framework to aid in evaluation and analysis of energy technology system proposals in the context of engineering, political, social, economic, and environmental goals. |

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| Code | **IE455** |
| Name | **Green Buildings** |
| Hour per week | 3 (3+0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate/4 |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites |  |
| Content | This course is designed to describe the ecological structures and understanding the environmental, economic and social benefits of ecological structures. This course provides identification, implementation and evaluation of ecological building metrics. Ecological building operations are analyzed by value chain. Moreover, the viability of ecological building possibilities are analyzed using quantitative models and techniques. |

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| Code | **IE456** |
| Name | **Operations Research in Sustainability** |
| Hour per week | 3(3+0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate/4 |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites | IE213, IE212, IE221, IE222, IE325 |
| Content | Operations research in sustainability deals with the application of operation research methods to address problems in planning and control of systems in forestry, mining, water resources or energy related industries such as large-scale networks of gas and electricity. Moreover, this course focuses on analysis of operations and design problems arising in renewable energy, organic agriculture, green chemistry, sustainable mobility, sustainable development issues such as fair trade and microfinance, and advanced systems for energy management such as smart grids; design of markets for electricity, gas, or other resources, market-based approaches for environmental issues such as emissions trading. |

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| Code | **IE457** |
| Name | **Operations Research Applications in Energy Systems** |
| Hour per week | 3 (3+0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate/4 |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites | IE212 |
| Content | Review and critical assessment of the literature that involves application of operation research methods to address problems in sustainable energy. To be able to formulate, to develop the computational implementation and to find the optimal solution of the sustainable energy problems by applying operations research methods. |

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| Code | **IE458** |
| Name | **Smart Transportation Systems** |
| Hour per week | 3 (3+0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate/4 |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites |  |
| Content | This course presents the fundamental concepts of Intelligent Transportation Systems (ITS) to students with interest in engineering, transportation systems, communication systems, vehicle technologies, transportation planning, transportation policy, and urban planning. ITS refers to information and communication technologies, as applied to transportation infrastructure and vehicles, that improve transportation safety, productivity, environment, and travel reliability. |

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| Code | **IE459** |
| Name | **Smart Cities** |
| Hour per week | 3 (3 + 0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate / 4 |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites | IE212, IE213, IE221, IE222, IE325, IE326 |
| Content | Smart cities are places where information technology is combined with infrastructure, architecture, everyday objects, and even our bodies to address social, economic, and environmental problems. The course discusses how industrial engineering and operations research techniques can be used in the development of smart systems in the context of smart cities. Some topics to discuss are smart grid, smart transportation systems, smart buildings, cyber-physical systems, smart manufacturing systems, and smart logistics. |

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| Code | **IE 461** |
| Name | **Manufacturing Process** |
| Hour per week | 3 + 0 (Theory + Practice) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate/4 |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites |  |
| Content | The course is designed to teach the students manufacturing processes. The course includes casting, metal forming and metal cutting with special machining operations (turning, milling, drilling, and grinding), product and process design, The course provides a comprehensive knowledge about manufacturing automation such as numerical control, CNC programming, PLC, FMS cells, industrial robots, and related software. |

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| Code | **IE462** |
| Name | **Lean Manufacturing** |
| Hour per week | 3 (3+0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate/4 |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites | IE221, IE222, IE213, IE212 |
| Content | This course will introduce lean manufacture principles and practice. Industrial engineers must develop systems that are fast, flexible, focused for their companies, customers and production associates. The course will provide the student with an introduction to lean manufacture, describing the background behind its development and how evaluations and assessments of production systems are performed. Lean manufacture tools and techniques will be described and in some cases demonstrated in simulation exercises. Issues relating to employee involvement, improvement teams, training and culture will be presented. Planning for lean process implementation and the necessity of sustain improvements will be discussed. Examples of applications in manufacturing and business processes will be presented. |

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| Code | **IE463** |
| Name | **Disaster and Emergency Management** |
| Hour per week | 3(3+0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate / 4 |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites | IE 213, IE 212, IE 221, IE 222 and IE 325 |
| Content | The purpose of the course is to familiarize the students with the basic principles and main problems of disaster/emergency management. Several issues with regard to four phases of disaster/emergency management, namely, mitigation, preparedness, response, and recovery, are discussed in depth. Disaster trends, hazards, risk, and vulnerability as well as management structures and advancements together with recent national and international initiatives around the world are addressed. |

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| Code | **IE464** |
| Name | **Operations Research Models in Disaster Management** |
| Hour per week | 3(3+0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate / 4 |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites | IE213, IE212, IE221, IE222, IE325 |
| Content | The course firstly deals with basic concepts in disaster management, definitions and terminology used in disaster management, types and categories of disasters. The main objective of the course is to investigate Operations Research models used to solve several problems in disaster operations management. The models span issues in mitigation, preparedness, response, and recovery phases of disaster management. |

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| Code | **IE465** |
| Name | **Operations Research and Homeland Security** |
| Hour per week | 3 (3 + 0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate/4 |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites | IE212, IE213, IE221, IE222, IE325, IE326 |
| Content | The course is designed to teach the students how operations research techniques can be applied to solve several problems in homeland security through several real-world cases. Homeland security deals with problems such as preventing terrorist attacks, planning and preparing for emergencies, and responding to and recovering from disasters. Several OR models and methods, e.g., interdiction models, game-theoretic approaches, risk and decision analysis, data mining, and optimization, are studied. |

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| Code | **IE466** |
| Name | **Vulnerability and Resilience** |
| Hour per week | 3 (3 + 0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate/4 |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites | IE212, IE213, IE221, IE222, IE325 |
| Content | Vulnerability is defined as the manifestation of the inherent states of a system that can be subjected to a natural hazard or be exploited to adversely affect that system, whereas resilience is defined as the ability of the system to withstand a major disruption within acceptable degradation parameters and to recover within an acceptable time, and composite costs, and risks. The course addresses how resilience can be introduced into a system to decrease its vulnerability considering several risk factors. Some systems analyzed and studied are transportation systems, cyber-physical systems, computer systems, SCADA systems, and counter-terrorism systems. |

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| Code | **IE467** |
| Name | **Critical Infrastructure Planning** |
| Hour per week | 3 (3 + 0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites | IE212, IE213, IE221, IE222, IE325, IE326 |
| Content | Sustainable and resilient critical infrastructure systems are an emerging paradigm in an evolving era of depleting assets in the midst of natural and man-made threats. In this course, recent advances in simulation, modeling, sensing, communications/information, and intelligent and sustainable technologies that have resulted in the development of sophisticated methodologies and instruments to design, characterize, optimize, and evaluate critical infrastructure systems, their resilience, and their condition and the factors that cause their deterioration are discussed. |

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| Code | **IE 472** |
| Name | **Production Planning and Scheduling** |
| Hour per week | 3 (3+0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate/4 |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites | IE 375, IE 376 |
| Content | This course is designed to develop both a theoretical understanding and a practical basis for work in the area. Topics include inventory control, production planning and scheduling, and demand forecasting. Students should be able to (i) analyze time series data, choose an appropriate forecasting model, and then optimize that model; (ii) apply the concepts of sequencing and scheduling in their personal lives and on the factory floor. |

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| Code | **IE 474** |
| Name | **Humanitarian Logistics** |
| Hour per week | 3(3+0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate / 4 |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites | IE213, IE212, IE221 |
| Content | This course firstly introduces humanitarian operations and basic concepts, definitions and terminologies used in disaster management. The main objective of the course is to investigate humanitarian logistics operations in disaster management cycle and location, routing, allocation and inventory problems in humanitarian logistics. Mathematical models are formulated and solution methodologies are developed for these problems. |

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| Code | **IE475** |
| Name | **Facility Layout and Location** |
| Hour per week | 3(3+0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate / 4 |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites | IE 213, IE 212, IE 221, IE375, IE376 |
| Content | This course provides knowledge of facility location, facility layout, production line and material handling. Location factors, location analysis with fixed costs and continuous facility location are analyzed in facility location part of the course. Objectives, facility layout models, optimal and heuristic procedures, computerized layout planning are the topics for facility layout. Production line concentrates on mass production management, design and operation of single-model and mixed-model lines and buffer stocks. Lastly, definitions, objectives, principles, equipment selection of material handling are discussed. |

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| Code | **IE476** |
| Name | **Logistics Engineering** |
| Hour per week | 3 (3 + 0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate/4 |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites | IE212, IE213, IE221 |
| Content | Introduction to business logistics. Facility Location Decisions. Covering Problems. Center and Median Problems. Fixed Charge Facility Location Problems. Transportation Decisions. Vehicle routing problems. Inventory policy decisions. Storage and handling systems. Combined models. Contemporary issues (Carbon footprint, sustainability, information systems etc.). |

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| Code | **IE477** |
| Name | **Inventory Models** |
| Hour per week | 3 (3+0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate/ 4 |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites | IE212, IE213 |
| Content | The course introduces the context of inventory management, basic economic order quantity model, quantity discounts, single item inventory models, time variant demand, models with perishable goods, coordinated replenishment, multi-echelon inventory systems |

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| Code | **IE478** |
| Name | **Scheduling** |
| Hour per week | 3 (3+0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate/ 4 |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites | IE212, IE213, IE375 |
| Content | The course introduces machine (resource) scheduling problems of manufacturing and service systems and techniques for solving these problems. The topics covered in this course are (i) machine scheduling: deterministic single machine, flow shop, and job shop scheduling, (ii) project scheduling: overview of CPM (critical path method) and PERT (project evaluation and review technique), workforce scheduling, crew scheduling. |

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| Code | **IE 482** |
| Name | **Economics of Healthcare** |
| Hour per week | 3 (3+0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate / 4 |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites |  |
| Content | In this course we will use mathematical models to investigate how different aspects of the health care system function and to assess the implications for different policies designed to improve that functioning. We will use tools and techniques to (i) master different economic techniques in the context of health care markets and (ii) learn about the specific institutional details and policies relevant to those markets. |

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| Code | **IE484** |
| Name | **Optimization Models in Health Care** |
| Hour per week | 3 (3 + 0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate / 4 |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites | IE212, IE213, IE221, IE335 |
| Content | This course introduces utilization of different optimization techniques such as Markov decision processes, stochastic programming and dynamic programming on optimization applications in healthcare operations management including appointment and operating room scheduling, capacity planning, staff scheduling, healthcare facility location, organ allocation and transplantation, radiation therapy treatment planning, breast cancer screening, and vaccine design. |

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| Code | **IE486** |
| Name | **Healthcare Operations Management** |
| Hour per week | 3 (3+0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate / 4 |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites |  |
| Content | This course demonstrates the important relationship between operations research and the management of complex health care delivery organizations. It will focus on the formulation of competitive strategy in operations management decision areas, including strategic planning, process design, quality control, and staff allocation. This course will be of interest to future health care delivery system managers, operations consultants, and decision-makers in organizations that support health care delivery. |

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| Code | **IE488** |
| Name | **Healthcare Policy Analysis** |
| Hour per week | 3 (3+0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate / 4 |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites |  |
| Content | The course is designed to develop the skills required to define researchable policy questions, critically analyze policy issues and problems, articulate relevant policy options and bring research skills and data to help frame decision-making. |

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| Code | **IE489** |
| Name | **Optimization in Medicine and Biology** |
| Hour per week | 3 (3+0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate / 4 |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites | IE212 |
| Content | The course is designed to cover a wide range of possible areas of biology and medicine. This course is designed to advance a student’s ability to interpret experimental biological data and to construct primary mathematical descriptions of the phenomenon under investigation. It provides with wide comprehension of statistical nature underlying biological data together with competence to operate basic mathematical models in biology. |

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| Code | **IE497** |
| Name | **Systems Analysis and Design Project I** |
| Hour per week | 4 (4 + 0) |
| Credit | 4 |
| ECTS | 10 |
| Level/Year | Undergraduate / 4 |
| Semester | Fall |
| Type | Compulsory |
| Prerequisites | IE221, IE213, IE212, IE222, IE375, IE376 |
| Content | This course is the first of two-quarter capstone sequence. The course is a good means for improving university-industry collaboration. The students will gain ability to design a complex system, process, device, or product to solve a real-world problem. In this context, the students will analyze the system, determine the problem(s) in the system, develop conceptual and mathematical models of the system, apply models to solve the problem(s), and prepare a project report. The project will be team-based and conducted to solve a real problem of an organization or a research problem under the supervision of academic and industry advisors. Students are expected to complete the problem analysis and model development phases in the first quarter. |

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| Code | **IE498** |
| Name | **Systems Analysis and Design Project II** |
| Hour per week | 4 (4 + 0) |
| Credit | 4 |
| ECTS | 10 |
| Level/Year | Undergraduate / 4 |
| Semester | Spring |
| Type | Compulsory |
| Prerequisites | IE221, IE213, IE212, IE222, IE375, IE376, IE497 |
| Content | This course is the first of two-quarter capstone sequence. The course is a good means for improving university-industry collaboration. The students will gain ability to design a complex system, process, device, or product to solve a real-world problem. In this context, the students will analyze the system, determine the problem(s) in the system, develop conceptual and mathematical models of the system, apply models to solve the problem(s), and prepare a project report. The project will be team-based and conducted to solve a real problem of an organization or a research problem under the supervision of academic and industry advisors. Students are expected to apply the proposed solution methodology to solve the problem, to complete the report, and present the project to an audience in this quarter. |

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| Code | **IE499** |
| Name | **Industry 4.0** |
| Hour per week | 3 (3 + 0) |
| Credit | 3 |
| ECTS | 5 |
| Level/Year | Undergraduate / 4 |
| Semester | Fall or Spring |
| Type | Elective |
| Prerequisites | IE212, IE213, IE221, IE222, IE325 |
| Content | Industry 4.0, also known as the fourth industrial revolution, is a name for the current trend of automation and data exchange in almost all sectors even though the focus is on manufacturing technologies. It includes cyber-physical systems, the Internet of things, cloud computing and cognitive computing, modeling and simulation, and data analytics. The course addresses the concept and implementation of Industry 4.0 together with how industrial engineering and operations research can be useful in several areas of Industry 4.0. |